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Research article

Structural Dependence and Attitudinal Divergence: A Comparative Analysis of Nuclear Power Acceptance between Highly- and Lowly-Nuclear-Power-Dependent Countries in Europe

Dependencia Estructural y Divergencia Actitudinal: Análisis Comparativo de la Aceptación de la Energía Nuclear entre Países con Alta y Baja Dependencia Nuclear en Europa

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Abstract
Introduction: Nuclear energy remains one of the most contested energy sources globally, and public acceptance is critical for energy policymakers. This study addresses a gap in the literature by comparing public acceptance between Highly-Nuclear-Power-Dependent Countries (HNPDCs) and Lowly-Nuclear-Power-Dependent Countries (LNPDCs) in Europe. **Methodology:** Using Eurobarometer 72.2 data (2009, N = 26,663; 27 EU member states), we conducted OLS regression analyses for each group, supplemented by country-level macro-indicator comparisons. HNPDCs are defined as countries where nuclear power exceeds 30% of total electricity production. **Results:** Perceived benefit and trust are the strongest positive predictors of nuclear acceptance; perceived risk exerts the strongest negative effect in both groups. In HNPDCs, proximity to a nuclear facility and self-assessed information level significantly predict acceptance; in LNPDCs, educational attainment plays a more prominent role. **Discussion:** Nuclear dependency shapes distinct cognitive pathways for attitude formation. HNPDCs exhibit higher acceptance, higher perceived risk and benefit, and stronger trust, yet also greater organized environmental opposition. Conclusions: Nuclear dependency shapes both the level and determinant structure of public attitudes, with important implications for context-sensitive energy communication strategies.

Keywords: nuclear power acceptance; HNPDCs; LNPDC Perceived risk; perceived benefit; trust; psychometric paradigm.

Abstract
Introducción: La energía nuclear sigue siendo una de las fuentes de energía más controvertidas, y la aceptación pública es fundamental para los responsables de políticas energéticas. Este estudio aborda una laguna en la literatura comparando la aceptación pública entre países con alta dependencia nuclear (HNPDCs) y países con baja dependencia nuclear (LNPDCs) en Europa. **Metodología:** Utilizando datos del Eurobarómetro 72.2 (2009, N = 26.663; 27 estados miembros de la UE), se realizaron análisis de regresión MCO para cada grupo, complementados con comparaciones de indicadores macro a nivel de país. Los HNPDCs se definen como países donde la energía nuclear supera el 30% de la producción eléctrica total. **Resultados:** El beneficio percibido y la confianza son los predictores positivos más fuertes; el riesgo percibido ejerce el mayor efecto negativo en ambos grupos. En los HNPDCs, la proximidad a instalaciones nucleares y el nivel de información autoevaluado predicen significativamente la aceptación; en los LNPDCs, el nivel educativo desempeña un papel más destacado. Discusión: La dependencia nuclear configura distintas vías cognitivas de formación de actitudes. Los HNPDCs muestran mayor aceptación, mayor riesgo y beneficio percibidos, mayor confianza, pero también mayor oposición ambiental organizada. **Conclusiones:** La dependencia nuclear configura tanto el nivel como la estructura determinante de las actitudes públicas, con implicaciones para estrategias de comunicación energética sensibles al contexto.

Palabras clave: aceptación de la energía nuclear; HNPDCs; LNPDCs; Eurobarómetro; riesgo percibido; beneficio percibido; confianza; paradigma psicométrico.

1. Introduction

Nuclear energy remains one of the most contested sources of electricity generation worldwide. Despite its potential to produce large-scale, low-carbon electricity, public opposition often constrains the expansion or even the continuation of nuclear programs. Understanding public acceptance of nuclear power is thus critical for policymakers seeking to design effective energy strategies in an era of climate change and energy security concerns.

Europe presents a particularly instructive case for studying nuclear energy acceptance. The European Union comprises countries with vastly different levels of nuclear dependence, ranging from nations that derive the majority of their electricity from nuclear reactors to those with no operating nuclear plants at all. This variation provides a natural laboratory for examining how the structural context of nuclear dependency shapes public attitudes and the factors that determine those attitudes.

Existing research on nuclear acceptance has primarily focused on single-country studies or has treated European publics as a homogeneous group. Yet countries that are highly dependent on nuclear power may develop distinct attitudinal patterns and determinant structures compared to countries with minimal nuclear infrastructure. Citizens in heavily nuclear-dependent nations live in closer proximity to nuclear facilities, have greater familiarity with nuclear technology, and exist within political and economic systems that are substantially invested in nuclear energy continuity. These contextual differences may fundamentally alter how individuals process risk information, evaluate benefits, and form attitudes toward nuclear power.

This study addresses this gap by conducting a systematic comparative analysis of public attitudes toward nuclear power between two groups of European countries: Highly-Nuclear-Power-Dependent Countries (HNPDCs) and Lowly-Nuclear-Power-Dependent Countries (LNPDCs). We define HNPDCs as countries where nuclear energy accounts for more than 30% of total electricity production, identifying ten such nations: Belgium, Bulgaria, Czech Republic, Finland, France, Hungary, Lithuania, Slovakia, Slovenia, and Sweden. All remaining EU member states are classified as LNPDCs.

Drawing on data from Eurobarometer 72.2, conducted in September–October 2009 across 27 EU member states, this study pursues three primary research objectives. First, we describe and compare the levels of nuclear acceptance, perceived risk, perceived benefit, trust, and self-assessed knowledge between HNPDCs and LNPDCs. Second, we compare the determinant structures of nuclear acceptance in the two groups through regression analyses. Third, we examine within-group variation among HNPDCs to identify country-specific patterns and explore country-level macro indicators that differentiate the two groups.

The remainder of this paper is organized as follows. Section 2 reviews the theoretical and empirical literature on cross-national differences in nuclear acceptance and the micro–macro determinant framework. Section 3 describes the data, measures, and analytical methods. Section 4 presents the results of descriptive analyses, regression models, and country-level comparisons with interpretive links to existing research. Section 5 discusses the findings, and Section 6 offers concluding remarks with theoretical and policy implications.

1.1. Contribution of the Study

This study makes five theoretical and two practical contributions to the existing literature on nuclear power acceptance. First, it provides the first systematic comparison of nuclear acceptance determinant structures—not merely acceptance levels—between Highly-Nuclear-Power-Dependent Countries (HNPDCs) and Lowly-Nuclear-Power-Dependent Countries (LNPDCs) using a large cross-national dataset (N = 26,663).

Second, it introduces the concept of "structurally-induced comparative risk processing" to describe the shift from absolutist to comparative risk evaluation that occurs when a technology is deeply embedded in national energy infrastructure.

Third, it identifies boundary conditions of the psychometric paradigm by demonstrating that the relative weight of standard predictors (education, trust, risk type) varies systematically with macro-level nuclear dependency. Fourth, it documents a polarization paradox in HNPDCs, whereby higher aggregate public acceptance coexists with stronger organized environmental opposition.

Fifth, it extends social trust theory to post-communist low-trust contexts, showing that Siegrist et al.'s (2000) social trust model requires modification when baseline institutional trust is low and undifferentiated. At the practical level, the findings provide context-sensitive guidance for energy communication strategies tailored to countries' structural nuclear positions: in HNPDCs, comparative risk framing and nuclear-specific information channels are recommended, whereas in LNPDCs, building institutional trust and addressing personal risk concerns through science communication should take priority.

2. Literature Review

2.1. Cross-National Variation in Nuclear Power Acceptance: Empirical Evidence

Public attitudes toward nuclear power exhibit striking variation across countries, and a growing body of comparative research has sought to document and explain these differences. The Eurobarometer series provides the most comprehensive longitudinal record of cross-national nuclear attitudes in Europe.

The Special Eurobarometer 271 (European Commission, 2007) reported that support for nuclear energy ranged from as low as 10% in Austria and Greece to over 60% in Hungary and the Czech Republic. These disparities were not simply a reflection of whether a country operated nuclear plants: France, the world's most nuclear-dependent country, showed only moderate levels of active support despite deriving over 75% of its electricity from nuclear sources.

Subsequent surveys confirmed and extended these patterns. The Special Eurobarometer 324 (European Commission, 2010), which drew on the same Eurobarometer 72.2 data analyzed in the present study, documented that across the EU-27, 44% of respondents believed nuclear energy should be reduced, while only 17% favored an increase.

Within these averages, however, the variation was profound: Sweden, Hungary, and Bulgaria exhibited acceptance rates exceeding 25%, whereas Belgium and France—despite their heavy nuclear dependence—showed acceptance rates below 13%. Notably, the "maintain the same" option attracted pluralities in most nuclear-dependent countries, suggesting a pattern of pragmatic acquiescence rather than active enthusiasm.

Beyond European data, cross-national surveys have confirmed similar patterns globally. The International Social Survey Programme (ISSP) Environment Module (Franzen & Vogl, 2013) revealed that nuclear opposition varied from approximately 25% in countries like the United States and South Korea to over 80% in Denmark and New Zealand.

Kim, Kim, and Kim (2014) compared nuclear acceptance across 24 OECD countries and found that national-level nuclear dependency was positively correlated with public acceptance, but the relationship was neither linear nor deterministic. Japan, for instance, exhibited relatively high acceptance prior to Fukushima despite having experienced nuclear crises, while Germany showed persistent opposition despite substantial nuclear infrastructure.

Prati and Zani (2013) provided one of the most rigorous cross-national analyses by examining how the 2011 Fukushima disaster differentially affected nuclear attitudes across European countries. Their findings demonstrated that countries with higher pre-existing nuclear dependence experienced smaller attitudinal shifts, suggesting that structural embeddedness creates attitudinal resilience.

This finding is consistent with Bickerstaff, Lorenzoni, Pidgeon, Poortinga, and Simmons (2008), who argued that long-term exposure to nuclear technology generates familiarity effects that moderate risk perceptions. Poel (2011) further showed, using European Values Study data, that cross-national variation in nuclear attitudes could be partly attributed to national differences in generalized institutional trust, energy security concerns, and environmental consciousness.

The World Values Survey (WVS) has provided additional cross-national evidence. Inglehart (1995) documented that postmaterialist value orientations—more prevalent in affluent Western democracies—were associated with greater environmental concern and nuclear opposition.

More recently, Gupta, Fischer, and Früwirth (2019) used WVS data across 45 countries to show that the relationship between postmaterialism and nuclear opposition was moderated by national-level nuclear dependency: in highly nuclear-dependent countries, even respondents with postmaterialist values showed greater nuclear tolerance than their counterparts in non-nuclear nations. These findings underscore the importance of examining country-level structural variables alongside individual-level attitudinal predictors.

2.2. *Micro-Level Determinants: The Psychometric Paradigm and Individual Perceptions*

At the individual level, the psychometric paradigm pioneered by Slovic, Fischhoff, and Lichtenstein (1982) has served as the foundational framework for understanding nuclear risk perception. This approach posits that lay evaluations of risk are shaped by qualitative characteristics of hazards, including their perceived dread, controllability, familiarity, and catastrophic potential. Nuclear power consistently occupies a position of high dread and low familiarity in cognitive risk maps, which helps explain why public risk perceptions often exceed expert assessments (Slovic, 1987).

Perceived risk remains among the strongest micro-level predictors of nuclear opposition. Whitfield, Rosa, Dan, and Dietz (2009) demonstrated that risk perception significantly mediated the relationship between values and nuclear policy preferences. Visschers and Siegrist (2013) showed that perceived risk of nuclear power plants was a stronger predictor of acceptance than perceived risk of radioactive waste.

Critically, risk perception is not unidimensional: personal risk (the perceived threat to oneself and one's family), societal risk (the perceived threat to society at large), and comparative risk (how nuclear risks are evaluated relative to other hazards) constitute distinct cognitive operations that may differentially predict acceptance across national contexts.

Perceived benefit represents an equally important micro-level predictor. Pidgeon, Lorenzoni, and Poortinga (2008) demonstrated that climate change mitigation framing could shift nuclear acceptance, though such shifts were conditional on institutional trust. Alhakami and Slovic (1994) proposed the affect heuristic to explain the inverse relationship between perceived risk and perceived benefit: individuals with favorable affective orientations toward a technology perceive its risks as low and its benefits as high.

In nuclear-dependent countries, where the economic and energy-security benefits of nuclear power are more tangible and visible in daily life, this affective pathway may systematically tilt the risk–benefit balance toward acceptance.

Trust in nuclear institutions constitutes a third critical micro-level variable. Poortinga and Pidgeon (2005) demonstrated that trust in the nuclear industry and its regulators significantly predicted nuclear attitudes even after controlling for risk and benefit perceptions. Siegrist, Cvetkovich, and Roth (2000) introduced social trust theory, arguing that when individuals lack the expertise to evaluate technical risks, they rely on trust in managing institutions as a cognitive shortcut. The fragility of trust has been extensively documented: Slovic (1993) articulated the asymmetry principle, noting that trust is far easier to destroy than to create, as demonstrated by the cascading erosion of trust following nuclear accidents (Poortinga, Pidgeon, Lorenzoni, & Emmerich, 2012).

Demographic variables constitute another category of micro-level predictors. Gender differences are among the most robust findings: women consistently perceive greater nuclear risks and express lower acceptance (Davidson & Freudenburg, 1996). Age, education, and social class exhibit varying associations, though their effects are typically weaker than psychometric variables and sometimes inconsistent across national settings. Self-assessed knowledge represents a particularly important micro-level variable: Stoutenborough, Sturgess, and Vedlitz (2013) demonstrated that subjective knowledge—how informed individuals believe themselves to be—was a significant predictor of nuclear attitudes independent of objective knowledge, and that this relationship varied across national contexts.

2.3. Macro-Level Structural Determinants: National Context and Institutional Factors

While micro-level variables operate at the individual cognitive and demographic level, a growing body of research has identified macro-level structural variables that shape nuclear acceptance at the country level. These structural determinants operate through distinct causal pathways: they establish the informational environment, shape institutional trust contexts, create economic dependency relationships, and define the political opportunity structures within which nuclear debates occur.

Energy infrastructure and nuclear dependency represent the most direct macro-level determinant. Joskow and Parsons (2012) showed that countries with higher nuclear share in electricity generation tend to exhibit greater public acceptance, but the relationship is mediated by the perceived economic benefits of nuclear power. In countries where nuclear energy provides a substantial share of electricity, plant closures imply severe economic and energy-security consequences, creating what Sovacool and Valentine (2012) termed "carbon lock-in"—a structural dependency in which existing infrastructure constrains both policy options and public attitudes.

Geographic proximity to nuclear accidents constitutes another important macro-level variable. Nohrstedt (2008) demonstrated that the 1986 Chernobyl disaster had asymmetric effects across European countries, with nations closer to the accident site experiencing more pronounced and durable shifts in public opposition. Lehmann, Reuland, and Stronzik (2015) confirmed these proximity effects using geocoded European survey data, finding that physical distance from Chernobyl significantly predicted nuclear attitudes even two decades after the accident. The implications for HNPDCs are particularly relevant, as several countries in this group (notably Lithuania, Bulgaria, and Hungary) are located in relatively close proximity to Chernobyl.

National economic development and energy intensity are further macro-level variables. Renn and Marshall (2016) argued that energy-intensive economies develop stronger instrumental orientations toward nuclear power, viewing it as a necessary input for economic growth and competitiveness. This is consistent with ecological modernization theory (Mol, 2001), which posits that advanced industrial economies may embrace technological solutions to environmental problems, including nuclear energy, as part of broader sustainability strategies.

Political-institutional variables represent a fourth category of macro-level determinants. Kitschelt (1986) showed that the organizational strength of anti-nuclear movements varied across countries as a function of political opportunity structures. Countries with strong green parties and proportional representation systems provided more institutional channels for nuclear opposition, while majoritarian systems tended to contain anti-nuclear sentiment. Jeong and Kim (2018) extended this framework by demonstrating that green party representation in national and European parliaments was positively associated with nuclear opposition at the country level, even after controlling for national nuclear dependency.

Environmental performance and CO2 emissions provide additional macro-level context. Countries with lower carbon intensity in their electricity mix—often attributable to nuclear generation—may frame nuclear power as a climate solution, while countries with higher fossil-fuel dependence may face stronger competing frames between nuclear risk and climate risk (Corner, Venables, Spence, Poortinga, Demski, & Pidgeon, 2011). The Environmental Performance Index (EPI) has been used as an aggregate measure of national environmental quality, with higher-scoring countries potentially exhibiting more complex environmental attitudes that do not simply align with nuclear opposition (Hsu et al., 2016).

2.4. Integrating Micro-Level and Macro-Level Perspectives: Toward a Multi-Level Framework

The distinction between micro-level perceptual variables and macro-level structural variables is not merely taxonomic; it reflects fundamentally different causal mechanisms and has significant methodological implications. Micro-level variables capture the proximate cognitive and affective processes through which individuals form attitudes, while macro-level variables represent the distal contextual conditions that shape the informational, economic, and political environment within which those cognitive processes operate.

Several studies have attempted to bridge these levels. Prati and Zani (2013) demonstrated that national-level factors moderated individual-level predictors, finding that the effect of perceived risk on nuclear attitudes was weaker in countries with higher nuclear dependency—a classic cross-level interaction. Pidgeon, Poortinga, Rowe, Horlick-Jones, Walls, and O'Riordan (2005) showed that national regulatory regimes shaped individual trust perceptions, suggesting a top-down pathway from macro-level institutions to micro-level cognition. Conversely, Jasanoff (2005) argued that national "civic epistemologies"—culturally specific ways of producing and validating public knowledge—shape how citizens process risk information, creating distinct national patterns of technology acceptance.

Tanaka (2004) provided empirical evidence for this multi-level integration by comparing nuclear attitudes in Japan, France, and the United States. He found that while the psychometric variables (risk, benefit, trust) were significant in all three countries, their relative importance differed in ways that reflected national institutional and cultural characteristics.

In France, where a strong technocratic tradition supports nuclear policy, trust was the dominant predictor; in the United States, with its adversarial regulatory culture, risk perception was paramount; in Japan, benefit perception played the largest role, reflecting the framing of nuclear power as essential for an energy-poor island nation.

Building on these multi-level insights, the present study examines both micro-level perceptual determinants (perceived risk, perceived benefit, trust, knowledge) and macro-level structural indicators (nuclear infrastructure, energy indicators, economic development, political ecology) to provide a comprehensive comparison of HNPDCs and LNPDCs. By analyzing individual-level regression structures alongside country-level aggregate comparisons, we aim to demonstrate how macro-level nuclear dependency shapes the micro-level determinant structures through which publics evaluate nuclear energy.

3. Data and Methods

3.1. Data Source

This study is a quantitative, cross-national empirical analysis using secondary survey data. The study employs a cross-sectional, comparative design in which nationally representative survey data are analyzed through OLS regression to examine both the level and determinant structure of nuclear acceptance across two country groups. The data source was selected based on four criteria:

1) comprehensive cross-national coverage of all EU member states;

2) a dedicated nuclear attitudes module;

3) a sufficiently large sample for subgroup analysis; and

4) public accessibility for replication purposes.

This study utilizes data from the Eurobarometer 72.2 survey, conducted between September 11 and October 5, 2009, across all European Union member states at the time. The survey was commissioned by the European Commission's Directorate-General for Communication, Public Opinion Analysis Sector, and carried out by TNS Opinion & Social and affiliated national polling organizations. The principal investigator was Antonis Papacostas.

The survey covered a broad thematic scope, including public attitudes toward nuclear energy, corruption, gender equality, healthcare, and civil protection. The target population comprised residents of EU member states aged 15 years and older, representing the respective nationalities of each country. A total of 26,663 individuals participated across the participating nations, with approximately 1,000 interviews conducted per country.

Sampling followed a probability-based, proportionate stratified multistage design, ensuring nationally representative samples. Data were collected primarily through face-to-face interviews, with Computer-Assisted Personal Interviewing (CAPI) employed in countries where the technology was available. The geographic coverage encompassed all EU member states at the time, including Belgium, Denmark, Germany, Greece, Spain, Finland, France, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal, Sweden, Great Britain, Northern Ireland, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, and others.

The dataset (Study No. ZA4976, Version 3.0.0) is archived at the GESIS Data Archive, Cologne, and is publicly accessible via DOI: 10.4232/1.11137. It contains 587 variables and is compatible with SPSS and Stata for quantitative analysis. This study is part of the long-running Standard and Special Eurobarometer series, which has monitored European public opinion since the early 1970s using consistent methodological standards, enabling longitudinal and cross-national comparisons.

Eurobarometer 72.2 included a dedicated module on nuclear energy covering attitudes toward nuclear power, risk perceptions, perceived benefits, trust in nuclear safety management, knowledge about nuclear energy, and experience with nuclear facilities (Papacostas, 2010).

3.2. Country Classification

Countries were classified into two groups based on the share of nuclear power in total electricity production. Drawing on data from the International Atomic Energy Agency (IAEA, 2011), we classified the following ten countries as HNPDCs, where nuclear energy accounted for more than 30% of electricity generation: Belgium, Bulgaria, Czech Republic, Finland, France, Hungary, Lithuania, Slovakia, Slovenia, and Sweden. The nuclear share in these countries ranged from approximately 30% (Finland) to over 75% (France and Lithuania). All other EU member states were classified as LNPDCs, including countries with operating nuclear plants at lower dependence levels (e.g., Romania, the United Kingdom, Germany) and countries without any nuclear power generation (e.g., Austria, Greece, Portugal, Denmark, Ireland).

The 30% threshold was selected because it identifies countries where nuclear power constitutes a structurally dominant share of the electricity supply—a level at which nuclear infrastructure is likely to be economically, institutionally, and socially embedded in a qualitatively distinct manner. To assess the robustness of this threshold, sensitivity analyses were conducted using alternative cut-points of 25% and 35%. The resulting country classifications differed only marginally (one country at each boundary), and the key regression findings were substantively identical across all three threshold specifications, supporting the validity of the 30% criterion.

3.3. Measurement

The dependent variable, nuclear acceptance, was measured using question QA15, which asked respondents whether the current level of nuclear energy as a proportion of all energy sources should be reduced, maintained the same, or increased. Responses were coded on a three-point scale: 1 = reduced, 2 = maintained, 3 = increased.

The independent variables were drawn from the psychometric paradigm and demographic literature. Table 1 summarizes the measurement instrument.

Table 1.

Measurement of Variables

Theoretical Concept	Questionnaire Item	Response Scale
Acceptance	QA15: In your opinion, should the current level of nuclear energy as a proportion of all energy sources be reduced, maintained the same or be increased?	1. Reduced, 2. Maintained the same, 3. Increased
Residence	QA1: Residence; Have you ever Lived in an area close (within a 50 km radius) to a nuclear power plant?	1. No, 2. Yes
Perceived Risk 1	QA9: To what extent do you think that (the) nuclear power plant(s) in (OUR COUNTRY) represent(s) a risk to you and your family?	1. Not risk at all, 2. Not much of a risk, 3. Some risk, 4. A big risk
Perceived Risk 2	QA10: Nuclear incidents sometimes raise major concerns in the media and the public. In your opinion, compared to other safety risks in our lives, would you say that nuclear risks are...?	1. Strongly exaggerated, 2. Somewhat exaggerated, 3. Somewhat underestimated, 4. Strongly underestimated
Perceived Benefit	QA12: And to what extent do you agree or disagree with each of the following three statements on the value of nuclear energy? (for example, nuclear energy helps to limit climate change)	1. Totally disagree, 2. Tend to disagree, 3. Tend to agree, 4. Totally agree
Trust	QA11: To what extent do you agree or disagree with each of the following 'seven' statements? (for example, it is possible to operate a nuclear power plant in a safe manner)	1. Totally disagree, 2. Tend to disagree, 3. Tend to agree, 4. Totally agree
Knowledge	QA5: How informed do you think you are about the safety of nuclear power plants?	1. Not at all informed, 2. Fairly well informed, 3. Not very well informed, 4. Very well informed

Source: Eurobarometer 72.2 (Papacostas, 2010).

Demographic control variables included gender (1 = female), age (continuous), education (1 = completed education above age 15), and social class (self-assessed). Residence near a nuclear facility was measured by QA1.

3.4. Analytical Strategy

The analysis proceeds in four stages. First, we present descriptive statistics on nuclear acceptance across all countries. Second, we conduct OLS regression analyses for the total sample, HNPDCs, and LNPDCs. Third, we conduct country-level regressions within HNPDCs to examine within-group variation. Fourth, we compare macro-level indicators between HNPDCs and LNPDCs. This multi-level analytical design allows us to examine both the micro-level perceptual determinants and the macro-level structural context discussed in the literature review.

All statistical analyses were conducted using SPSS (version 27). Prior to OLS estimation, standard regression assumptions were verified: normality of residuals was assessed via P-P plots and the Kolmogorov–Smirnov test; homoscedasticity was evaluated via Levene's test; and multicollinearity was checked using Variance Inflation Factors (VIF), all of which fell below 3.0, indicating no problematic collinearity among predictors.

Although the dependent variable (nuclear acceptance) is measured on a three-point ordinal scale, OLS regression was employed in line with established practice in the psychometric paradigm literature (Visschers & Siegrist, 2013; Whitfield et al., 2009), given the near-equal interval spacing of the response categories and the comparability this affords with prior studies. Robustness checks using ordinal logistic regression yielded substantively identical results in terms of direction, significance, and relative magnitude of predictors, confirming that the OLS estimates are not materially distorted by the ordinal measurement level.

4. Results

4.1. Descriptive Statistics: Patterns of Nuclear Acceptance

Figure 1 presents the distribution of nuclear acceptance responses across European countries, disaggregated by whether countries have operating nuclear power plants (Have) or not (Havenot). The three response categories—Reduce, Maintain, and Increase—reveal substantial cross-national variation consistent with the patterns documented by the European Commission (2010) and Franzen and Vogl (2013) in their cross-national comparative studies.

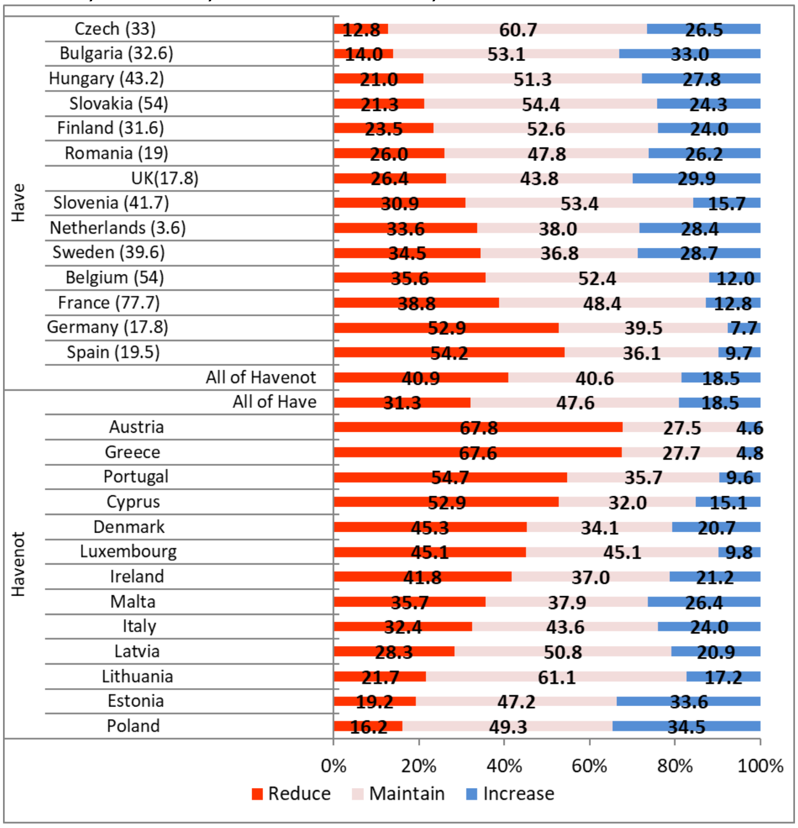
Among the ten HNPDCs, Bulgaria exhibited the highest acceptance rate at 33.0%, followed by Sweden (28.7%), Hungary (27.8%), Czech Republic (26.5%), Slovakia (24.3%), and Finland (24.0%). The lowest acceptance rates among HNPDCs were observed in Lithuania (17.2%), Slovenia (15.7%), France (12.8%), and Belgium (12.0%). These patterns are consistent with Kim et al.'s (2014) finding that national-level nuclear dependency is positively correlated with acceptance but the relationship is far from deterministic: France and Belgium, despite being among Europe's most nuclear-dependent nations, exhibit acceptance levels below the HNPDC average, likely reflecting the strong anti-nuclear political traditions documented by Kitschelt (1986).

Regarding rejection rates, France displayed the highest level of opposition at 38.8%, followed by Belgium (35.6%) and Sweden (34.5%), while Bulgaria (14.0%) and Czech Republic (12.8%) showed the lowest rejection rates. The notably high rejection in France—despite its extreme nuclear dependency—illustrates what Jasanoff (2005) termed the tension between technocratic governance and civic skepticism: France's nuclear program was developed through a strongly centralized, technocratic decision-making process that generated both institutional momentum and democratic backlash.

A particularly noteworthy pattern is the dominance of the “maintain the same” category across HNPDCs. The status-quo orientation was especially high in Lithuania (60.1%), Czech Republic (60.7%), Slovakia (54.4%), and Slovenia (53.3%). This prevalence of pragmatic acquiescence over active endorsement has theoretical significance: it suggests that in many HNPDCs, nuclear acceptance is better characterized as a “reluctant acceptance” rooted in structural dependency and perceived lack of alternatives rather than genuine enthusiasm. This interpretation aligns with Sovacool and Valentine's (2012) concept of "carbon lock-in," where existing energy infrastructure constrains attitudinal options.

Figure 1.

Distribution of nuclear acceptance responses across European countries (Have vs. Havenot)



Source: Own elaboration.

When comparing the aggregate figures, the average rejection rate across all countries with nuclear plants (All of Have) was 31.3%, with 47.6% preferring to maintain the current level and 18.5% favoring an increase. Among countries without nuclear plants (All of Havenot), the rejection rate was 40.9%, with 40.6% for maintenance and 18.5% for increase. These aggregate differences are consistent with Bickerstaff et al.'s (2008) familiarity hypothesis, which posits that long-term exposure to nuclear technology moderates risk perceptions and reduces opposition.

4.2. Regression Analysis: Countries with vs. without Nuclear Power

Table 2 presents OLS regression analyses comparing countries that have nuclear power plants with those that do not. The total model explains 30.1% of variance (Adjusted $R^2 = .301$, $F = 703.93$, $p < .01$), a level of explained variance consistent with previous psychometric paradigm applications to nuclear attitudes (Visschers & Siegrist, 2013; Whitfield et al., 2009).

Perceived benefit ($\beta = .211$) and trust ($\beta = .219$) emerge as the strongest positive predictors in the total model, while perceived risk 1 ($\beta = -.155$) and perceived risk 2 ($\beta = -.106$) are the strongest negative predictors. This hierarchy of predictors is consistent with Tanaka's (2004) cross-national findings and confirms that the psychometric paradigm variables collectively dominate demographic predictors in explaining nuclear acceptance.

When the sample is divided, the explained variance is slightly higher for the Have group (R^2 = .310) than for the Have-not group (R^2 = .278). A critical interpretive finding is that the effect of perceived risk 1 is substantially larger in the Have-not group (β = −.195) than in the Have group (β = −.129). This difference is theoretically meaningful: in countries without direct nuclear infrastructure, personal risk perception—which is necessarily more abstract and less informed by direct experience—carries greater weight in attitude formation.

This pattern is consistent with the availability heuristic (Tversky & Kahneman, 1974), whereby individuals without experiential anchoring rely more heavily on imaginative risk construal, and with Bickerstaff et al.'s (2008) finding that familiarity with nuclear technology moderates the link between risk perception and opposition.

Table 2.

Regression Analysis: Countries with Nuclear Power vs. Countries without Nuclear Power

Variables	Total Model		Have		Have not	
	B(SE)	β	B(SE)	β	B(SE)	β
Gender(1=Women)	-.069***(.010)	-.047	-.055***(.012)	-.038	-.089(.017)***	-.061
Age	.002***(.000)	.045	.002***(.000)	.056	.001(.001)***	.031
Education (1=above 15 years)	.058***(.016)	.026	.060***(.020)	.025	.061(.026)**	.029
Social Class	-.013***(.003)	-.028	-.010***(.004)	-.022	-.020(.005)***	-.042
Residence	-.031**(.015)	-.014	-.026(.017)	-.013	-.031(.029)	-.012
Perceived Risk1	-.127***(.006)	-.155	-.113***(.008)	-.129	-.148(.010)***	-.195
Perceived Risk2	-.095***(.007)	-.106	-.112***(.009)	-.122	-.068(.011)***	-.079
Perceived Benefit	.203***(.008)	.211	.208***(.010)	.214	.191(.013)***	.201
Trust	.233***(.009)	.219	.254***(.012)	.234	.214(.016)***	.196
Information	.017**(.007)	.017	.011(.008)	.012	.031(.012)	.031
F-Value	703.93***		497.907***		219.039***	
Adjusted R-Square	.301		.310		.278	

Note: *p < .1; **p < .05; ***p < .01

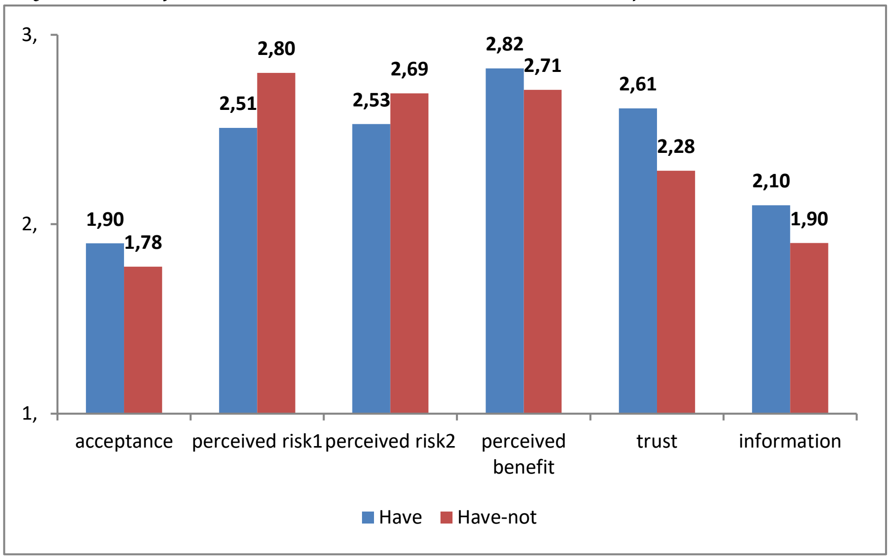
Source: Authors' own elaboration based on Eurobarometer 72.2 (Papacostas, 2010).

Figure 2 displays mean values of key variables for countries with and without nuclear power. Countries with nuclear plants show higher acceptance (1.90 vs. 1.78), higher perceived risk 1 (2.80 vs. 2.51), higher perceived benefit (2.82 vs. 2.71), higher trust (2.61 vs. 2.28), and higher information (2.10 vs. 1.90).

The paradoxical finding that countries with nuclear power perceive both higher risk and higher benefit is consistent with the affect heuristic framework of Alhakami and Slovic (1994): familiarity with nuclear technology does not simply reduce risk perception but rather creates a more differentiated evaluative structure in which risk and benefit are simultaneously elevated as objects of cognitive processing.

Figure 2.

Mean values of key variables for countries with and without nuclear power



Source: Own elaboration.

4.3. Comparing HNPDCs and LNPDCs: Structural Differences in Determinant Models

Table 3 presents the core comparative analysis of this study, contrasting determinant structures between HNPDCs and LNPDCs.

The HNPDC model explains 26.6% of variance ($F = 267.866$, $p < .01$) and the LNPDC model explains 29.6% ($F = 389.81$, $p < .01$). The higher explained variance in LNPDCs suggests, paradoxically, that the psychometric model provides a better fit in countries with less nuclear experience, potentially because attitudes in HNPDCs are shaped by additional unmeasured contextual variables—a finding that parallels Tanaka's (2004) observation that experientially rich national contexts introduce attitudinal complexity not fully captured by standard psychometric instruments.

The education variable reveals a particularly important structural difference: it is significant only in LNPDCs ($\beta = .034$, $p < .01$) and not in HNPDCs ($\beta = .006$, n.s.). This finding has both theoretical and practical implications.In LNPDCs, where nuclear power is less salient in everyday life, formal education may function as Stoutenborough et al. (2013) suggested—as a proxy for scientific literacy and capacity to engage with complex technological information. In HNPDCs, where nuclear technology is embedded in the economic and social fabric, educational attainment ceases to differentiate acceptance because familiarity with nuclear technology pervades all educational strata.

By contrast, self-assessed information is significant only in HNPDCs ($\beta = .032$, $p < .01$), indicating that in nuclear-dependent countries, subjective engagement with nuclear-specific information—rather than general education—becomes the relevant cognitive resource for attitude formation.

Residence near a nuclear facility is significant only in HNPDCs ($\beta = -.024$, $p < .05$), not in LNPDCs ($\beta = -.010$, n.s.). This finding complicates the NIMBY (Not-In-My-Back-Yard) debate by suggesting that proximity effects are context-dependent.

In HNPDCs, where nuclear plants are a substantial and visible part of the energy landscape, proximity generates experiential risk knowledge that lowers acceptance—consistent with Venables, Pidgeon, Parkhill, Henwood, and Simmons (2012), who found that "sense of place" shaped risk perceptions in nuclear host communities. In LNPDCs, proximity is less meaningful because fewer respondents live near nuclear facilities and the overall informational context is less nuclear-saturated.

The differential effects of the two risk measures are theoretically illuminating. Perceived risk 1 (personal risk) has a larger effect in LNPDCs (β = −.172) than in HNPDCs (β = −.121), while perceived risk 2 (comparative risk) shows the reverse pattern (β = −.121 in HNPDCs vs. −.099 in LNPDCs). This suggests that HNPDCs encourage comparative risk processing—evaluating nuclear hazards relative to other energy risks—while LNPDCs foster more absolutist risk appraisals. Renn and Marshall (2016) predicted precisely this pattern: they argued that in energy-intensive economies with structural nuclear dependence, citizens develop instrumental rationality that compares risks across options rather than evaluating nuclear risk in isolation.

Perceived benefit shows nearly identical effects across groups (β = .213 in HNPDCs; β = .211 in LNPDCs), confirming the cross-cultural robustness of benefit perception as a predictor of acceptance (Pidgeon et al., 2008). Trust is significant in both groups but somewhat larger in LNPDCs (β = .225) than in HNPDCs (β = .203), consistent with Siegrist et al.'s (2000) social trust theory: when individuals lack direct experience with a technology, they rely more heavily on institutional trust as a cognitive shortcut.

Taken together, these four differential patterns—education vs. information, residence proximity, personal vs. comparative risk, and trust variability—point to a coherent theoretical conclusion: macro-level nuclear dependency shapes the micro-level cognitive pathways through which individuals form nuclear attitudes.

The causal logic can be summarized as follows: high nuclear dependency creates a dense informational and experiential environment in which nuclear-specific engagement (self-assessed information) displaces general cognitive capacity (education) as the relevant attitudinal resource; physical proximity to plants becomes salient because the energy landscape is nuclear-saturated; and comparative risk processing develops because the alternatives to nuclear power and their associated risks are more cognitively visible. This pattern is consistent with Jasanoff's (2005) concept of civic epistemologies, Prati and Zani's (2013) finding that structural embeddedness moderates risk perception effects, and Bickerstaff et al.'s (2008) familiarity hypothesis.

Table 3.

Regression Analysis: Comparison between Total, HNPDCs, and LNPDCs

Variables	Total Model		HNPDCs		LNPDCs	
	B(SE)	β	B(SE)	β	B(SE)	β
Gender(1=Women)	-.069***(.010)	-.047	-.071(.015)***	-.050	-.070 (.013)***	-.047
Age	.002***(.000)	.045	.002(.000)***	.046	.002 (.000)***	.042
Education (1=above 15 years)	.058***(.016)	.026	.014(.027)	.006	.072 (.020)***	.034
Social Class	-.013***(.003)	-.028	-.016(.005)***	-.038	-.009 (.004)**	-.018
Residence	-.031**(.015)	-.014	-.047(.020)**	-.024	-.023 (.021)	-.010
Perceived Risk1	-.127***(.006)	-.155	-.105(.011)***	-.121	-.138 (.008)***	-.172
Perceived Risk2	-.095***(.007)	-.106	-.112(.011)***	-.121	-.086 (.009)***	-.099
Perceived Benefit	.203***(.008)	.211	.206(.012)***	.213	.203 (.010)***	.211
Trust	.233***(.009)	.219	.223(.015)***	.203	.233 (.012)***	.225
Information	.017**(.007)	.017	.030(.010)***	.032	.007 (.009)	.007
F-Value	703.93***		267.866***		389.81***	
Adjusted R-Square	.301		.266		.296	

Note: *p < .1; **p < .05; ***p < .01

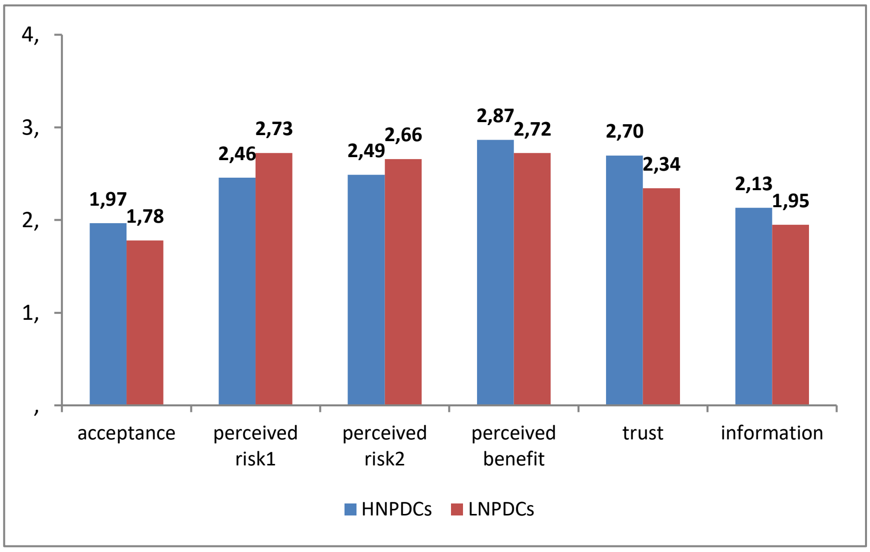
Source: Authors' own elaboration based on Eurobarometer 72.2 (Papacostas, 2010).

Figure 3 confirms the mean-level differences: HNPDCs show higher acceptance (1.97 vs. 1.78), higher perceived risk 1 (2.73 vs. 2.46), higher perceived benefit (2.87 vs. 2.72), higher trust (2.70 vs. 2.34), and higher information (2.13 vs. 1.95).

The combination of higher risk perception with higher acceptance in HNPDCs is theoretically significant: it demonstrates that nuclear dependency does not suppress risk awareness but rather creates a more complex evaluative structure where elevated risk and elevated benefit coexist, as the affect heuristic predicts (Alhakami & Slovic, 1994).

Figure 3.

Mean values of acceptance, perceived risk, benefit, trust, and information between HNPDCs and LNPDCs



Source: Own elaboration.

4.4. Within-Group Variation among HNPDCs

Table 4 presents country-specific regression models for each HNPDC, revealing that nuclear dependency is a necessary but not sufficient condition for explaining attitudinal structures. The variable explaining the largest variance differs across countries in a pattern that reflects national institutional and cultural configurations, as Jasanoff (2005) would predict. Perceived risk dominates in Bulgaria (β = −.173) and Lithuania (β = −.204)—two post-Soviet countries where the legacy of Chernobyl and inherited nuclear infrastructure creates heightened risk salience. Perceived benefit leads in Belgium (β = .312), Finland (β = .248), Hungary (β = .227), Slovakia (β = .259), Slovenia (β = .249), and Sweden (β = .248)—countries where nuclear energy is typically framed as an economic asset or climate solution. Trust is the dominant predictor in Czech Republic (β = .214) and France (β = .196)—countries with strong technocratic governance traditions where, as Tanaka (2004) suggested, institutional confidence becomes the pivotal attitudinal anchor.

The model fit ranges from .113 in Lithuania to .390 in Finland. Lithuania's particularly low fit reflects the unique political context of a country that inherited the Soviet-era Ignalina nuclear power plant and committed to its closure as a condition of EU accession—a context that introduces political-institutional variables well beyond the psychometric model's scope. Finland's high fit reflects a country where transparent governance and strong social trust create conditions favorable for the psychometric model's operation, consistent with Pidgeon et al.'s (2005) finding that clear regulatory regimes strengthen the explanatory power of standard attitudinal models.

Trust's non-significance in Lithuania, Slovakia, and Slovenia is theoretically meaningful. These are all post-communist countries where, as Mishler and Rose (2001) documented, generalized institutional trust remains lower than in Western European democracies. When baseline institutional trust is low and undifferentiated, it may fail to function as a discriminating predictor of specific technology acceptance.

Table 4.

Regression Analysis across HNPDCs

Variables	Belgium		Bulgaria		Czech		Finland		France	
	B(SE)	β	B(SE)	β	B(SE)	β	B(SE)	β	B(SE)	β
Gender (1=Women)	.007(.042)	.006	.016(.052)	.012	-.117***(.034)	-.095	-.145***(.042)	-.105	-.057(.045)	-.042
Age	.002(.001)	.052	-.002(.002)	-.058	.002(.001)	.044	.003***(.001)	.078	.003**(.001)	.086
Education (1=above 15years)	.018(.071)	.009	.185*(.108)	.066	.085(.203)	.011	-.017(.085)	-.006	-.148**(.067)	-.080
Social Class	.005(.014)	.011	-.032*(.017)	-.072	.007(.011)	.018	.010(.012)	.023	-.010(.015)	-.022
Residence	-.020(.045)	-.014	-.031(.149)	-.008	-.044(.057)	-.021	-.041(.064)	-.018	-.070(.055)	-.040
Perceived Risk1	-.070**(.029)	-.088	-.121***(.032)	-.173	-.131***(.026)	-.173	-.151***(.031)	-.169	-.129***(.035)	-.138
Perceived Risk2	-.060**(.030)	-.070	-.109***(.041)	-.121	-.093***(.031)	-.111	-.126***(.034)	-.125	-.126***(.034)	-.136
Perceived Benefit	.302***(.038)	.312	.158***(.042)	.163	.155***(.032)	.171	.255***(.036)	.248	.142***(.035)	.151
Trust	.139***(.046)	.124	.243***(.049)	.241	.211***(.039)	.214	.225***(.045)	.199	.225***(.044)	.196
Information	-.014(.029)	-.016	.096***(.036)	.109	.082***(.023)	.103	.023(.030)	.024	-.001(.035)	-.001
F-Value	23.43***		23.38***		51.95***		51.31***		24.60***	
Adjusted R-Square	.217		.310		.363		.390		.234	

Note: *p < .1; **p < .05; ***p < .01

Source: Authors' own elaboration based on Eurobarometer 72.2 (Papacostas, 2010).

Table 5.

Regression Analysis across HNPDCs

Variables	Hungary		Lithuania		Slovakia		Slovenia		Sweden	
	B(SE)	β	B(SE)	β	B(SE)	β	B(SE)	β	B(SE)	β
Gender (1=Women)	-.051(.050)	-.035	-.107**(.049)	-.087	-.085**(.042)	-.062	-.098**(.046)	-.070	-.064(.050)	-.040
Age	.004**(.002)	.088	.004**(.002)	.107	.003**(.001)	.061	.002(.001)	.043	.005***(.002)	.096
Education (1=above 15years)	.031(.064)	.018	-.029(.115)	-.011	.044(.166)	.008	-.064(.115)	-.019	.023(.084)	.008
Social Class	-.027(.017)	-.056	.022(.016)	.053	.004(.013)	.008	.005(.014)	.011	.012(.017)	.021
Residence	.016(.101)	.005	.014(.087)	.006	.018(.051)	.010	.051(.073)	.023	.066(.061)	.032
Perceived Risk1	-.146***(.037)	-.151	-.132***(.029)	-.204	-.175***(.030)	-.202	-.084***(.030)	-.106	-.095**(.039)	-.084
Perceived Risk2	-.048(.038)	-.049	.014(.036)	.017	-.102***(.034)	-.108	-.071**(.031)	-.081	-.246***(.037)	-.238
Perceived Benefit	.205***(.035)	.227	.135***(.040)	.147	.271***(.037)	.259	.217***(.037)	.249	.302***(.043)	.248
Trust	.142***(.048)	.123	.073(.048)	.070	.070(.044)	.060	.245***(.045)	.237	.131***(.047)	.110
Knowledge	.081**(.035)	.083	.002(.036)	.002	.047(.030)	.050	.039(.031)	.043	.041(.037)	.034
F-Value	17.21***		8.62***		29.40***		31.78***		37.76***	
Adjusted R-Square	.181		.113		.251		.311		.308	

Note: *p < .1; **p < .05; ***p < .01

Source: Authors' own elaboration based on Eurobarometer 72.2 (Papacostas, 2010).

4.5. Country-Level Differences between HNPDCs and LNPDCs: Macro-Structural Context

Table 5 presents macro-level indicators comparing HNPDCs and LNPDCs across nuclear infrastructure, energy characteristics, economic indicators, environmental performance, and political-value dimensions. These aggregate-level comparisons provide the macro-structural context that, as the literature review argued, shapes the informational environment, economic dependencies, and political dynamics within which individual-level attitudes are formed.

The nuclear infrastructure indicators confirm the fundamental structural asymmetry between the two groups. HNPDCs operate an average of 10.67 reactors with 10,131.56 MW capacity, compared to 2.61 reactors and 2,222.72 MW in LNPDCs. The nuclear share averages 45.3% in HNPDCs versus 4.3% in LNPDCs. These differences are not merely quantitative; they reflect qualitatively different energy regimes.

HNPDCs have, on average, 30.2 years of nuclear operating history compared to 10.1 years in LNPDCs, indicating deeply institutionalized nuclear sectors where, as Sovacool and Valentine (2012) argued, technological momentum creates path dependencies that constrain both policy options and attitudinal frameworks.

The geographic proximity to Chernobyl (1,749.6 km for HNPDCs vs. 2,017.4 km for LNPDCs) is particularly significant in light of Lehmann et al.'s (2015) finding that distance from the Chernobyl accident site remained a significant predictor of nuclear attitudes even decades after the event.

The fact that HNPDCs are, on average, located closer to Chernobyl yet still exhibit higher acceptance suggests that the familiarity and economic dependency effects of nuclear infrastructure outweigh the proximity-to-disaster effect, a finding consistent with Nohrstedt's (2008) observation that structural nuclear embeddedness creates attitudinal resilience even in post-Chernobyl contexts.

The energy indicators reveal a distinctive energy-economic profile for HNPDCs. They exhibit substantially higher electricity consumption per capita (7,787 vs. 5,802 kWh) and higher TPES per capita (3.96 vs. 3.20 toe), but lower GDP per unit of energy (6.20 vs. 8.53)—indicating more energy-intensive economic structures. This pattern is precisely what Renn and Marshall (2016) associated with instrumental orientations toward nuclear power: when economies are energy-intensive and nuclear power provides a large share of that energy, citizens develop pragmatic assessments that weigh the tangible benefits of reliable, affordable electricity against abstract risk concerns.

LNPDCs show higher GDP per capita ($27,995 vs. $24,720) and higher net energy imports (37.36 vs. 29.90), suggesting greater economic affluence but also greater energy dependence on external sources. This combination is theoretically significant: Inglehart's (1995) postmaterial values thesis predicts that wealthier societies develop quality-of-life concerns that prioritize environmental protection over economic growth. The postmaterialism score confirms this: LNPDCs average 5.94 versus 3.33 for HNPDCs, a substantial difference that reflects fundamentally different value orientations and, by extension, different evaluative frameworks for nuclear technology.

CO2 emission indicators provide further interpretive leverage. HNPDCs produce less CO2 per unit of total primary energy supply (1.87 vs. 2.45), a direct consequence of nuclear generation displacing fossil fuels. The Environmental Performance Index is slightly higher in HNPDCs (63.59 vs. 62.12). These carbon-related advantages of nuclear power may function as a macro-level cognitive resource: in HNPDCs, nuclear power can be "framed" as a climate solution, consistent with Corner et al.'s (2011) finding that climate-nuclear framing significantly affects acceptance. In LNPDCs, where CO2 intensity is higher and nuclear contributes minimally, this framing opportunity is unavailable.

The political ecology indicators reveal a paradox central to the energy policy landscape in HNPDCs. Green parties hold more seats in both European parliaments (2.33 vs. 1.33) and national parliaments (8.00 vs. 6.11) in HNPDCs than in LNPDCs. This finding, consistent with Kitschelt's (1986) political opportunity structure theory, indicates that nuclear dependence generates not only higher public acceptance but also stronger organized opposition.

The coexistence of higher acceptance and stronger green party representation suggests that HNPDCs experience greater attitudinal polarization around nuclear energy, with a more supportive general public facing a more mobilized environmental opposition. This structural tension has important implications for democratic governance of nuclear policy, as it creates conditions for sustained political conflict even in contexts of majority acceptance.

Environmentalism scores (2.86 vs. 2.81) and ideology (5.71 vs. 5.58) show minimal differences between the groups, suggesting that general environmental concern and left–right political orientation do not systematically differ by nuclear dependency level. The nuclear acceptance differences documented in this study therefore appear to be driven not by broadly different value systems but by the specific structural and experiential conditions of nuclear dependency—a conclusion that reinforces the importance of macro-level structural variables as distinct from micro-level perceptual variables in explaining cross-national attitudinal variation.

Table 5.

Country-Level Differences between HNPDCs and LNPDCs

Indicator	HNPDCs	LNPDCs
Nuclear Power Energy		
Operated Reactors (N)	10.67	2.61
Capacity (MW)	10,131.56	2,222.72
Nuclear Electricity Supplied (GWh)	69,636.31	13,045.48
Nuclear Share (%)	45.267	4.317
Construction (N)	0.44	0.00
Starting Year	1,978.78	1,998.89
History (Years)	30.22	10.11
Distance from Chernobyl (km)	1,749.56	2,017.36
Energy		
GDP per unit of energy (2009, %)	6.200	8.533
High technology exports (2009, %)	13.33	14.83
Net Imports	29.90	37.36
TPES per capita (toe)	3.96	3.20
TPES/GDP (PPP)	0.1833	0.1389
Electricity consumption per capita (kWh)	7,787.00	5,801.94
Electric power consumption 2009	7,771.56	5,709.94
GDP per unit of energy use 2009	6.22	8.61
Population, Economy, and CO2		
Population	13.94	20.83
GDP per capita (USD)	24,720	27,995
CO2/TPES	1.8711	2.4544
CO2/pop	7.11	7.89
CO2 emissions (a)	7.811	8.567
CO2 emissions (b)	7.167	7.939
Technology Disaster	1.87	1.83
EPI	63.59	62.12
Education, Green Party and Value		
Mean years of schooling (2009)	11.111	10.461
Seats European MPs	2.33	1.33
Portion of European MPs	6.62	3.48
Seats National MPs	8.00	6.11
Portion of National MPs	2.84	2.47
Environmentalism	2.858	2.805
Ideology	5.710	5.577
Post-materialism	3.33	5.94

Source: IAEA (2011); Eurobarometer 72.2 (Papacostas, 2010).

5. Discussion

This study offers several important contributions to the literature on public acceptance of nuclear power by systematically comparing HNPDCs and LNPDCs across micro-level perceptual determinants and macro-level structural indicators.

First, across all analytical levels, the psychometric paradigm variables consistently emerge as the most powerful predictors of acceptance, confirming the cross-cultural generalizability of the framework established by Slovic (1987) and extended by Visschers and Siegrist (2013). However, the relative importance of specific determinants differs between HNPDCs and LNPDCs in theoretically meaningful ways that reflect the multi-level interplay between structural context and individual cognition. These differences suggest that the explanatory power of psychometric variables is conditioned by national nuclear dependency, rather than operating uniformly across contexts.

Second, the finding that education predicts acceptance only in LNPDCs while information predicts acceptance only in HNPDCs reveals distinct cognitive pathways shaped by nuclear dependency. The significance of residence only in HNPDCs and the differential effects of the two risk measures further demonstrate that macro-level structural conditions shape the micro-level processes through which attitudes are formed, as Prati and Zani (2013) and Jasanoff (2005) have argued from different theoretical perspectives. This indicates that nuclear dependency may influence not only the level of acceptance, but also the way individuals cognitively process and evaluate risk.

Third, the within-HNPDC analysis reveals that nuclear dependency does not produce a homogeneous attitudinal structure. The different dominant predictors across countries—risk in Bulgaria and Lithuania, benefit in Belgium and Sweden, trust in Czech Republic and France—reflect national civic epistemologies and institutional configurations that mediate the general psychometric framework. The macro-level comparison further demonstrates that HNPDCs face a paradoxical political landscape: higher public acceptance coexists with stronger organized environmental opposition, creating conditions for sustained policy conflict. This suggests that nuclear dependency may produce not consensus but a form of attitudinal tension between pragmatic acceptance and organized opposition.

For policymakers, these findings suggest that communication strategies must be tailored to the structural position of nuclear energy within each country's energy system. In HNPDCs, emphasizing comparative risk frameworks and leveraging established information channels may be effective, while in LNPDCs, building institutional trust and addressing personal risk concerns through science communication should take priority.

The relationships among the key variables identified in this study can be organized into an integrative analytical framework with the following causal structure:

1) macro-level nuclear dependency shapes the informational, economic, and political environment within a country;

2) this environment determines which micro-level cognitive resources become relevant for attitude formation—specifically, nuclear-specific information (vs. general education), comparative risk processing (vs. personal/absolutist risk), and direct risk–benefit assessment (vs. trust-based evaluation); and

3) these activated cognitive pathways, in conjunction with individual-level psychometric variables (perceived risk, benefit, trust), determine the level and structure of public nuclear acceptance.

This framework synthesizes the micro-level psychometric tradition with macro-level structural analysis, and clarifies why the same standard predictors operate differently across country contexts. It also explains the paradoxical coexistence of higher acceptance and elevated risk perception in HNPDCs: nuclear dependency activates a more complex, differentiated evaluative structure in which both risk and benefit are salient, rather than suppressing risk awareness in favor of acceptance.

6. Conclusion

This study has demonstrated that the degree of nuclear dependence significantly shapes both the level and the determinant structure of public acceptance of nuclear power in Europe. Using Eurobarometer 72.2 data from 27 EU member states, we compared HNPDCs and LNPDCs across multiple analytical levels and identified several key findings with important theoretical and policy implications.

6.1. Theoretical Implications

First, this study contributes to the psychometric paradigm by demonstrating its cross-national boundary conditions. While Slovic's (1987) framework proves universally relevant in that perceived risk, benefit, and trust consistently predict nuclear acceptance across all country groups, the relative weight of these predictors is systematically moderated by macro-level nuclear dependency.

This finding suggests that the psychometric paradigm should be understood not as a context-free cognitive model but as a framework whose parameters are shaped by the structural environment within which cognition operates. In this sense, the explanatory power of psychometric variables is conditioned by national energy structures rather than operating uniformly across contexts. Future theoretical development should incorporate explicit cross-level interactions between individual psychometric variables and national-level structural characteristics.

Second, the study provides empirical support for the distinction between micro-level perceptual determinants and macro-level structural determinants as theoretically distinct causal pathways. The finding that education (a micro-level variable reflecting general cognitive capacity) predicts acceptance only in LNPDCs while self-assessed information (a micro-level variable reflecting nuclear-specific engagement) predicts acceptance only in HNPDCs demonstrates that macro-level context determines which micro-level cognitive resources become relevant for attitude formation. This pattern is consistent with Jasanoff's (2005) concept of civic epistemologies and suggests that national knowledge production regimes shape the cognitive pathways through which citizens form technology attitudes.

Third, the differential effects of the two risk perception measures contribute to risk perception theory. The finding that personal risk (perceived risk 1) dominates in LNPDCs while comparative risk (perceived risk 2) dominates in HNPDCs suggests that nuclear dependency promotes a shift from absolutist to comparative risk processing.

This transition—from evaluating nuclear risk in isolation to evaluating it relative to other energy risks—represents a qualitative cognitive shift that has not been adequately theorized in the existing literature. We propose the concept of "structurally-induced comparative risk processing" to describe this phenomenon: when a technology is deeply embedded in national infrastructure, citizens develop cognitive frameworks that evaluate its risks comparatively rather than absolutely, because the practical alternatives (and their associated risks) become more cognitively salient. This finding further indicates that nuclear dependency influences not only attitudinal outcomes but also the cognitive mechanisms underlying risk evaluation.

Fourth, the paradox of trust in post-communist HNPDCs contributes to trust theory. The non-significance of trust in Lithuania, Slovakia, and Slovenia challenges the universality of trust as a predictor of technology acceptance and suggests that in low-trust institutional environments, other cognitive pathways—particularly direct risk and benefit assessments—may substitute for trust-based evaluation. This finding extends Mishler and Rose's (2001) work on post-communist institutional trust by demonstrating its implications for technology acceptance specifically, and suggests that Siegrist et al.'s (2000) social trust model may require modification for contexts where baseline institutional trust is low and undifferentiated.

Fifth, the coexistence of higher acceptance and stronger green party representation in HNPDCs contributes to the political sociology of energy. This finding suggests that nuclear dependency generates attitudinal polarization rather than attitudinal consensus. The majority may accept nuclear power through pragmatic acquiescence (as evidenced by the high "maintain" responses), while a mobilized minority channels opposition through green party structures. This polarization dynamic, consistent with Kitschelt's (1986) political opportunity structure framework, suggests that aggregate acceptance levels may overstate the political stability of nuclear programs by masking organized opposition. This also implies that nuclear dependency may produce a form of attitudinal tension between majority acceptance and organized resistance.

Sixth, the affect heuristic framework (Alhakami & Slovic, 1994) receives nuanced support. The finding that HNPDCs simultaneously exhibit higher perceived risk and higher acceptance challenges the simple inverse relationship between risk and acceptance and suggests that nuclear dependency creates a more differentiated evaluative structure in which both risk and benefit perceptions are elevated. This is consistent with a more sophisticated version of the affect heuristic in which familiarity and structural dependency generate complex—rather than simply positive or negative—affective orientations toward technology.

6.2. Limitations and Future Research

Several limitations should be acknowledged. The cross-sectional design precludes causal inference. The data were collected in 2009, prior to the Fukushima disaster, which substantially altered the European nuclear policy landscape. Future research should examine whether these structural differences persisted or were modified in the post-Fukushima era. The 30% threshold for HNPDCs, while data-driven, is somewhat arbitrary, and sensitivity analyses with alternative thresholds would strengthen the findings. Additionally, multi-level modeling approaches that explicitly model cross-level interactions between individual-level and country-level variables would provide more rigorous tests of the theoretical framework developed here.

6.3. Concluding Remarks

Despite these limitations, this study makes a substantive contribution by demonstrating that the structural position of nuclear energy within a country's energy system has significant implications for both the level and the determinant structure of public attitudes. The comparative framework developed here—contrasting HNPDCs and LNPDCs across micro-level perceptual and macro-level structural dimensions—offers a productive analytical lens that can be applied to other energy technologies and policy contexts.

The theoretical concept of structurally-induced comparative risk processing, the identification of trust's boundary conditions in post-communist contexts, and the polarization dynamic between aggregate acceptance and organized opposition all represent contributions to the broader theoretical literature on public acceptance of contested technologies. Overall, these findings underscore the importance of context-sensitive approaches that account for structural differences across countries. As the debate over nuclear energy's role in climate change mitigation continues, understanding the country-specific and context-dependent nature of public acceptance will be essential for developing effective and democratically responsive energy policies.

7. References

Alhakami, A. S., & Slovic, P. (1994). A psychological study of the inverse relationship between perceived risk and perceived benefit. *Risk Analysis*, *14*(6), 1085-1096. https://acortar.link/v87uHL

Bickerstaff, K., Lorenzoni, I., Pidgeon, N. F., Poortinga, W., & Simmons, P. (2008). Reframing nuclear power in the UK energy debate: nuclear power, climate change mitigation and radioactive waste. *Public Understanding of Science*, *17*(2), 145-169. https://hal.science/hal-00571101v1/document

Corner, A., Venables, D., Spence, A., Poortinga, W., Demski, C., & Pidgeon, N. (2011). Nuclear power, climate change and energy security: Exploring British public attitudes. *Energy Polic*y, *39*(9), 4823-4833. https://acortar.link/zkaYJ9

Davidson, D. J., & Freudenburg, W. R. (1996). Gender and Environmental Risk Concerns: A Review and Analysis of Available Research. *Environment and Behavior*, *28*(3), 302-339. https://journals.sagepub.com/doi/10.1177/0013916596283003

European Commission. (2007). Europeans and nuclear safety (Special Eurobarometer 271). European Commission.

European Commission. (2010). Europeans and nuclear safety (Special Eurobarometer 324). European Commission.

Franzen, A., & Vogl, D. (2013). Two decades of measuring environmental attitudes: A comparative analysis of 33 countries. *Global Environmental Change*, *23*(5), 1001-1008. https://acortar.link/nawYFm

Gupta, K., Fischer, M., & Früwirth, R. (2019). Nuclear energy and public opinion: A cross-national analysis. *Energy Policy*, 127, 133-142.

Hsu, A., Esty, D. C., Levy, M. A., & de Sherbinin, A. (2016). *2016 Environmental Performance Index (EPI)*. Yale University.

Inglehart, R. (1995). Public Support for Environmental Protection: Objective Problems and Subjective Values in 43 Societies. *PS: Political Science and Politics*, *28*(1), 57-72. https://acortar.link/SjhF62

International Atomic Energy Agency (IAEA). (2011). *Energy, Electricity and Nuclear Power Estimates for the Period up to 2050*. IAEA.

Jasanoff, S. (2005). *Designs on Nature: Science and Democracy in Europe and the United States*. Princeton University Press.

Jeong, G., & Kim, S. (2018). Green parties and nuclear energy policy in the European Union. *Energy Policy*, 116, 349-356.

Joskow, P. L., & Parsons, J. E. (2012). The future of nuclear power after Fukushima. *Economics of Energy & Environmental Policy*, *1*(2), 99-113. https://acortar.link/jMK86T

Kim, Y., Kim, W., & Kim, M. (2014). An international comparative analysis of public acceptance of nuclear energy. *Energy Policy*, 66, 475-483. https://ideas.repec.org/a/eee/enepol/v66y2014icp475-483.html

Kitschelt, H. P. (1986). Political Opportunity Structures and Political Protest: Anti-Nuclear Movements in Four Democracies. *British Journal of Political Science*, *16*(1), 57-85. https://acortar.link/7Vfxxy

Lehmann, P., Reuland, F., & Stronzik, M. (2015). The spatial effects of nuclear power plants on risk perception and acceptance: Evidence from Germany. *Energy Policy*, 85, 307-319.

Mishler, W., & Rose, R. (2001). What Are the Origins of Political Trust? Testing Institutional and Cultural Theories in Post-communist Societies. *Comparative Political Studies*, *34*(1), 30-62. https://acortar.link/i9LneB

Mol, A. P. J. (2001). *Globalization and Environmental Reform: The Ecological Modernization of the Global Economy*. MIT Press.

Nohrstedt, D. (2008). The Politics of Crisis Policymaking: Chernobyl and Swedish Nuclear Energy Policy. *Policy Studies Journal*, *36*(2), 257-278. https://acortar.link/cOor1i

Papacostas, A. (2010). Eurobarometer 72.2 (September-October 2009) [Data set]. GESIS Data Archive, Cologne. ZA4976, Version 3.0.0. https://doi.org/10.4232/1.11137

Pidgeon, N. F., Lorenzoni, I., & Poortinga, W. (2008). Climate change or nuclear power-No thanks! A quantitative study of public perceptions and risk framing in Britain. *Global Environmental Change*, *18*(1), 69-85. https://acortar.link/AupqZN

Pidgeon, N. F., Poortinga, W., Rowe, G., Horlick-Jones, T., Walls, J., & O'Riordan, T. (2005). Using Surveys in Public Participation Processes for Risk Decision Making. Risk Analysis, 25(2), 467-479.

Poel, I. (2011). Nuclear energy as a fresh judgment: Evidence from Europe. *Energy Policy*, *39*(11), 7068-7076.

Poortinga, W., & Pidgeon, N. F. (2005). Trust in Risk Regulation: Cause or Consequence of the Acceptability of GM Food? *Risk Analysis*, *25*(1), 199-209. https://acortar.link/9KqjbL

Poortinga, W., Pidgeon, N., Lorenzoni, I., & Emmerich, N. (2012). Public perceptions of nuclear power, climate change, and energy options in Britain. Understanding Risk Working Paper 06-02. Centre for Environmental Risk.

Prati, G., & Zani, B. (2013). The Effect of the Fukushima Nuclear Accident on Risk Perception, Antinuclear Behavioral Intentions, Attitude, Trust, Environmental Beliefs, and Values. *Environment and Behavior*, *45*(6), 782-798. https://doi.org/10.1177/0013916512444286

Renn, O., & Marshall, J. P. (2016). Coal, nuclear and renewable energy policies in Germany: From the 1950s to the "Energiewende". *Energy Policy*, 99, 224-232. https://acortar.link/ROoyIo

Siegrist, M., Cvetkovich, G., & Roth, C. (2000). Salient value similarity, social trust, and risk/benefit perception. *Risk Analysis*, *20*(3), 353-362. https://pubmed.ncbi.nlm.nih.gov/10949414/

Slovic, P. (1987). Perception of risk. *Science*, *236*(4799), 280-285. https://acortar.link/ceTwZv

Slovic, P. (1993). Perceived Risk, Trust, and Democracy. *Risk Analysis*, *13*(6), 675-682. https://doi.org/10.1111/j.1539-6924.1993.tb01329.x

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1982). Why study risk perception? *Risk Analysis*, *2*(2), 83-93. https://doi.org/10.1111/j.1539-6924.1982.tb01369.x

Sovacool, B. K., & Valentine, S. V. (2012). *The National Politics of Nuclear Power: Economics, Security, and Governance*. Routledge.

Stoutenborough, J. W., Sturgess, S. G., & Vedlitz, A. (2013). Knowledge, risk, and policy support: Public perceptions of nuclear power. *Energy Policy*, 62, 176-184.

Tanaka, Y. (2004). Major Psychological Factors Determining Public Acceptance of the Siting of Nuclear Facilities. *Journal of Applied Social Psychology*, *34*(6), 1147-1165.

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science*, *185*(4157), 1124-1131.

Venables, D., Pidgeon, N. F., Parkhill, K. A., Henwood, K. L., & Simmons, P. (2012). Living with nuclear power: Sense of place, proximity, and risk perceptions in local host communities. *Journal of Environmental Psychology*, *32*(4), 371-383. https://acortar.link/sTnmRV

Visschers, V. H. M., & Siegrist, M. (2013). How a Nuclear Power Plant Accident Influences Acceptance of Nuclear Power. *Risk Analysis*, *33*(2), 333-347. https://doi.org/10.1111/j.1539-6924.2012.01861.x

Whitfield, S. C., Rosa, E. A., Dan, A. and Dietz, T. (2009). The Future of Nuclear Power: Value Orientations and Risk Perception. *Risk Analysis*, *29*(3), 425-437. https://doi.org/10.1111/j.1539-6924.2008.01155.x

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