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Strategic industrial policy in the European Union: the uneven geography of Important Projects of Common European Interest (IPCEIs) participation

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ABSTRACT

This article examines whether Important Projects of Common European Interest (IPCEIs) mitigate or intensify inequalities in the geography of state aid across European Union (EU) Member States. It provides the first systematic empirical assessment of IPCEI distribution across all initiatives approved up to 2025. Integrating core-periphery dynamics with state capacity, strategic coupling in European value chains and path dependence, it argues that IPCEIs create upgrading opportunities only where sectoral alignment and administrative capabilities jointly meet demanding project requirements. The analysis shows that absolute IPCEI support is heavily concentrated in core economies, while several peripheral and semi-peripheral countries display disproportionate commitment intensity relative to their overall state aid. Participation does not map onto a simple core-periphery rift; instead, a multi-tier structure is emerging as a subset of lower-capacity states remains consistently excluded. Overall, IPCEIs operate as selective levelling mechanisms: they can enable peripheral upgrading under specific conditions while simultaneously reinforcing stratification in EU industrial policy governance, such that core dominance is not incidental but structurally embedded in how the instrument operates.

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Introduction

For decades the European Union's (EU) *de facto* industrial policy was shaped by ordoliberal principles that prioritised competitive neutrality and restricted selective state intervention (Bulfone 2022). A confluence of crises, geopolitical tensions and structural

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dislocations has challenged this market-centric consensus (McNamara 2023, Terzi *et al.* 2023, Veugelers *et al.* 2024). A first rupture emerged in 2018, when the United States imposed tariffs on European steel and aluminium under national security provisions (Section 232 of the Trade Expansion Act of 1962), signalling a 'weaponisation' of trade dependencies, exposing the EU's vulnerability to coercive economic measures (Meunier and Nicolaïdis 2019, Schade 2023). In response, debates on Europe's 'strategic autonomy', industrial resilience and capacity to withstand geopolitical disruption intensified (Harte 2018, Varma 2024).

These concerns became institutionalised under the von der Leyen Commission, which introduced a discourse of 'open strategic autonomy' and 'technological sovereignty' that marked a shift away from the EU's prior reluctance to use public resources for strategic industrial goals (Haroche 2023, McNamara 2023). The Commission's 2020 New Industrial Strategy framed industrial policy as a tool for resilience and security, sustainability and digital transformation (European Commission 2021b). Subsequent crises further reinforced these priorities. The COVID-19 pandemic exposed deep vulnerabilities in global supply chains (European Commission 2021b). Russia's 2022 invasion of Ukraine destabilised energy security. Simultaneously, the United States' Inflation Reduction Act (IRA) and CHIPS Act intensified global subsidy competition, raising concerns about European deindustrialisation and 'green investment leakage' to more supportive subsidy regimes, as well as about protectionist, trade-distorting measures that risk poaching investment and triggering a hazardous subsidies race (Hobbs 2020, Kleimann *et al.* 2023, Scheinert 2023).

Against this backdrop, Important Projects of Common European Interest (IPCEIs) assumed new prominence. Although created in 2014, IPCEIs became operational only with the approval of the first microelectronics project in 2018 (Meunier and Mickus 2020, Schmitz *et al.* 2025, Seidl and Lopes-Valença 2025). IPCEIs are large, cross-border industrial and innovation initiatives involving a minimum of four Member States, authorised to receive exceptional state aid when they support first-of-a-kind technologies or processes that address market failures of strategic EU relevance and generate benefits that spill over beyond the participating countries (European Commission 2014, 2021a). Between 2018 and 2025, eleven major IPCEIs, covering microelectronics, batteries, hydrogen, cloud infrastructure and health technologies, mobilised more than €104 billion in public and private investment (European Commission 2025). As the EU shifted toward a more interventionist economic governance paradigm, IPCEIs became emblematic of this transition: they constitute an institutionalised mechanism through which Member States can collectively pursue strategic industrial priorities beyond the constraints of traditional state aid rules.

However, the pursuit of open strategic autonomy and rapid de-risking in key value chains does not automatically align with territorial cohesion objectives. In practice, the imperative to mobilise existing industrial strengths swiftly may privilege already-advantaged regions, raising questions about the distributive implications of these new instruments. Indeed, the distributive implications of IPCEIs remain contested. Supporters emphasise their potential to foster pan-European collaboration and industrial upgrading across regions (Di Carlo and Schmitz 2023). Critics argue that their demanding criteria, requiring high co-financing commitments and advanced technological capacities, systematically privilege core Member States with deeper fiscal resources and stronger

administrative infrastructures (Meunier and Mickus 2020). A joint non-paper endorsed by eleven Member States in 2021 criticised IPCEIs for generating an 'uneven playing field' and called for reforms to broaden access (Joint non-paper 2021). Recent scholarship reinforces these concerns: Schmitz *et al.* (2025) show that administrative burdens and stringent conditionalities generate adverse selection and favour actors with high administrative capacity; Gräf (2024) documents how battery IPCEIs privilege technologically advanced firms and core states; and Lavery and Lopes-Valença (2025) demonstrate that semiconductor IPCEIs and CHIPS Act subsidies concentrate resources in longstanding core economies. Whether IPCEIs reinforce core-periphery hierarchies or create new forms of selective convergence thus remains an open empirical question.

Despite these contributions, empirical research remains dominated by sector-specific case studies and qualitative assessments. Systematic, EU-wide quantitative evidence on IPCEI distribution is largely absent. This study addresses that gap by providing a complete empirical assessment of authorised IPCEI state aid across all 27 Member States and all approved initiatives from 2018 to 2025. The analysis moves beyond illustrative cases to map distributional patterns, quantify inequality and explain the mechanisms (core dominance, peripheral marginalisation and selective upgrading) that structure the emerging geography of European industrial policy. IPCEIs are not cohesion-policy instruments in a budgetary sense, but they are justified in terms of 'common European interest' and cross-border spillovers (European Commission 2014, 2021a), raising an empirical question about whether their operation aligns with cohesion ambitions or entrenches cumulative advantage. In other words, the distributive patterns documented in this article should be understood as the *de facto* outcomes of an instrument primarily geared towards strategic upgrading and resilience, rather than as the implementation of an explicitly redistributive cohesion mandate. We therefore ask: through which mechanisms do IPCEIs mitigate or exacerbate inequality in state aid allocation among EU Member States and under what conditions do peripheral economies secure meaningful participation and high relative commitment?

The findings confirm aspects of the 'constrained politics' argument (Schmitz *et al.* 2025), showing extreme concentration of absolute resources and reinforcing concerns about administrative and fiscal barriers to entry. At the same time, the analysis identifies a subset of peripheral and semi-peripheral countries that achieve exceptionally high IPCEI intensity relative to their total state aid budgets. These cases indicate that, under certain sectoral and institutional conditions, strategic alignment and sufficient administrative capacity can allow peripheral actors to exploit upgrading opportunities embedded in IPCEIs. Explaining this pattern requires a framework that integrates core-periphery structures, path dependence, state capacity and strategic coupling within global production networks.

The article is organised as follows. Section 2 introduces four theoretical perspectives as interpretive frameworks for the observed patterns: core-periphery dynamics, state capacity constraints, strategic coupling in innovation networks and path dependence in participation. Section 3 outlines the data and methodological approach. Section 4 reports the empirical results on participation and funding patterns. Section 5 interprets the results through the four theoretical lenses and discusses methodological limitations and avenues for future research. Section 6 synthesises the main findings and sets out policy implications.

Theoretical framework: competing explanations of IPCEI distribution

Core-periphery dynamics and structural hierarchies

A first perspective posits that entrenched core-periphery dynamics in Europe will shape IPCEI allocation. Core-periphery theory emphasises that European integration, rather than equalising development, has historically produced uneven industrial geographies, with core economies retaining diversified high-tech activities and control over value-added networks, while peripheral economies remain locked into subordinate positions within European value chains (Becker *et al.* 2010, Simonazzi *et al.* 2013, Rodrik 2016, Weissenbacher 2019). Given that IPCEIs are large-scale projects requiring co-financing, technological sophistication and coordination, core states are expected to capture a disproportionate share of authorised aid and shape project priorities, while peripheral states face structural constraints and weaker fiscal and industrial bases. This predicts a persistent pattern of core dominance and peripheral marginalisation.

State capacity

A second perspective emphasises cross-national differences in state capacity as a primary determinant of IPCEI participation. In this context, state capacity is multi-dimensional: it includes analytical capacity to evaluate technologies and additionality; legal-administrative capacity to prepare state aid notifications and manage compliance requirements; fiscal capacity to commit multi-year co-financing; and coordination capacity to align ministries, agencies, firms and research organisations in complex cross-border consortia (Besley and Persson 2009, 2011, Bruszt and Campos 2019, Domorenok *et al.* 2021). High-capacity states typically combine competent civil services with specialised expertise, strategic planning and cross-ministerial coordination mechanisms. Low-capacity states, by contrast, may struggle to execute ambitious initiatives even when political will exists, due to administrative fragility and limited developmental policy capabilities (Bruszt and Campos 2018).

In the EU, the deep integration and accession process did spur capacity building in newer Member States, particularly in horizontal, market-enabling domains such as judicial independence, regulatory oversight and autonomous bureaucracies. However, these gains were uneven, often fragile and did not always extend to the sector-specific or developmental capacities required to design and coordinate complex industrial policy instruments (Schimmelfennig and Sedelmeier 2005, 2019, Bruszt and Campos 2019, Vukov 2025). Conversely, deeper integration into European value chains can itself foster capacity building over time, as sustained industrial embeddedness creates demands for specialised agencies, policy learning and cross-ministerial coordination. We therefore treat state capacity and strategic coupling as mutually reinforcing: a minimum threshold of analytical, legal-administrative, fiscal and coordination capacities is required to seize IPCEI opportunities, while sustained participation in European production networks can, over time, generate the specialised capabilities that make such participation feasible.

From this standpoint, institutional capacity is decisive for IPCEI participation because IPCEIs impose demanding administrative and coordination requirements. Governments must assemble and coordinate consortia internationally, navigate complex state aid procedures and demonstrate additionality and spillover effects, while committing substantial

co-financing over multiple years (Schmitz *et al.* 2025). These tasks require specialised competencies in technology assessment, finance and EU competition law, as well as cross-ministerial coordination and participation in transnational policy learning networks (Domorenok *et al.* 2021). Comparative work on broadband state aid governance shows that national governance models condition how complex schemes are designed and implemented (Manica *et al.* 2024).

Strategic coupling in innovation networks

A third perspective draws on economic geography and global production networks theory, particularly the concept of strategic coupling. This approach posits that peripheral and semi-peripheral regions can sometimes secure upgrading opportunities by aligning their local assets with the needs and strategies of focal firms within global production networks (Coe *et al.* 2004, Yeung 2016, 2021). Rather than structural dependence alone determining outcomes, strategic coupling highlights agency and context-specific opportunities. Peripheral regions may possess niche sectoral strengths, natural resources or specialised skills that allow them to become key nodes in transnational production networks, even if they lack diversified industrial structures (Coe *et al.* 2004, MacKinnon 2012, Eder 2018). In the EU context, global production network theory suggests that value chain fragmentation can create 'entry points' for peripheral states, allowing them to specialise in particular segments of strategic sectors (Coe *et al.* 2004, MacKinnon 2012, Yeung 2016, 2021).

Examples include regions leveraging unique natural resources, specialised skills or particular industrial clusters to gain prominence in green hydrogen, renewable energy technologies or battery supply chains. The viability of strategic coupling via IPCEIs will depend on the match between peripheral capabilities and IPCEI project requirements. Radošević (2018) distinguishes between R&D-based innovation capacities (concentrated in core regions) and production capacities (design, engineering, management, manufacturing), which are more widely distributed across peripheral regions. As European value chains are geographically fragmented, some peripheral economies have accumulated specialised competencies on which core firms depend. For instance, Central European countries supply intermediate goods and manufacturing tasks into German production networks (Simonazzi *et al.* 2013), which could enable a meaningful contribution to IPCEIs. However, such coupling often means linking peripheral production platforms with standardised activities that generate limited local spillovers and it is associated with unequal value capture favouring the lead players (Coe *et al.* 2004, Yeung 2021, see also Hickel *et al.* 2022, on macrolevel value appropriation).

The notion of strategic coupling implies that certain peripheral or semi-peripheral countries could derive substantial benefits from IPCEIs, provided they possess specific sectoral assets aligned with the projects. By definition IPCEIs involve cross-border collaboration and integration into European value chains, allowing a well-positioned smaller economy to play a key role despite structural limitations. For example, a country with a strong presence in a particular niche, such as battery raw materials or an established automotive cluster, could assume a central role in a relevant IPCEI, disproportionate to its size (see Camuamba *et al.* 2025). This suggests that strategic coupling via IPCEIs benefits peripheral countries selectively rather than universally, leading to heterogeneous effects that reflect each country's specific position in European value chains.

Path dependence, first-mover advantage and multi-tier participation

Finally, European integration scholarship shows that policy participation can vary across Member States and sometimes harden into stable multi-tier structures. Differentiated integration research distinguishes multi-speed integration (temporary lag) from multi-tier integration (persistent inner and outer circles) (Schimmelfennig and Winzen 2022). While most mapping has focused on monetary union, Schengen or defence, similar dynamics can arise in other domains where participation is voluntary but conditioned by capacities and preferences (Schimmelfennig *et al.* 2022). Where entry costs are high, early participation can generate learning-by-doing advantages and network access that lower future barriers, whereas non-participation can lock states into persistent exclusion.

Although IPCEIs are not a formal enhanced-cooperation mechanism, they resemble a voluntary, capacity-conditioned form of differentiated integration in industrial policy (Eisl 2022). Participation requires fiscal space, administrative knowhow and involvement in relevant industrial activities. Feedback loops may create first-mover advantages: participating in demanding EU frameworks can build essential administrative capacities (Bruszt and Campos 2018), while non-participants forgo learning and coordination gains, raising future entry costs. This self-reinforcing dynamic is closer to a Matthew-effect or first-mover advantage logic than to legal differentiation *per se*, but its likely outcome is similar: an inner circle of repeat IPCEI participants and an outer circle of states that seldom or never join, potentially institutionalising a multi-tier Europe in strategic industries.

Data and methodology

Data sources and operationalisation

Our analysis covers all 27 EU Member States over the period 2018–25, corresponding to the full duration of the eleven approved IPCEIs from the inaugural microelectronics initiative (2018) through the most recent health technology initiatives (authorised in 2024 and 2025). We compile three interconnected datasets to capture both absolute IPCEI allocations and relative national commitments within broader state aid portfolios.

First, we collect official data on public funding authorised under each IPCEI by Member State. This includes approved state aid ceilings for each country's participating firms and projects, based on European Commission authorisation decisions published in the Official Journal. We compile total authorised IPCEI funding per country (in million euro) and the number of IPCEI participations per country. This allows analysis of absolute funding distribution and participation intensity in terms of engagement breadth (Table 1).

Second, we compile macroeconomic and state aid context indicators for each country. We collect GDP data (Eurostat, accumulated 2017–24) and population data (Eurostat, population as of 1 January 2025). We also collect data on each country's total general state aid spending (excluding crisis measures) from the European Commission's State Aid Scoreboard (2017–24). These variables provide measures of economic size, wealth and baseline subsidy capacity (Table 2).

Third, we compute IPCEI intensity as the ratio of total authorised IPCEI funding to total state aid spending. This measure captures the degree to which each Member State prioritised IPCEIs within its overall state aid portfolio. It allows comparison across economies of

Table 1. Public funding authorised for IPCEIs by country and project, 2018–25, and number of IPCEI participations.

Country	1st MIC (2018)	1st BAT (2019)	2nd BAT (2021)	1st H2 (2022)	2nd H2 (2022)	2nd MIC (2023)	CLD (2023)	3rd H2 (2024)	4th H2 (2024)	1st HLT (2024)	2nd HLT (2025)	Total	Number of IPCEIs
AT			55	140	100	256						551	4
BE		75	45	37	206					30		393	5
BG													
CY													
CZ				30		56						86	2
DE	965	1 143	1 750	734		4 506	437	4 676	469			14 680	8
DK				87	41							128	2
EE				46					19			65	2
EL			45	756	26	19						846	4
ES			3	74	1 320	406	187		143	21		2 154	7
FI		36	15	150	244	48						493	5
FR	411	750	125	2 162	319	1 014	40	306	530	614	125	6 396	11
HR			125									125	1
HU							67			65	5	137	3
IE						85						85	1
IT	725	700	625	1 078	497	986	409	991	22	194	226	6 453	11
LT													
LU													
LV													
MT						60						60	1
NL				22	1 329	257	61	86	199			1 954	6
PL		250	25	24	511	103	36	143				1 092	7
PT				45	228			339				612	3
RO						196						196	1
SE		575	55		473							1 103	3
SI											7	7	1
SK			125	36		139		365	59	84	40	848	7

Note: Monetary values are expressed in million euro (mEUR), except for the number of IPCEIs.
Source: Authors' compilation based on European Commission IPCEI State aid authorisation decisions.
Legend: MIC – Microelectronics; BAT – Batteries; H2 – Hydrogen; CLD – Cloud; HLT – Health technologies.

Table 2. Country-level GDP and general state aid (2017–24), population and per-capita indicators.

Country	Accumulated GDP 2017–24 (mEUR)	Population	General state aid 2017–24 (mEUR)	GDP per capita (€/person/year)	General state aid per capita (€/person/year)
AT	3 354 093	9 197 213	16 194	45 586	220
BE	4 136 099	11 900 123	39 395	43 446	414
BG	588 265	6 437 360	3 447	11 423	67
CY	210 429	979 865	946	26 844	121
CZ	2 032 836	10 909 500	26 907	23 292	308
DE	29 975 150	83 577 140	354 808	44 832	531
DK	2 706 497	5 992 734	36 006	56 454	751
EE	253 041	1 369 995	2 475	23 088	226
EL	1 563 720	10 409 547	9 943	18 777	119
ES	10 468 652	49 077 984	94 979	26 663	242
FI	1 995 413	5 635 971	18 722	44 256	415
FR	20 306 067	68 635 943	216 181	36 981	394
HR	500 817	3 874 350	6 441	16 158	208
HU	1 276 867	9 539 502	20 256	16 731	265
IE	3 445 670	5 439 898	11 247	79 176	258
IT	15 179 117	58 934 177	73 340	32 195	156
LT	464 829	2 890 664	4 704	20 100	203
LU	563 343	681 973	1 795	103 256	329
LV	261 258	1 856 932	3 169	17 587	213
MT	133 885	574 250	1 753	29 143	382
NL	7 242 326	18 044 027	36 036	50 171	250
PL	4 888 409	36 497 495	53 834	16 742	184
PT	1 836 261	10 749 635	9 969	21 353	116
RO	2 031 336	19 036 031	15 174	13 339	100
SE	4 067 895	10 587 710	34 215	48 026	404
SI	423 365	2 130 850	3 751	24 835	220
SK	829 702	5 419 451	4 255	19 137	98

Source: Eurostat (GDP and population, population as of 1 January 2025); European Commission, State Aid Scoreboard (general state aid, 2017–24). GDP and general state aid in current prices. General state aid (non-crisis aid).

different sizes and fiscal capacities. High intensity indicates that a country devoted a large share of its state aid budget to IPCEIs, reflecting strategic prioritisation of these projects relative to other subsidy instruments (Figure 1). This measure directly tests whether IPCEIs enable peripheral upgrading through selective resource concentration, as strategic coupling theory predicts.

We classify Member States into core, semi-peripheral and peripheral categories following Weissenbacher's (2019) structural typology of European capitalism. This classification accounts for historical trajectories of productive capacity development, technological infrastructure density, position within cross-border value chains and patterns of trade specialisation. Weissenbacher's typology is particularly suited to our research question because it operationalises core-periphery status in terms of productive structure and value-chain position rather than income alone and it distinguishes semi-peripheral cases that combine medium-technology production with partial upgrading. At the same time, we use this typology heuristically rather than normatively: it structures our initial expectations about uneven participation, but the subsequent analysis develops an empirically grounded, finer-grained topology of IPCEI engagement that can diverge from these prior categories. Core countries (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, Netherlands, Sweden; n = 10) exhibit advanced manufacturing capabilities, dense innovation networks and high value-added specialisations. Semi-peripheral countries (Cyprus, Czech Republic, Italy, Malta, Slovenia, Spain; n = 6) combine medium-technology manufacturing with segments of lower value chain

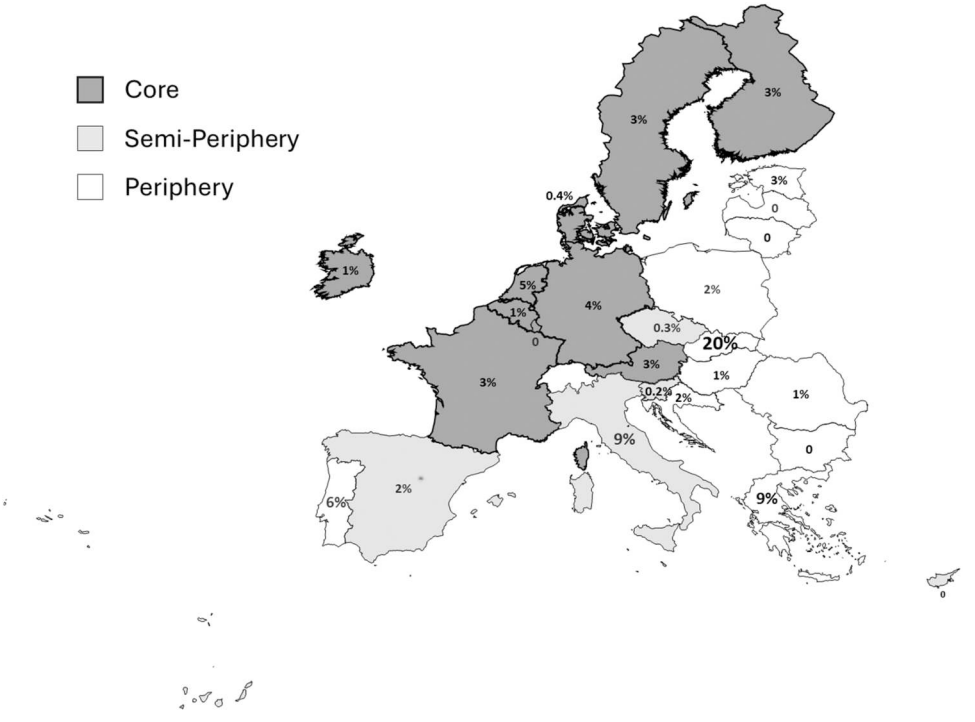


Figure 1. IPCEI intensity by Member State (IPCEI aid as a share of general state aid, percentage).
Source: Authors' elaboration.

integration. Peripheral countries (Bulgaria, Croatia, Estonia, Greece, Hungary, Latvia, Lithuania, Poland, Portugal, Romania, Slovakia; n = 11) predominantly occupy subordinate positions in European production networks, with lower technological intensity and greater dependence on cost-based competition. All the data collected is included as supplementary material.

One observation must be noted in relation to data collection. The IPCEI dataset covers 2018–25, corresponding to the full set of Commission authorisations available at the time of data collection. For macroeconomic and general state aid indicators, the most recent complete data available refer to 2017–24; this window ensures an equivalent eight-year coverage across datasets while relying exclusively on officially published figures.

Theoretical expectations and hypotheses

The analytical approach is structured around four complementary theoretical perspectives that generate distinct, though not mutually exclusive, predictions about IPCEI distribution patterns.

Core-periphery theory predicts that IPCEIs, as strategic industrial instruments requiring advanced technological capacity, substantial co-financing and sophisticated governance capabilities, will predominantly benefit core economies. The structural advantages of core regions (superior fiscal resources, established innovation ecosystems, historical governance influence over EU institutions and proven track records in complex European

programmes) position them to dominate both absolute funding and governance control. We therefore expect (H1) extreme concentration of total IPCEI funding in core Member States, exceeding their share of EU GDP, with peripheral countries accessing disproportionately small allocations. Moreover, we anticipate that core countries will coordinate the majority of IPCEI initiatives, institutionalising their gatekeeping role. If confirmed, this would imply that, notwithstanding spillover requirements and pan-European rhetoric, IPCEIs operate in practice as accumulative instruments that can reinforce territorial asymmetries.

State capacity theory emphasises that IPCEI participation imposes stringent administrative requirements. Governments must possess sufficient technical expertise, administrative competence and institutional coordination mechanisms to design and implement complex industrial projects. Peripheral states may be excluded not only due to structural economic weakness but due to institutional deficiencies. We expect (H2a) that variation in IPCEI intensity among peripheral states will be explained by differences in state capacity: higher-capacity peripheral states will show greater participation and intensity, while low-capacity states will remain absent. We also expect (H2b) that some wealthy states may exhibit low participation if their sectoral structures are poorly aligned with IPCEI domains, indicating that wealth alone is not a sufficient predictor.

Strategic coupling theory suggests that IPCEIs can provide selective upgrading opportunities for peripheral states that possess relevant sectoral assets and strategic alignment with EU industrial priorities. This predicts (H3) that some peripheral and semi-peripheral countries may exhibit disproportionately high IPCEI intensity, devoting large shares of their state aid budgets to IPCEIs, despite receiving relatively small absolute funding. Such high intensity would reflect strategic prioritisation and sectoral coupling rather than overall subsidy capacity. We expect these cases to be concentrated among peripheral countries with niches in strategic value chains such as automotive manufacturing (battery IPCEIs), renewable energy potential (hydrogen IPCEIs) or digital governance strengths (cloud IPCEIs).

Path dependence and *first-mover advantage* perspectives examine how variable participation across policy domains can harden into multi-tier membership structures through self-reinforcing feedback mechanisms. Initial participation generates policy expertise, network relationships, institutional track records and credibility with Commission evaluators, advantages that reduce barriers to subsequent engagement. Conversely, initial non-participation deprives countries of learning opportunities, network access and demonstration effects, raising entry costs for future projects. We therefore expect (H4) emerging multi-tier patterns in IPCEI participation: an 'inner circle' of repeat participants accumulating advantages (predominantly core countries plus select high-capacity peripheral states) and an 'outer circle' of systematically excluded countries unable to overcome administrative and fiscal barriers. Temporal analysis should reveal (H4a) that participation rates accelerate for early adopters while persistently excluded countries remain absent over successive IPCEI waves and (H4b) that geographic concentration in early IPCEIs solidifies rather than diffuses. This expectation is closely aligned with a Matthew-effect/first-mover advantage mechanism and does not require IPCEIs to be a formal differentiation instrument.

Analytical strategy

We apply a multi-method approach combining descriptive analysis, inequality metrics, clustering algorithms, inferential techniques and econometric approaches to capture the complexity of IPCEI distribution. The analysis proceeds in five steps.

Descriptive analysis and inequality measurement

First, we compute descriptive statistics on the distribution of IPCEI funding, identifying total authorised funding per country and participation counts. We compare country shares of total IPCEI funding with their shares of EU GDP to assess disproportionality and examine governance dominance by identifying IPCEI coordinators.

Second, we calculate inequality and concentration measures. We compute the Gini coefficient for IPCEI funding distribution among Member States to quantify inequality, comparing it to the Gini coefficient for GDP distribution. We also compute the Herfindahl-Hirschman Index (HHI) for IPCEI funding to assess concentration, using standard thresholds for interpreting market concentration (European Commission 2004). These metrics provide a formal basis for evaluating core-periphery partition.

Nonparametric statistical tests

Third, we test group differences across core, semi-periphery and periphery categories (H2a, H3). Given our full sample data ($N = 27$) and non-normal IPCEI intensity distribution (Shapiro-Wilk $p < 0.001$), we use nonparametric Kruskal-Wallis rank-sum tests to assess whether median IPCEI intensity differs across these categories. If significant, we perform pairwise Mann-Whitney U tests to identify which group differ.

Fourth, we examine correlational relationships between IPCEI outcomes and economic indicators. We compute Spearman rank correlations between IPCEI intensity and GDP per capita, as well as between total IPCEI funding and GDP, to assess whether wealth and size predict participation.

Quantile regression analysis

Fifth, we model heterogeneity using quantile regression. Quantile regression estimates the conditional distribution of IPCEI intensity across different percentiles – $\tau = 0.25$, 0.50, 0.75, 0.90 (Koenker and Bassett 1978), corresponding to low, median, high and top participation levels –, allowing us to examine whether predictors (GDP per capita, state aid per capita, core-periphery category) have different effects for low-intensity versus high-intensity countries. This is important given the expected heterogeneity within the periphery.

Hierarchical cluster analysis

Finally, we perform hierarchical cluster analysis (Ward's method) on standardised variables (IPCEI intensity, GDP per capita, state aid per capita and number of IPCEIs) to identify clusters of countries with similar participation patterns. Ward's method merges clusters by minimising the increase in within-cluster variance at each step, producing compact, well separated clusters. We use the elbow method and theoretical interpretability to decide on the number of clusters. Cluster analysis helps uncover patterns that may cut across core-periphery categories, capturing multi-dimensional participation strategies.

Results

Distribution of IPCEI funding and participation

A descriptive mapping reveals markedly skewed allocation of IPCEI resources across Member States. Germany and France alone account for €14.68 billion and €6.40 billion respectively, securing 55 per cent of all approved IPCEI state aid, far above their combined 42 per cent share of EU GDP. Including Italy, the three largest contributors control over 71 per cent of all allocated resources, compared to their combined 54 per cent share of EU GDP. In contrast, several countries (primarily in Eastern and Southern Europe) allocated negligible shares or none at all (Bulgaria, Cyprus, Lithuania, Latvia and Luxembourg report zero participation). In terms of power and influence, it is worth noting that Germany and France coordinated ten of the eleven IPCEIs, while the remaining IPCEI was coordinated by the Netherlands.

Relative commitment, measured by IPCEI intensity, although also skewed, diverges significantly from absolute funding patterns. While core economies dominate in total funding, several peripheral and semi-peripheral countries exhibit the highest intensity values: Slovakia (19.9 per cent), Italy (8.8 per cent), Greece (8.6 per cent) and Portugal (6.1 per cent). Notably, this intensity is not a simple function of economic size, since some less affluent states devoted a much larger portion of their state aid to IPCEIs than wealthier states.

Inequality and concentration metrics

Formal measures confirm the intuition of extreme concentration. The Gini coefficient for the distribution of approved IPCEI funding among Member States is 0.78, substantially higher than the Gini for GDP (0.66), indicating a much more uneven allocation than economic size alone would predict. The Herfindahl-Hirschman Index (HHI) for IPCEI funding is 2106, implying a highly concentrated distribution according to the usual thresholds (European Commission 2004). A small set of countries thus holds a disproportionate share of resources and, by extension, influence in shaping these projects.

Group differences: core, semi-periphery, periphery

Nonparametric tests offer a more detailed picture of group dynamics. The Kruskal-Wallis H-statistic ($H = 0.33$, $p = 0.85$) finds no statistically significant differences in median IPCEI intensity across the core, semi-periphery and periphery groups, suggesting that broad geographic category by itself is not the primary driver of relative participation. Pairwise Mann-Whitney comparisons likewise reveal no significant differences between any two groups ($p > 0.59$). However, descriptive patterns show that while the peripheral category contains both the lowest and highest intensity values, most peripheral countries cluster at the very low end or have no participation, whereas a small subset (notably Slovakia, Greece and Portugal) stand out with exceptionally high intensities, suggesting a bimodal structure rather than a monotonic trend.

Correlational structure: economic size, wealth and intensity

Spearman rank correlations confirm the role of economic size in absolute funding but not in intensity. Total IPCEI funding is strongly and significantly associated with national GDP

($\rho = 0.84$, $p < 0.001$) as well as with total state aid spending ($\rho = 0.82$, $p < 0.001$), meaning the largest economies secured the greatest funding. By contrast, IPCEI intensity shows essentially no correlation with GDP per capita ($\rho = 0.14$, $p = 0.48$), reinforcing that a country's relative prioritisation of IPCEIs is not explained by its economic prosperity.

Quantile regression: heterogeneous effects across the distribution

Quantile regression results reveal heterogeneity consistent with selective peripheral success. Across the participation distribution, GDP per capita and state aid per capita have coefficients near zero (with confidence intervals spanning zero), indicating limited association with IPCEI intensity for most countries. However, at the 90th percentile (the top performers), the model explains more variance (Pseudo-$R^2 = 0.20$). In this top tier, peripheral countries achieve higher relative intensity than core states. Notably, Slovakia, combining one of the lowest GDP per capita and state aid per capita with the highest IPCEI intensity, demonstrates that strategic sectoral alignment and focused commitment, rather than fiscal capacity, are critical determinants of exceptional outcomes. This provides quantitative support for the strategic coupling hypothesis.

Ward's method: Clustering IPCEI participation across EU countries

Agglomerative cluster analysis (Ward's method on four standardised variables – IPCEI intensity, GDP per capita, state aid per capita and number of IPCEI projects) identifies four distinct profiles:

(1) Wealthy low-engagement states (IE, LU): Extremely high GDP per capita but low IPCEI engagement.
(2) Core participants (AT, BE, DE, DK, FI, FR, NL, SE): Core countries with high capacity and consistent (though not extreme) IPCEI involvement.
(3) Low or non-participants (BG, CY, CZ, EE, HR, HU, LT, LV, MT, RO, SI): Mostly peripheral or semi-peripheral with marginal or no participation and below average resources.
(4) High-intensity mixed participants (EL, ES, IT, PL, PT, SK): A mix of core and peripheral countries distinguished by high IPCEI intensity and participation in multiple projects, despite having only average or below average fiscal capacity.

These profiles show that IPCEI participation cannot be reduced to a simple core-periphery divide. The periphery is bifurcated between a large low-participation group and a small 'all-in' group with exceptionally high intensity. Core countries are also not monolithic: most are consistent participants, but the two wealthiest economies (measured in terms of GDP per capita) cluster as low-engagement cases, indicating that sectoral structure and strategic orientation may matter alongside capacity. Figure 2 presents the Ward's-method hierarchical clustering dendrogram for the 27 Member States, based on standardised IPCEI intensity, GDP per capita, state aid per capita and IPCEI project counts and visually identifies the four-cluster structure (wealthy low-engagement states, core participants, low or non-participants and high-intensity mixed participants).

Goodness-of-fit metrics support the four-cluster solution: the Silhouette Score (0.37) reaches its maximum at $k = 4$ among tested partitions ($k = 2$–7), indicating optimal within-

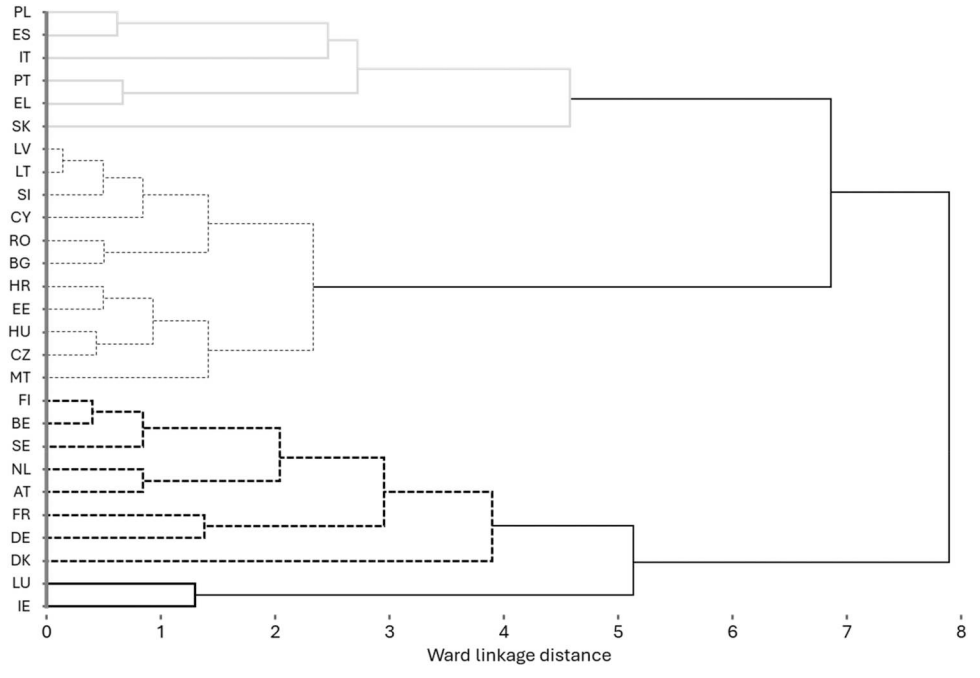


Figure 2. Clusters of EU countries by IPCEI engagement.
Source: Authors' elaboration (hierarchical clustering dendrogram, Ward's method).

cluster cohesion relative to between-cluster separation. The Calinski-Harabasz index increases from three to four clusters and the Davies-Bouldin index decreases, supporting k = 4 as balancing separation and cohesion. These findings mean the solution captures meaningful groupings without artificially inflating distinctions and the interpretation above remains robust.

Summary of empirical patterns

Three main patterns emerge. First, absolute IPCEI funding and leadership are extremely concentrated in core economies, consistent with core-periphery theory. Second, a subset of peripheral and semi-peripheral countries achieved remarkably high IPCEI intensity that cannot be explained by their size or overall subsidy levels, highlighting the importance of context specific alignment and capacity (as suggested by strategic coupling and state capacity perspectives). Third, participation has not spread evenly: a pronounced multi-tier structure is evident, with certain lower capacity peripheral states consistently excluded and strong path dependence favouring early entrants. These findings provide a balanced empirical foundation for comprehending the distributive, strategic and integrative ramifications of the IPCEI instrument within the context of the European political economy.

Discussion

This study set out to ask whether IPCEIs, as a type of EU-backed interventionism, mitigate or exacerbate inequalities in state aid allocation across the European Union. Using

comprehensive data covering all 27 Member States and eleven IPCEI initiatives (2018–25), our multi-method analysis finds a complex answer. IPCEIs simultaneously concentrate absolute resources in core economies, enable selective peripheral upgrading through strategic coupling and produce emergent multi-tier participation patterns via path dependence and first-mover advantage. Given that IPCEIs authorise national subsidies rather than EU budgetary transfers, any cohesion-relevant effects are indirect and contingent on how the instrument operates in practice. We next interpret these findings, consider theoretical implications, note methodological limitations and outline policy implications.

Interpreting the findings: conjunctural causation and complex outcomes

Our three core empirical findings (extreme core concentration, selective peripheral prioritisation and persistent multi-tier exclusion) are not contradictory but rather interrelated elements of a complex causal puzzle. Each operates at a different analytical level and together they illustrate conjunctural causation: outcomes shaped by multiple causal mechanisms interacting (Mahoney 2000, Ragin 2000). No single theoretical perspective fully accounts for IPCEI distribution patterns; instead, their combination produces the configuration we observe.

Core-periphery dynamics provide the underlying structure and explain the pronounced absolute concentration. Industrially advanced economies with diversified high-tech sectors, superior fiscal resources, established innovation ecosystems and structural influence over EU governance naturally dominate innovation-focused instruments. Germany and France's capture of 55 per cent of total IPCEI funding, their coordination of more than 90 per cent of all initiatives and the core's collective ∼67 per cent share (exceeding their ∼64 per cent of EU GDP) directly confirm structural political economy expectations. Moreover, the institutional design of IPCEIs, demanding co-financing, complex approval procedures, stringent additionality criteria, functions as a *de facto* gatekeeping mechanism privileging experienced, well-resourced actors embedded in EU networks (Eisl 2022, Schmitz *et al.* 2025). Core dominance is thus not incidental but structurally embedded in how IPCEIs operate.

State capacity helps explain why peripheral outcomes vary so widely, from Slovakia's 19.9 per cent intensity to Bulgaria's zero participation, despite similar structural constraints. IPCEI participation imposes hidden institutional demands: analytical capacity to develop sophisticated proposals, specialised legal expertise in state aid law, multi-year fiscal coordination for co-financing and interministerial alignment across industrial, innovation and regional policies (Besley and Persson 2009, 2011). Quantile regression confirms that wealth alone does not determine engagement: economic variables (GDP per capita, state aid per capita) were insignificant across most of the distribution. Instead, context-specific administrative capabilities make the difference and they condition whether strategic coupling opportunities can be translated into successful participation. Estonia's participation in two IPCEI initiatives contrasts sharply with Latvia and Lithuania's total exclusion despite comparable economic profiles and EU accession timelines, directly demonstrating capacity's decisive role. This explains the emerging multi-tier stratification: countries with above-threshold institutional effectiveness navigate IPCEI procedures successfully, while those lacking such capacity remain systematically excluded regardless of upgrading needs or sectoral potential.

Strategic coupling accounts for the exceptional intensity achievements of certain peripheral countries. Slovakia (19.9 per cent), Italy (8.8 per cent), Greece (8.6 per cent) and Portugal (6.1 per cent) attained disproportionate IPCEI intensity because they aligned pre-existing sectoral assets with IPCEI project requirements (Coe *et al.* 2004, Yeung 2021). Slovakia's automotive manufacturing base aligned with battery IPCEIs amid the electric vehicle transition; Greece's renewable energy endowment positioned it as a plausible hydrogen hub; and Portugal leveraged its capabilities in renewable energy for hydrogen-related projects. The cluster analysis corroborates this mechanism: these countries form a profile defined by high-intensity commitment despite much lower GDP per capita, transcending predefined core-periphery categories. Strategic coupling thus enables selective upgrading, but it presupposes foundational assets and a minimum threshold of institutional capacity, which most peripheral states do not possess.

Path dependence and first-mover advantage help explain how initial disparities harden into lasting multi-tier divisions through self-reinforcing feedback loops. IPCEI participation generates policy expertise, network relationships, institutional track records and credibility with Commission evaluators, advantages that lower barriers to future entry. Conversely, exclusion deprives countries of learning opportunities, network access and demonstration effects, raising the costs of subsequent engagement. Our temporal analysis illustrates this dynamic: core countries reached 50 per cent participation by the second IPCEI, while peripheral countries hit that threshold only by the fifth; after eleven initiatives, several Eastern states (Bulgaria, Latvia, Lithuania, Cyprus) remain entirely absent. This reflects multi-tier rather than a purely multi-speed dynamic (Schimmelfennig and Winzen 2022). At the same time, low engagement does not always imply incapacity: Ireland and Luxembourg combine very high GDP per capita with minimal IPCEI participation, suggesting that sectoral structure and strategic orientation may reduce incentives to engage. Hungary's more modest intensity may likewise reflect strategic choices about investment partners and instrument mixes. These interpretations are necessarily tentative without dedicated case evidence, but they highlight that participation is shaped by both constraints and strategy.

Analytical and policy contributions

Our findings advance several debates. First, for *EU industrial policy* research, we provide the first systematic empirical assessment of IPCEI distribution across the entire EU-27 population. Prior work focused on individual cases (Schmitz *et al.* 2025), legal analysis of state aid rules (Boronat 2024) or normative arguments about legitimacy (Meunier and Mickus 2020) without comprehensive comparative data. By combining inequality metrics, non-parametric tests, quantile regression and clustering, we document not only that IPCEIs concentrate resources but how this concentration interacts with selective successes and exclusions, revealing a complex stratification invisible to single-method analyses.

Second, for *core-periphery* theory in European political economy, our results show that geographic and structural hierarchies remain highly consequential, but they do not fully determine IPCEI outcomes. Absolute funding concentration does validate structural predictions (Becker *et al.* 2010, Weissenbacher 2019), but relative intensity patterns and the cluster results defy a linear core-periphery model. The peripheral group is bifurcated –

seven countries excluded or marginal (Cluster 3), four achieving exceptional intensity (Cluster 4). This suggests that peripherality is not an immutable condition but the product of specific national capabilities and strategic decisions that enable or constrain participation. Peripheral success is clearly conditional rather than automatic, requiring specific conjunctures of sectoral fit, administrative capacity and strategic orientation that most peripheral states lack. This nuance refines dependency perspectives: structural hierarchies powerfully shape outcomes but do not entirely preclude upgrading by agile peripheral actors.

Third, for *state capacity* literature, we extend recent European integration scholarship (Bruszt and Campos 2019, Vukov 2025) by showing that capacity asymmetries directly translate into participation gaps in strategic domains beyond traditional single market integration. The Estonia-Latvia-Lithuania comparison provides quasi-experimental evidence: controlling for economic structure, EU accession timing and geography, variation in administrative capacity (Estonia's strength) explains IPCEI participation differences. This validates Besley and Persson's (2011) argument that complex policy implementation hinges on multi-dimensional institutional capabilities, not merely political will or formal eligibility. Furthermore, the low R^2 values across our regressions, even with advanced techniques, suggest that qualitative institutional factors (specialisation, coordination mechanisms, policy networks) are more important than standard quantitative indicators. This supports the need for mixed-method approaches: statistical analysis to map broad patterns combined with in-depth case studies to unpack the institutional specifics.

Fourth, for *differentiated integration* scholarship, we document an emergent multi-tier pattern in a policy domain not usually covered by differentiation research. Schimmelfennig and Winzen's (2022) mapping focused on traditional areas (monetary union, Schengen, defence); we extend attention to industrial policy, showing that even a voluntary opt-in instrument can produce stratification when capacity barriers and first-mover advantages exist. Our temporal and cluster analyses reveal path dependence: early exclusion often leads to continued absence and early participation begets repeated engagement. This self-reinforcing 'Matthew effect' in industrial policy threatens permanent stratification unless deliberate countermeasures (capacity-building, geographic balance criteria, greater EU co-financing) intervene. The policy implication is stark: without proactive inclusiveness mechanisms, IPCEIs risk institutionalising a two-speed Europe in strategic industries, with troubling legitimacy consequences for peripheral states already sceptical of EU industrial governance (Bruszt and Vukov 2024).

Fifth, for *economic geography* and global production networks, we contribute evidence of strategic coupling operating at the national level within a regional integration context, extending literature typically focused on subnational regions (Coe *et al.* 2004, Yeung 2021). Slovakia, Greece and Portugal exemplify how peripheral countries (not just regions) can leverage sectoral assets to position themselves as indispensable nodes in transnational value chains, achieving influence beyond their structural position. However, our findings also support Manning and Richter's (2023) caution that successful coupling requires 'upgrading against the odds': deliberate institutional work to build exchange relationships, not automatic gains from network insertion. The quantile regression result that peripheral high-performers concentrate resources intensively (high IPCEI intensity despite low state aid per capita) suggests coupling succeeds

through strategic prioritisation rather than resource abundance, a finding relevant for industrial policy design in resource-constrained contexts.

Methodological limitations

Several caveats are warranted. First, our statistics describe the EU-27 context in 2017–25; they are not intended to support broad inference beyond this context.

With N = 27 and multiple covariates, regression models face limited degrees of freedom. We cannot control for the full range of potential confounders (for example, sectoral composition, R&D intensity, historical structural funds, political orientation, regulatory quality, network embeddedness) that qualitative case studies consider. The persistently low R^2 values (0.07–0.20 in our quantile regressions; 0.09 in OLS) underscore that much of IPCEI participation depends on context-specific qualitative factors not captured by parsimonious quantitative models. This is not a failure of the analysis but a substantive insight: institutional capacity, sectoral specialisation and strategic network positioning are crucial and understanding them fully requires qualitative investigation. Our quantitative results should be read as consistent with mechanisms rather than as causal estimates, providing motivation and boundaries for follow-up case research.

IPCEI data reflect authorised aid ceilings, not actual disbursements or realised impacts, so we assess ex ante commitments and the distributive logic at approval rather than implementation effectiveness. Future research tracking disbursement and outcomes (as data become available) can determine whether initial advantages persist, widen or narrow through implementation.

While our data span 2018–25, the small number of discrete IPCEI initiatives (eleven projects) and uneven timing limit rigorous longitudinal analysis. Our approach remains fundamentally cross-sectional, comparing participation patterns across countries rather than tracing within-country changes over time. We document patterns, measure inequality, test differences and examine associations, providing a robust descriptive characterisation and evidence consistent with certain mechanisms, but we do not establish causation. Future studies employing quasi-experimental designs (for example, synthetic control comparisons of IPCEI participants vs. similar nonparticipants) or process-tracing case studies could strengthen causal claims.

Quantile regression coefficients describe conditional quantile associations, not causal effects. Even where GDP per capita's coefficient is statistically small and remains negative across the conditional distribution, this pattern does not prove wealth causes high intensity for top performers; unmeasured variables (for example, institutional quality or network centrality) could be driving the relationship. Moreover, quantile estimates can be sensitive to outliers at distribution tails; with N = 27, the 90th percentile result should be interpreted cautiously (Slovakia's exceptional case may exert outsized influence). We attempted alternative quantiles (0.60, 0.80) to check robustness, but sample-size constraints remain and the substantive conclusions are therefore tentative rather than definitive.

Cluster analysis involves discretionary choices (linkage method, distance metric, cluster number) that influence results. We applied Ward's method and identified a four-cluster solution that showed theoretical coherence (supported by pseudo-F and silhouette measures). Alternative approaches (k-means, Gaussian mixtures, different linkage criteria)

might yield different groupings; testing multiple algorithms would assess robustness. Nonetheless, our core substantive finding, that countries cluster by participation strategy rather than purely by geography, held across reasonable variations, strengthening confidence in our interpretation.

Despite these limitations, the convergence of evidence across methods (inequality metrics, rank tests, quantile regression, cluster analysis) provides a robust portrayal of IPCEI distribution. The consistency of conclusions across these approaches suggests that the observed patterns (extreme concentration, selective peripheral success, emerging multi-tier stratification) reflect genuine dynamics rather than methodological artifacts.

Avenues for future research

A number of research avenues emerge from the findings. Longitudinal analyses tracking IPCEI participants over time could employ quasi-experimental methods (for example, synthetic control or difference-in-differences) to estimate causal effects on industrial performance, employment and innovation. Such analyses would reveal whether participation leads to measurable upgrading, whether benefits accrue primarily to core leaders and whether IPCEI-driven collaborations produce technological spillovers for peripheral actors or mainly reinforce core advantages.

Comparative case studies of successful and unsuccessful peripheral engagement (for example, Slovakia vs. Poland, both with strong presence in the automotive value-chain) could clarify what enables effective strategic coupling. Process-tracing the proposal stage, consortium building and Commission interactions would help uncover the micro-foundations of how some peripheral states overcome the odds to participate.

Cross-national surveys of government officials and firms involved in IPCEIs could pinpoint perceived barriers and capacity gaps. Identifying which administrative challenges (for example, technical expertise or interministerial coordination) most hinder participation would inform targeted capacity-building and technical assistance initiatives.

Analysing where IPCEI funds go within countries would show whether concentration occurs internally. For example, much of Germany's €14.68 billion likely went to leading industrial regions (for example, Baden-Württemberg, Bavaria) and much of France's €6.40 billion probably concentrated in Île-de-France and Auvergne-Rhône-Alpes. Understanding intranational concentration would reveal if IPCEIs risk exacerbating regional inequalities domestically.

Finally, analyses could examine how IPCEI outcomes influence national preferences on industrial policy. States consistently excluded from IPCEIs may advocate alternative, more inclusive instruments (emphasising cohesion), whereas high-intensity peripheral participants might champion IPCEIs as vehicles for their advancement. Mapping these coalitions would clarify the political feasibility of reforms aimed at making IPCEIs more inclusive, especially in a geo-economic environment (see Lu *et al.* 2023, Ofori *et al.* 2025, Yang *et al.* 2025).

Conclusion

IPCEIs act as selective levelling mechanisms rather than engines of universal convergence. Absolute funding remains heavily concentrated in core economies, validating structural

political economy predictions and indicating that core dominance is not incidental but structurally embedded in IPCEI design and practice. However, exceptional peripheral intensity levels, driven by strategic coupling where domestic assets align with IPCEI priorities, suggest conditional upgrading opportunities. At the same time, permanent multi-tier participation patterns are emerging via capacity-based exclusion and path-dependent feedback loops that generate first-mover advantages for early entrants. These outcomes result from conjunctural causation: structural core-periphery dynamics, state capacity constraints, strategic coupling opportunities and participation feedback mechanisms operate simultaneously, conditioning each other to produce complex, multi-layered distributive effects.

Theoretically, our findings contribute to scholarship on EU industrial policy, core-periphery divisions, state capacity, participation feedback in integration and economic geography. Methodologically, we demonstrate the value of multi-method triangulation (combining inequality metrics, non-parametric tests, quantile regression and clustering) in capturing stratification dynamics that single-method analyses could miss. Empirically, we provide the first comprehensive assessment of IPCEI distribution across all Member States and initiatives, making the most of publicly available data and baseline evidence for future causal and qualitative research.

Policy implications are clear: IPCEIs can strengthen Europe's competitiveness and strategic autonomy, but their inclusiveness is not automatic. If they are expected to complement the EU's cohesion ambition, design and governance choices should address participation barriers. Options include capacity-building support for low-participation states, facilitation of consortium entry for weaker administrations, greater attention to geographic balance and ongoing distributive monitoring. Without such measures, IPCEIs risk entrenching a multi-tier Europe in strategic industries, with adverse consequences for territorial cohesion and the legitimacy of EU industrial governance in an era of intensifying inter-bloc rivalry. The institutional choices made in designing the next generation of IPCEIs will determine whether this instrument becomes a flagship of inclusive European industrial strategy or an emblem of concentrated strategic capitalism.

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Data availability statement

All data used in this study are included in the supplementary material submitted with the manuscript.

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