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FORECASTING CONSTRUCTION IN EUROPE: THE LEADING ROLE OF BUILDING PERMITS IN COST MANAGEMENT

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Abstract:

This study examines how building permits predict next-year construction outcomes across Europe's main subsectors, Building Construction(BC), Civil Engineering(CE), and Specialized Construction(SC), from 2005 to 2023. Using Eurostat data for 28 European countries, the analysis applies dynamic panel Fixed-Effects(FE) models with Driscoll-Kraay standard errors to estimate elasticities linking permit volumes to turnover, employment, and profitability. Results reveal substantial heterogeneity across subsectors and countries. Building Construction and Specialized Construction show strong responsiveness to permit activity, particularly in employment and turnover, while Civil Engineering effects are mainly labor-related. Beyond permit volumes, the study evaluates the role of project composition. The findings indicate that smaller, more numerous projects generate higher economic returns per m², emphasizing the relevance of average project size for cost management efficiency and resource allocation. A structural break emerges after 2020, as the COVID-19 shock intensified the traditional permit-performance transmission mechanism, leading to higher elasticities. Country-specific results diverge markedly, suggesting that institutional capacity and market structure shape how permits translate into realized activity. Findings underscore permits not only as planning indicators but also as strategic tools for forecasting, cost management, and portfolio optimization, offering relevant insights for construction firms, policymakers, and regulators operating in various European markets.

Key words: *Economic forecasting, Management, Construction, Building Permits, Panel Data*

1. Introduction

The construction sector is a pillar segment in Europe's economic architecture. Its cycles not only mirror but often amplify broader economic trends. Timely predictions of construction activity support macroeconomic stability, investment planning, cost management, and resource allocation. Building permits have long been viewed as leading indicators of future construction dynamics. However, despite their widespread use in forecasting, gaps persist in understanding how these permits translate into real economic outcomes and influence project cost management strategies.

Existing research frequently treats the construction industry as a monolith, overlooking the distinct behaviours of its key segments, Building Construction(BC), Civil Engineering(CE), and Specialized Construction(SC). Similarly, many studies assume uniform relationships across nations and economic cycles, failing to account for the profound shocks introduced by societal or economic crises. Moreover, the qualitative aspects of what is permitted, such as the average size of projects, are often neglected despite their potential influence on project portfolio cost efficiency, employment intensity and resource allocation.

This study seeks to address these gaps by providing a thorough analysis of the permit-to-activity link across Europe from 2005 to 2023, for construction managers and government planners. By disaggregating outcomes by subsector, our findings transform building permits from a mere planning indicator into a proactive tool for cost management, informing strategic decisions on resource allocation, portfolio composition, and country-specific forecasting error mitigation.

2. Literature review

2.1. Permits as forward-looking macroeconomic indicators

The construction sector contributes directly to gross domestic product(GDP), employment, and infrastructure formation while closely reflecting broader economic stability (Alaloul et al., 2022). Within this framework, building permits extend beyond administrative authorization. They regulate construction activity, shape planning lead times and managerial costs, and signal forthcoming investment intentions (Mpié Simba et al., 2023). By specifying location, floor area, and intended use, permits embed expectations regarding urban growth, renovation cycles, and sustainability objectives (Mpié Simba et al., 2023; Fauth et al., 2024).

Empirical research increasingly treats permits as forward-looking macroeconomic indicators. The dwelling and floor area indices are core short-term business cycle measures, with permit volumes closely tracking downturns and their volatility predicting financial market fluctuations up to 18 months ahead (Eurostat, 2025; Cortes and LaPoint, 2024; Parhusip and Iqbal, 2025). Theoretical models show that regulatory frictions in permitting can amplify macroeconomic volatility and transmit interest-rate shocks (Gete, 2014), while broader structural linkages, such as export performance dynamics, shape construction expectations and domestic investment cycles (Vancea et al., 2021).

Digitalization reforms seek to enhance transparency and coordination in permitting systems (Ataide et al., 2023; Riau and Pasaribu, 2024; Fauth et al., 2022), and integration with Geographic Information Systems(GIS) improves spatial planning and data consistency (Mpié Simba et al., 2023). Nevertheless, institutional fragmentation and procedural opacity across jurisdictions continue to generate frictions that may delay economic adjustment (Ataide et al., 2023; Fauth et al., 2025; Fauth and Soibelman, 2022). Similar regulatory complexities in other sectors demonstrate how institutional environments can amplify volatility (Aivaz et al., 2022; Aivaz et al., 2023).

Although this literature establishes permits as economically relevant and institutionally embedded instruments, much of the evidence remains U.S.-focused, simulation-based, or centered on administrative reform. Cross-country econometric analysis linking disaggregated permit issuance to sectoral performance outcomes remains limited.

2.2. Construction Sector Cyclicality and Forecasting Dynamics

The construction industry is strongly pro-cyclical, expanding during economic booms and contracting sharply during downturns due to its reliance on external financing and deferrable investment decisions (European Central Bank, 2009; Okoye et al., 2016). Sectoral shocks often transmit to the broader economy (Alaloul et al., 2022), and employment dynamics display pronounced asymmetry, with construction jobs peaking early in expansions and declining rapidly during recessions (Hadi, 2011).

Macroeconomic disturbances, including the COVID-19 pandemic, further demonstrate the vulnerability of construction activity to supply chain disruptions and labor market constraints (Selçuk, 2025). Given this cyclical sensitivity, permits are sought after tools for strategic construction planning and cost management. Similar cyclical sensitivities are observed in other regulated infrastructure sectors, where operational efficiency and profitability respond strongly to institutional and economic shifts (Aivaz et al., 2025).

Because construction demand is derived from broader economic activity, shifts in permit volumes signal anticipated changes in investment cycles (Low and Lau, 2019). However, predictive strength varies across institutional settings. Elastic housing markets display stronger permit-financial volatility linkages than highly regulated ones (Cortes and LaPoint, 2024). Streamlined permitting systems operate as a macroeconomic lever that amplifies the managerial impact of investment decisions. They also enhance responsiveness, while costly or slow procedures dampen adjustment dynamics (Gete, 2014). Consequently, interpreting aggregate permit data without accounting for subsectoral and institutional heterogeneity risks oversimplification.

Despite evidence of cyclicality, much of the literature relies on descriptive macroeconomic analysis or single-country time-series approaches. Systematic cross-country panel estimation distinguishing construction subsectors remains underdeveloped.

2.3. Methodological Approaches in Panel Econometrics

Panel econometric techniques are particularly suited to examining construction dynamics across countries and over time. By combining cross-sectional and time-series

dimensions, panel data control for unobserved heterogeneity and capture structural differences across national contexts (Supianti, 2023; Fauth et al., 2025).

Robust inference requires addressing heteroskedasticity, serial correlation, and cross-sectional dependence. Fixed Effects(FE) Models and associated specification tests are widely employed in applied macroeconomic analysis (Supianti, 2023). Driscoll-Kraay standard errors provide consistent inference under cross-sectional dependence (Mehmood and Mustafa, 2014; Millo, 2017), while dynamic modeling approaches in regulated sectors demonstrate the importance of long-run adjustment mechanisms (Aivaz et al., 2025). Broader econometric guidance emphasizes careful specification and robustness diagnostics in multivariate settings (Hair et al., 2021).

Despite the availability of advanced econometric tools, their application to building permit dynamics remains limited. Existing studies either emphasize process modeling (Fauth et al., 2025) or spatial micro-analysis (Mpié Simba et al., 2023), rather than macro-level cross-country forecasting of turnover, employment, and profitability.

Table 1. Structured Synthesis and Positioning of the Current Study

Study	Core Focus	Data Context	Methods	Key Insight	Contribution Relative to Current Study
Cortes & LaPoint (2024); Gete (2014)	Permits as macro-financial signals	U.S.; macro simulations	Long-run macro modeling	Permits anticipate downturns; regulatory frictions amplify volatility	Shifts from U.S. macro theory to EU panel estimation of subsectoral turnover, employment, and surplus elasticities.
ECB (2009); Alaloul et al. (2022); Low & Hou (2019); Hadi (2011)	Construction cyclicality	Euro area; USA; China; UK	Descriptive macro; impulse response	Construction is pro-cyclical and employment-sensitive	Provides harmonized EU subsector-level elasticities with robust cross-sectional correction.
Fauth & Soibelman (2022); Fauth et al. (2022-2025); Ataide et al. (2023)	Permit systems and digitalization	Europe; USA; Italy	Institutional comparison; digital maturity	Digitalized permitting improves efficiency	Moves from administrative efficiency analysis to macroeconomic impact of aggregated permits.
Millo (2017); Mehmood & Mustafa (2014); Supianti (2023)	Panel methodology	Cross-country panels	FE tests; Driscoll-Kraay	Correcting cross-sectional dependence is essential	Establishes econometric basis for two-way FE with Driscoll-Kraay used here.
Aivaz et al. (2022; 2025); Selçuk (2025)	Regulation and crisis shocks	Regulated sectors	Multivariate; dynamic panels	Regulated sectors are shock-sensitive	Applies shock-transmission logic to EU construction permits pre- and post-2020.

Source: Own processing based on Literature Review

Table 1 consolidates the main research streams and their methodological approaches. Despite extensive work on permits, construction cyclicality, and econometric techniques, these strands remain insufficiently integrated. Cross-country panel evidence connecting disaggregated permit issuance to subsector performance is scarce.

2.4. Research Gap and Contribution

The literature converges around the three interconnected streams of building permits as forward-looking macroeconomic indicators, construction as a pro-cyclical and shock-sensitive sector, and the availability of panel econometric tools to model cross-country heterogeneity and dynamic adjustment. Yet these strands remain insufficiently integrated. Empirical cross-country panel evidence linking disaggregated permit issuance to subsector-level performance remains limited.

By disaggregating construction subsectors, incorporating project scale, and estimating two-way Fixed Effects(FE) models with Driscoll-Kraay corrections across European countries, this study bridges administrative, macroeconomic, and econometric perspectives. It advances the literature from descriptive cyclicality and process-level reform toward a quantitative evaluation of permit elasticities and their implications for sectoral resilience and policy design.

3. Methodology

3.1. Research Questions, Objectives, and Hypotheses

The research is guided by a focused set of research questions (RQ) and hypotheses (H) designed to provide a coherent deep analysis of the core issues. The objectives are to quantify and compare permit elasticities across subsectors, assess their stability and cross-country heterogeneity, and test whether average project size adds predictive content beyond permit volumes for construction management and cost planning.

RQ1: How substantial do building permits predict next-year economic activity across Europe's construction subsectors, and how do these predictive relationships vary by country and economic region?

RQ2: Does the composition of permitted projects (proxied by average project size), independently influence construction outcomes beyond the effect of permit volume?

H1 (Positive Elasticity): Permit volumes exhibit a positive and statistically significant predictive relationship with next-year construction activity, with magnitudes varying by subsector and outcome.

H2 (Heterogeneity and Structural Change): Permit elasticities display significant cross-country heterogeneity and structural reconfiguration following COVID-19.

H3 (Compositional Effects): Average project size exerts a statistically significant, independent effect on construction outcomes, suggesting that optimized cost management require strategic attention to project portfolio mix and scale.

2.2. Data Description and preparation

The European dataset (Table 2) is structured to support panel analysis. It draws on harmonized statistics from Eurostat, covering 27 European Union(EU) member states plus Norway, over the time frame 2005-2023, with 532 observations. The data encompass a rich combination of permit indicators, sector-specific outcomes, macroeconomic control, and a derived variable.

Table 2. Data organization and description

Category	Indicator	Variable	Description
Permit Predictors (t–1)	Dwelling permits	permits_dwellings_lag1	Number of dwelling permits (thousands)
	Floor area permits	permits_area_lag1	Total permitted floor area (million(M) m²)
Outcomes (t+1)	Turnover	bc_turnover; ce_turnover; sc_turnover	Construction turnover (M€)
	Gross operating surplus	bc_gross_surplus; ce_gross_surplus; sc_gross_surplus	Profitability indicator (M€)
	Personnel costs	bc_personnel_cost; ce_personnel_cost; sc_personnel_cost	Labor cost indicator (M€)
	Employees	bc_employees_number; ce_employees; sc_employees	Number of employees
	Investment	bc_investments; ce_investments; sc_investments	Gross investment in tangible assets (M€)
Control Variable	GDP growth	gdp_growth	Real GDP annual growth (%)
Derived Variable	Average m² per dwelling	m2_per_dwelling	Floor area divided by number of dwelling permits

Source: Own processing and organizing the data

Note: Detailed dataset information are reported in Appendix A1.

Table 3 presents key descriptive statistics for all the variables. The broad ranges, highlight the vast cross-country heterogeneity in construction activity, underlining the need for FE modelling. Thus, it provides context for interpreting the magnitudes of the regression coefficients.

Table 3. Descriptive Statistics

Variable	Mean	SD	Median	Min	Max
BP_area_m2	7.95	12.30	3.90	0.30	116.70
BP_dwellings_thousands	64.61	105.	29.10	2.10	735
gdp_growth	2.12	4.03	2.30	-16.04	24.62
bc_turnover	21,560.50	32,648	9,986.80	374.20	279,323.70
bc_gross_surplus	2,074.40	4,015	837.90	-3,250	38,172.70
bc_investments	951.80	1,490	386.40	5.80	15,085.60
bc_personnel_cost	3,152.50	4,600	1,371.20	40.40	35,203.40

bc_employees_number	102,824	134,489	58,405	2,725	1,196,412
ce_turnover	8,635.60	11,100	4,407.80	71.10	67,266.20
ce_gross_surplus	678.80	1,000	326	-7.10	7,736.60
ce_investments	475.80	833	193.90	1.30	12,358.50
ce_personnel_costs	1,798.70	2,800	699	10.70	16,283.50
ce_employees	49,710	59,415	24,402	669	293,910
sc_turnover	27,359	46,700	8,137	201	273,921
sc_gross_surplus	3,195.70	5,560	1,176.90	14.40	41,487.60
sc_investments	836.80	1,310	329.98	3.50	7,568.22
sc_personnel_cost	7,078.60	13,200	1,562.20	41.20	74,412
sc_employees	203,611	331,000	91,263	2,815	1,815,752

Source: Own processing via RStudio

The one-year lag specification is motivated by both data structure and sectoral production dynamics. Given the annual frequency of the panel, shorter lags are not observable. From an economic standpoint, building permits typically materialize into measurable construction output within the following fiscal year, when financing, mobilization, and execution converge.

To assess robustness, Appendix A3 reports two-year lag specifications. Across all subsectors, permit coefficients remain positive and statistically significant, although elasticities decline relative to the one-year models. This attenuation confirms that the strongest transmission of permit signals occurs within the first year, with diminishing but persistent effects thereafter. These findings support the one-year lag as the most economically meaningful and empirically powerful specification.

Missing values arise solely from the mechanical construction of lagged permit variables (first year of each country series). These observations were excluded via complete-case handling. No additional missing data were identified and no imputation procedures were required.

2.3. Econometric Methodology

We estimated two-way FE panel regressions to examine the effect of building permits on next-year construction outcomes (turnover, gross surplus, personnel cost, employment, investments), controlling for GDP growth (Equation 1).

$$Outcome_{ict+1} = \beta_0 + \beta_1 \, x \, Permits_{ict} + \beta_2 \, x \, GDP_growth_{ct} + \mu_i + \lambda_t + \varepsilon_{ict} \qquad (1)$$

where μ_i and λ_t denote country and year fixed effects, respectively.

Hausman test results (e.g., p=2.07×10^{-11} for Building Gross Surplus) supported FE over Random Effects(RE) for most models. For the few not rejecting RE, estimates were nearly identical, so FE was used uniformly for consistency. Significant cross-sectional dependence indicated by Pesaran CD test (e.g., z=28.4 for Specialized Gross Surplus) justified the use of Driscoll-Kraay standard errors to correct for spatial and serial correlation. Multicollinearity checks via variance inflation factor(VIF) (Appendix A2)

confirmed no collinearity concerns. To capture country-specific heterogeneity, we also estimated random-slopes mixed models (Equation 2):

$$Outcome_{ict+1} = (\beta_0 + u_{0_i}) + (\beta_1 + u_{1_i}) \times Permits_{ict} + \beta_2 \times GDP_growth_{ct} + \varepsilon_{ict} \quad (2)$$

where, β_1 denotes the average permit elasticity, identical to the fixed slope estimated in Equation (1), while u_{1i} captures country-specific deviations. This allowed permit elasticities ($\beta_1 + u_{1_i}$) to vary by country, reflecting local conditions.

All permit-outcome combinations included both lagged permit variables and GDP growth. At this stage, models were evaluated according to three explicit criteria. These are (1) statistical significance of the permit coefficient ($p < 0.05$, with priority given to 1% significance), (2) economic magnitude of the elasticity relative to sector scale, and (3) explanatory power measured by within-R^2. The objective was to identify economically meaningful predictive relationships rather than optimize mechanical fit statistics, as models represent distinct permit-outcome pairs rather than nested alternatives. The selected Champion relationships were subjected to deeper analysis including Driscoll-Kraay inference, structural break specifications (interaction with a post-2020 dummy) and inclusion of project composition controls. For Specialized Construction, Driscoll-Kraay errors were applied from the initial screening stage due to cross-sectional dependence. The screening included both permit variables, but in the final champion models, only the dominant predictor was retained.

This two-stage approach ensures comparability across subsectors while accounting for heterogeneity and cross-sectional dependence. Prior to estimation, scatterplots and Loess-smoothed curves were inspected to check for non-linearities and outliers. These confirmed generally monotonic relationships with mild diminishing returns at very high permit volumes.

4. Results/findings

4.1. Initial Testing and Champion Model Selection

Table 4 reports the baseline FE estimates used to identify statistically robust and economically meaningful permit-outcome relationships across subsectors(Table 4).

Table 4. Initial Screening Results and Champion Selection

Outcome	Permit Predictor	Estimate	Std. Error	p-value	R^2(within)	R^2(overall)	Champion Status
			Building Construction(BC)				
Turnover	permits_area_lag1	1,806.1	774.4	0.020	0.708	0.767	Chosen
Gross Surplus	permits_dwellings_lag1	45.8	5.89	<0.001	0.708	0.735	Chosen
Employees	permits_area_lag1	8,463.3	577.6	<0.001	0.811	0.797	Chosen
Personnel Cost	permits_dwellings_lag1	31.77	5.33	<0.001	0.616	0.715	Not Chosen

Investments	permits_dwellings_lag1	12.49	1.27	<0.001	0.433	0.547	Not Chosen
			Civil Engineering(CE)				
Turnover	permits_area_lag1	394.0	257.0	0.126	0.229	0.691	Not Chosen
Gross Surplus	permits_dwellings_lag1	1.97	7.34	0.788	0.130	0.447	Not Chosen
Personnel Cost	permits_dwellings_lag1	-3.59	11.2	0.750	0.109	0.638	Not Chosen
Employees	permits_area_lag1	2,515.0	864.0	0.0038	0.485	0.748	Chosen
Investments	permits_dwellings_lag1	-2.57	3.19	0.420	0.009	0.231	Not Chosen
			Specialized Construction(SC)				
Turnover	permits_area_lag1	304.0	213.0	0.158	0.167	0.633	Not Chosen
Gross Surplus	permits_dwellings_lag1	25.5	5.84	<0.001	0.128	0.410	Chosen
Personnel Cost	permits_dwellings_lag1	9.69	13.0	0.457	0.150	0.631	Not Chosen
Employees	permits_area_lag1	4,577.0	786.0	<0.001	0.462	0.691	Chosen
Investments	permits_dwellings_lag1	5.29	2.15	0.014	0.122	0.584	Not Chosen

Source: Own processing via RStudio

For the BC subsector, lagged permit area robustly predicted turnover (≈1,806 M€ per Mm²) and especially employment, forecasting 8,463 additional employees per Mm². Lagged dwelling permits also strongly predicted gross surplus (45.8 M€ per thousand units). In CE, only employment showed a consistent link to lagged permit area, predicting 2,515 employees per Mm². SC initially showed no significant results with country-clustered errors, but re-estimation using Driscoll-Kraay revealed highly significant effects. Employment rose by 4,577 per Mm² and gross surplus by 25.5 M€ per thousand units. This underscores how robust error estimation is imperative for uncovering true relationships in complex panel data. Reporting both R^2 measures provides practical value for stakeholders. For BC, the high R^2within identifies permits as a sensitive early warning system for tactical resource adjustments. In contrast, the gap between R^2 measures in CE and SC indicates these subsectors are influenced more by long-term infrastructure stability and maintenance cycles than by short-term permit fluctuations. Consequently, permits serve as high-precision tactical tools for building projects, while acting as broader strategic baseline indicators for specialized and infrastructure works.

3.2. Champion Models analysis

Table 5 presents that permit elasticities are positive and significant for these key outcomes(H1). A one Mm² increase in area permits predicts ≈€1.8 billion more Building turnover and about 8,500 additional jobs in the following year. Similarly, a 1,000-unit increase in dwelling permits forecasts an additional €45.8 million in gross surplus. The high

R^2within values, particularly for employment, suggest that these models explain a substantial proportion of the within-country variation in construction outcomes.

Table 5. BC Champion Models: Elasticities and Robustness

Outcome	Permit Predictor	Estimate	Std. Error	p-value	R^2(within)	95% CI (Lower)	95% CI (Upper)	Signif.
Turnover	permits_area_lag1	1,806.0	204.1	<0.001	0.708	1,407.0	2,205.0	***
Gross Surplus	permits_dwellings_lag1	45.8	1.98	<0.001	0.708	41.9	49.6	***
Employment	permits_area_lag1	8,463.3	296.5	<0.001	0.811	7,883.0	9,044.0	***

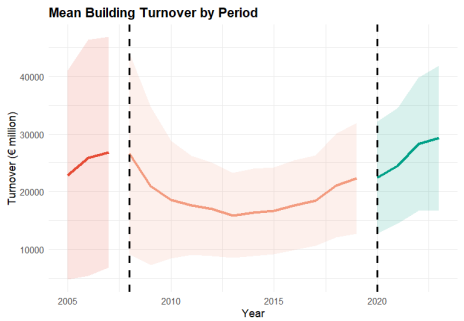
Source: Own processing via RStudio

Note: Estimates for Turnover and Gross Surplus are in M€. Employment is in number of employees. Permits are in Mm² for area and thousands for dwellings.

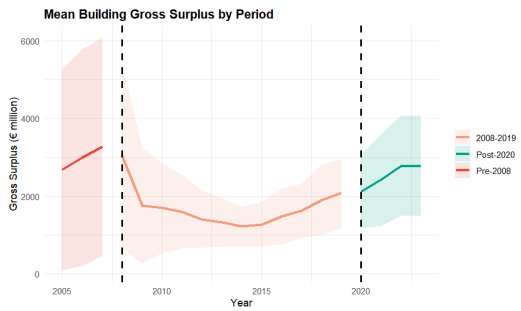
Figure 1 (a-c) trace the evolution of key building sector outcomes across three distinct periods (pre-2008, 2008 to 2020, post-2020 recovery). Both turnover and gross surplus follow a U-shaped trajectory, dropping sharply after the 2008 financial crisis to lows around 2013-2015 before gradually recovering.

Figure 1. BC: Mean Trends Pre vs. Post Crisis for Champion Outcomes with 95% confidence bands

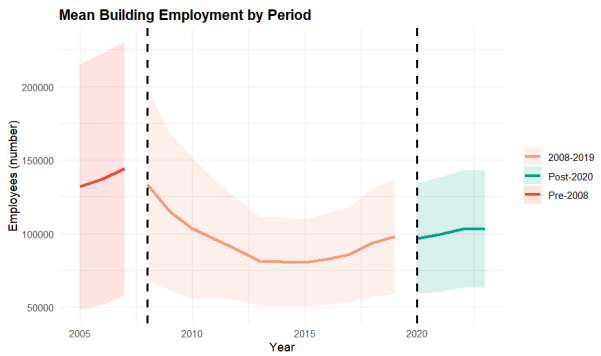
(a)Building Turnover



(b)Building Gross Surplus



(c)Building Employment



Source: Own processing via RStudio

Post-2020, turnover increases more rapidly than employment, indicating a divergence between output and workforce dynamics. Gross surplus recovers more gradually relative to turnover.

Table 6 reports the CE Champion specification. Lagged permit area is positively and statistically significantly associated with CE employment. One Mm² increase area permits predicts approximately 1,662 additional employees in the sector in the subsequent year.

Table 6. CE Champion Model: Elasticity and Robustness

Outcome	Permit Predictor	Estimate	Std. Error	p-value	R^2 (within)	95% CI (Lower)	95% CI (Upper)	Signif.
Civil Employment	permits_area_lag1	1,662.1	61.1	<0.001	0.476	1,543.0	1781.0	***

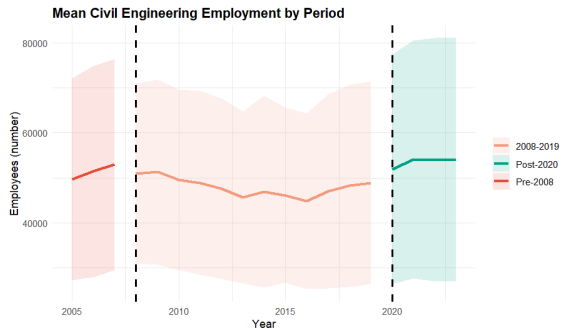
Source: Own processing via RStudio

Note: Estimate is in number of employees. Permits are in Mm².

This relationship is highly significant and the model explains 47.6% of the within-country variation in civilian employment. Thus, it suggests this sector is characterized by higher capital intensity and scale efficiency, requiring fewer marginal jobs per unit of area.

Figure 2 presents the average employment trend across three periods (pre-2008, 2008-2020, post-2020). Employment declines during the post-2008 contraction, recovers by 2019, and increases modestly after 2020 signalling not just recovery but modest growth beyond pre-crisis levels.

Figure 2. Mean Trend Pre vs. Post Crisis for CE with 95% confidence bands



Source: Own processing via RStudio

Table 7 reports the Specialized Construction Champion models estimated. Both selected relationships are positive and statistically significant.

Table 7. SC Champion Models: Elasticities and Robustness

Outcome	Permit Predictor	Estimate	Std. Error	p-value	R^2 (within)	95% CI (Lower)	95% CI (Upper)	Signif.
Gross Surplus	permits_dwellings_lag1	16.9	3.07	<0.001	0.126	10.9	22.9	***
Employment	permits_area_lag1	7,649.3	709.1	< 0.001	0.456	6,259.0	9,039.0	***

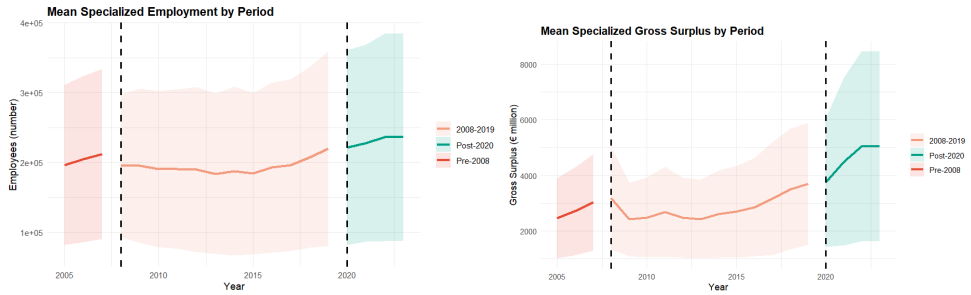
Source: Own processing via RStudio

Note: Estimates for Gross Surplus are in M€. Employment is in number of employees. Permits are in thousands for dwellings and Mm² for area.

Lagged dwelling permits significantly predict gross surplus (16.9 M€ per 1,000 units). Also, lagged permit area significantly predicts employment (7,649 jobs per Mm²). R^2within values are 0.126 for gross surplus and 0.456 for employment. This pattern indicates demand for specialized trades, requiring strategic labour resource management, but suggests cost pressures (H1) may limit profit margins more severely than in general building construction.

Figure 3. SC: Mean Trends Pre vs. Post-2020 for Champion Outcomes with 95% confidence bands

(a)Specialized Employment (b)Specialized Gross Surplus



Source: Own processing via RStudio

Figures 3 (a-b) show how SC employment and gross surplus evolved across three periods pre-2008, 2008-2019, and post-2020. Employment declines during the post-2008 contraction, recovers by 2019, and increases further after 2020. Gross surplus follows a similar contraction-recovery pattern, with higher levels observed after 2020.

To formally assess whether the permit-activity relationship shifted after 2020, we estimate interaction-based structural break specifications (Table 8). The post-2020 slope is computed as the sum of the baseline permit coefficient and its interaction with the post-2020 dummy.

The results, indicate statistically significant structural shifts in four of the five Champion Models. In BC, turnover elasticity increases from 2,099 to 2,730, and gross surplus elasticity increases from 45.51 to 49.87. The change in employment elasticity is not statistically significant. In CE, employment elasticity increases from 1,630 to 3,338. In SC, both gross surplus (15.65 to 36.59) and employment (7,531 to 13,911) exhibit statistically significant post-2020 increases in responsiveness.

Table 8. Pre- and Post-COVID Permit Slopes for Champion Models (Structural Break Specification)

Subsector	Champion Model	Permit Type	Pre-2020 Slope	Post-2020 Slope	Break p-value	R^2 (within)
Building	Turnover	Area permits	+2,099 M€	+2,730 M€	<0.001	0.731

	Gross Surplus	Dwelling permits	+45.51 M€	+49.87 M€	0.036	0.713
	Employment	Area permits	+8,451 jobs	+9,088 jobs	0.183	0.813
Civil Engineering	Employment	Area permits	+1,630 jobs	+3,338 jobs	<0.001	0.657
Specialised Construction	Gross Surplus	Dwelling permits	+15.65 M€	+36.59 M€	<0.001	0.257
	Employment	Area permits	+7,531 jobs	+13,911 jobs	<0.001	0.571

Source: Own processing via RStudio

Note: Coefficients represent two-way FE estimates from interaction (Chow-type) models allowing for post-2020 slope shifts. Break p-values refer to Driscoll–Kraay tests of the interaction term.

3.3. Country-Level Heterogeneity in Permit Elasticities

Addressing (RQ1), cross-country heterogeneity was quantifyed in permit-to-outcome elasticities. This specification allows the permit elasticity to vary across countries, with country-specific slopes obtained by combining the common FE estimate with each country's random deviation.

The division of countries into regional groups (Table 9) serves a comparative interpretative purpose rather than an econometric one. All models are estimated at the country level. The clustering is introduced solely to structure cross-country heterogeneity in a systematic manner. The regional classification combines geographic proximity with similarities in economic integration, construction market maturity, and structural responsiveness to investment cycles. In particular, Central Europe reflects economies closely integrated into the continental industrial core with relatively stable construction markets, while South-Eastern Europe captures later-convergence economies characterized by higher labor intensity and more volatile investment cycles. This structured grouping enables meaningful regional comparison without influencing the underlying slope estimation.

Table 9. Regional grouping

Region	Countries
Nordic	Denmark, Sweden, Finland, Norway
Western	France, Belgium, Netherlands, Ireland, Luxembourg
Central	Germany, Austria, Poland, Czechia, Slovakia, Hungary, Slovenia
Southern	Italy, Spain, Portugal, Greece, Cyprus, Malta
South-Eastern	Romania, Bulgaria, Croatia, Estonia, Latvia, Lithuania

Source: Own processing

Likewise, the focused selection of Denmark, Estonia, France, Germany, Italy, Poland, Romania, and Spain was designed to capture this diversity within a manageable analytical scope (Table 11). It balances mature economies (Germany, France), dynamic growth markets (Poland, Romania), crisis-and-recovery stories (Italy, Spain), the stable, high-value Nordic model (Denmark), and Estonia's distinctive digital-transitional profile. This deliberate sampling moves beyond simple averages, enabling a nuanced exploration

of the varied national pathways and strategic contrasts that characterize Europe's complex construction landscape.

Table 10. Summary of Country-Specific Random Slopes

Outcome	Average Slope (Fixed Effect)	Min Slope	Max Slope	Std. Dev. of Slopes
Building Turnover	+1,485 M €/m^2	-248 M €	+3,649 M €	745 M €
Building Gross Surplus	+21.4 M €/m²	-2.08 M €	+53.0 M €	11.4 M €
Building Employment	+5,998 jobs/m²	+18 jobs	+17,886 jobs	3,040 jobs
Civil Engineering Employment	+1,356 jobs/m²	-318 jobs	+5,493 jobs	1,022 jobs
Specialised Gross Surplus	+28.1 M €/1000 dwellings	+1.14 M €	+156 M €	26.7 M €
Specialised Employment	+7,557 jobs/m²	+1,184 jobs	+39,046 jobs	6,735 jobs

Source: Own processing via RStudio

Note: Slopes measure the change in the outcome per 1 Mm² of permit area or per 1,000 dwellings (for gross surplus), estimated via mixed-effects models with country-specific random slopes

The results (Table 10) elucidates marked cross-country heterogeneity, quantifying the extent of regulatory and economic variance that construction managers must navigate. The data explicitly supports H2, showing that relying on a single EU-wide average for planning is fundamentally unsound. Building Employment has an average elasticity of +5,998 jobs per Mm², with country-level slopes ranging from +18 to +17,886 and a standard deviation of 3,040 jobs. Building Turnover ranges from −248 to +3,649 M€ per Mm². Specialized Employment exhibits particularly wide variation, ranging from +1,184 to +39,046 jobs per Mm².

Table 11. Country-Specific Slopes for Selected Countries for Champion Outcomes

Country	Building Turnover (M€/Mm²)	Building Gross Surplus (M€/1000 dwellings)	Building Employment (jobs/Mm²)	Civil Engineering Employment (jobs/Mm²)	Specialised Gross Surplus (M€/1000 dwellings)	Specialised Employment (jobs/Mm²)
Denmark	1,601	16.1	3,858	1,158	27.0	10,651
Estonia	1,577	19.3	5,938	1,548	32.1	8,019
France	-248	8.02	18	-318	15.8	1,184
Germany	2,534	36.1	5,593	5,493	156.0	39,046
Italy	3,649	53.0	17,886	147	1.14	4,761
Poland	1,729	21.6	5,236	1,958	11.2	7,174
Romania	1,164	19.8	9,523	1,402	16.1	5,104
Spain	2,077	48.6	7,868	1,441	10.8	5,805

Source: Own processing via RStudio

Note: Slopes for Building Turnover, Building Employment, Civil Engineering Employment, and Specialized Employment are per Mm² of area permits. Slopes for Building Gross Surplus and Specialized Gross Surplus are per 1,000 dwellings.

Selected country-level slopes are reported in Table 11. France exhibits near-zero or negative slopes in several outcomes, including Building Turnover (−248 M€/Mm²) and Civil Engineering Employment (−318 jobs/Mm²). In contrast, Germany shows comparatively high elasticities across multiple sectors, particularly in Specialized Employment (+39,046 jobs/Mm²). Italy, while strong in employment, shows limited profitability (+1.14 M€/1,000 dwellings), likely reflecting price competition in fragmented markets. Romania emphasizes labour-intensive growth (+9,523 building jobs), while Poland blends strong turnover and civil engineering outcomes with a modest specialized surplus. Denmark, Estonia, and Spain represent more balanced profiles. These differences reflect not just economic variance but quantifiable management differentials rooted in labour flexibility, firm structure, and regulatory friction.

Table 12. Summary of Mean Regional Slopes for Champion Outcomes

Region	Building Construction Turnover (M €/m²)	Building Construction Gross Surplus (M €/m²)	Building Construction Employment (jobs/m²)	Civil Engineering Employment (jobs/m²)	Specialized Construction Gross Surplus (M€/1,000 dwell.)	Specialized Construction Employment (jobs/m²)
Nordic	1,828.3	21.3	5,031.5	1,367.3	30.5	9,200.7
Western	733.4	17.5	3,171.0	526.0	21.9	4,009.2
Central	1,780.3	21.5	5,833.3	1,953.5	43.3	12,142.7
Southern	1,655.5	27.7	8,096.7	1,270.5	15.7	4,522.3
S-Eastern	1,366.9	18.6	7,262.5	1,428.2	26.5	7,102.8

Source: Own processing via RStudio

Regional averages (Table 12) indicate that Nordic and Central European countries display higher mean permit elasticities in turnover and civil engineering employment relative to Western Europe. The Southern European group exhibits comparatively high building gross surplus elasticities (≈27.7 M€/1,000 dwellings) and elevated hiring responsiveness, influenced by Italy's particularly large Building Employment slope (+17,886 jobs/Mm²). In contrast, South-Eastern European countries exhibit moderate turnover responsiveness but comparatively higher employment elasticities, suggesting a more labor-intensive adjustment pattern relative to the Central and Nordic clusters.

3.4. Champion Models with Average Project Size as Additional Regressor

To assess the independent effect of project composition (RQ2, H3), the champion models were re-estimated with the average size of permitted dwellings included as an additional regressor. The results (Table 13) show that permit volumes remain strong predictors across outcomes, but project size itself has negative effects in three cases. Each additional m² per dwelling corresponds to roughly €129 million less turnover and about 330 fewer building jobs, with a similar pattern in specialized employment.

Table 13. Champion Models with Average Project Size as Additional Regressor

Model	Key Term	Estimate	Std. Error	p-value	Interpretation
Building Turnover	permits_area_lag1	2,035	103	< 0.001	Each additional Mm² of permits still predicts €2,035 m of turnover, controlling for size.
	m2_per_dwelling	-129	26.0	< 0.001	Larger average project size reduces turnover by €129/m².
	gdp_growth	24.0	120	0.84	No GDP effect.
Building Gross Surplus	permits_dwellings_lag1	45.1	1.77	< 0.001	Dwelling permits predict €45.1 m in surplus.
	m2_per_dwelling	-6.42	6.55	0.33	No clear size effect on surplus.
	gdp_growth	37.3	14.9	0.013	A small but significant positive GDP effect on surplus.
Building Employment	permits_area_lag1	8,269	239	< 0.001	Area permits forecast ≈8,269 jobs per Mm².
	m2_per_dwelling	-330	113	0.0004	Bigger projects link to ≈330 fewer jobs per Mm².
	gdp_growth	621	383	0.11	No GDP effect.
Civil Employment	permits_area_lag1	1,657	67.8	< 0.001	Area permits → ≈1 657 civil jobs per Mm².
	m2_per_dwelling	-8.14	51.3	0.87	No size effect.
	gdp_growth	29.4	199	0.88	No GDP effect.
Specialised Gross Surplus	permits_dwellings_lag1	17.4	3.49	< 0.001	Dwelling permits → €17.4 m surplus per thousand.
	m2_per_dwelling	4.53	5.06	0.37	No significant size effect.
	gdp_growth	-4.19	25.4	0.87	No GDP effect.
Specialised Employment	permits_area_lag1	7 535	726	< 0.001	Area permits → ≈7,535 specialized jobs per Mm².
	m2_per_dwelling	-194	101	0.056	Marginally significant: larger average size may reduce jobs.
	gdp_growth	76.9	804	0.92	No GDP effect.

Source: Own processing via RStudio

These results indicate that, controlling for permit volume, increases in average dwelling size are associated with lower turnover and employment responsiveness in selected subsectors.

5. Discussions

5.1. Synthesis: Permit Elasticities and Cost Management Implications

Addressing RQ1, our results confirm H1. Building permits are statistically significant predictors of next-year construction activity across Europe. Higher permit volumes predict increases in turnover, employment, and gross surplus. Employment

elasticities are particularly pronounced in BC and SC, while CE responses are more concentrated in labour outcomes. Each additional Mm² of Building permits forecasts about 8,500 jobs and €1.8 billion turnover. SC yields ≈7,600 jobs per Mm², while CE shows smaller but significant employment gains.

From a cost management perspective, these elasticities translate into quantifiable planning parameters. For example, the EU-wide average Building Employment elasticity (+5,998 jobs per Mm²) provides a baseline staffing multiplier that can inform workforce allocation models. However, the large dispersion of country-specific slopes implies that these multipliers must be calibrated at the national level or face increase forecast error and budget risk.

We also find a compositional effect (RQ2, H3). Project structure is relevant to cost management efficiency. Controlling for permit volume, larger average dwelling size is associated with lower turnover and employment responsiveness in selected subsectors. For management, this implies that portfolio structure, not only aggregate permit volume, affects resource intensity and labour deployment patterns (agile team structures to effectively manage multiple simultaneous construction starts). A permit pipeline dominated by numerous smaller projects is associated with higher short-term labour and revenue responsiveness per unit area. Conversely, while large projects benefit from economies of scale, they demonstrate lower short-term employment and revenue intensity per area. Management must subject these large-scale projects to thorough capital expenditure cost planning to account for the high carrying costs of capital tied up during extended planning and construction phases. The analysis suggests that firms should integrate the m2_per_dwelling metric into their internal project selection frameworks alongside traditional risk and financial metrics to ensure maximized efficiency of labour and capital.

GDP growth is rarely statistically significant once permit variables are included, likely because permits contain more direct, sector-specific forward information by embedding localized investment, financing, and regulatory decisions that precede realized activity. Alternative macroeconomic factors (such as credit conditions, interest rates, material cost inflation, or unemployment) may exert more immediate influence on short-term construction outcomes. The reported relationships should therefore be interpreted as predictive associations rather than causal effects, since permits may reflect expectations or regulatory timing that do not always materialize in output.

Moreover, the findings are conditioned by the institutional comparability of EU member states and harmonized Eurostat definitions. In economies with weaker permitting systems, informal construction channels, or structurally different governance and financing regimes, the magnitude and timing of permit elasticities may differ. Accordingly, permit-based multipliers should be treated as context-dependent planning parameters rather than universally transferable structural coefficients.

5.2. Post-2020 Structural Shifts and Adaptive Cost Planning

The results in Table 8 ilustrate that the permit-activity relationship did not weaken after 2020. Rather, it intensified. Post-2020 permit elasticities are numerically higher across all Champion models, with statistically significant slope increases in four cases.

This suggests that construction outcomes became more sensitive, not less predictable, to authorization volumes. While Figures 1-3 display volatile average outcome levels during the pandemic, the elasticity estimates capture a heightened marginal responsiveness once country and year effects are controlled. For cost management, this distinction is valuable. Level instability does not imply a loss of predictive power, but it does necessitate updated multipliers for accurate forecasting.

Three primary drivers likely explain this post-2020 shift. First, measurement lags between authorization and realization may have compressed as firms accelerated project activation to clear pandemic-induced backlogs. Second, the rapid digitalization of permitting procedures in many jurisdictions likely reduced administrative friction, shortening the lead time to execution. Third, shifting financing conditions and expanded public investment programs may have amplified the speed and scale of conversion from permit to production. Consequently, the key implication is not that permits lost predictive value, but that their transmission into activity became more responsive to contextual factors. Relying on static pre-2020 elasticities would systematically understate forecast error, whereas these interaction-based estimates provide the recalibrated multipliers essential for the current high-sensitivity environment.

5.3. Regional Management and Country-Specific Patterns

The country-level random-slopes analysis (Table 10) reveals substantial heterogeneity in permit elasticities across Europe. Variation in project composition further reinforces this heterogeneity. Firms must not only monitor total permit volumes but also evaluate project composition to optimize resource use and ensure efficient cost structures. A portfolio centred on frequent, small-scale developments requires different managerial strategies (standardized workflows and agile teams) compared to large-scale, capital-intensive civil projects. These differences directly impact overhead, labour allocation, and profitability. At the policy level, aligning permitting systems with national market structures is paramount. Effective construction management policy must synchronize permit processing with real sector capacity to minimize planning delays and improve the cost-efficiency of implementation.

The country-level slope analysis shows that EU-wide averages conceal substantial structural divergence. The mean Building Employment elasticity (+5,998 jobs per Mm²) ranges from +18 jobs in France to +17,886 in Italy, with a standard deviation of 3,040 jobs. For cost management, this dispersion implies that applying a uniform EU staffing multiplier would generate materially different budget outcomes across jurisdictions.

Germany exhibits consistently high responsiveness. Specialized Employment reaches +39,046 jobs per Mm² (EU mean +7,557), and Building Turnover exceeds +2,500 M€ per Mm². This suggests a strong short-run alignment between permits and realized production, allowing relatively tight calibration of workforce and revenue forecasts.

France represents the opposite extreme. Building Turnover is negative (−248 M€ per Mm²), Building Employment is near zero (+18 jobs), and Civil Engineering Employment is negative (−318 jobs). These patterns likely reflect institutional friction and extended pre-construction phases rather than a lack of demand. Specifically, France's complex

regulatory environment, for example the *Loi Élan*(a structural reform aimed at housing evolution and digital administrative transition which introduced stricter environmental standards and shifted licensing procedures), alongside similar zoning frameworks, can significantly extend the timeline between permit issuance and site mobilization. Other potential mechanisms include extended pre-construction phases, phased project activation, or timing differences in statistical recording. For cost management, permits in France may function as longer-horizon indicators, requiring extended realization assumptions rather than immediate staffing multipliers.

Italy combines very high labour responsiveness (+17,886 Building jobs per Mm²) with strong Building Gross Surplus elasticity (+53.0 M€), yet modest Specialized Gross Surplus (+1.14 M€ per 1,000 dwellings). This profile suggests labour-intensive expansion with tighter margin translation in trade-intensive segments, increasing sensitivity to labour allocation decisions. Romania displays strong employment multipliers (+9,523 Building jobs) with more moderate surplus elasticities, while Poland shows balanced responsiveness across turnover and civil employment, clustering near EU averages but with slightly elevated workforce intensity.

Nordic countries present more balanced structures. Denmark records +10,651 Specialized Employment jobs per Mm² alongside moderate Building Employment responsiveness (+3,858 jobs). Estonia occupies an intermediate position. Specialized Gross Surplus elasticity (+32.1 M€ per 1,000 dwellings) exceeds the EU mean (+28.1), while Building Employment responsiveness (+5,938 jobs) approximates the European average. As a post-socialist economy with advanced institutional modernization, Estonia illustrates a hybrid pattern of efficient margin translated in specialized segments without extreme labour volatility.

Regional aggregation confirms these contrasts. Southern Europe leads in Building Gross Surplus elasticity (≈27.7 M€ regional mean, driven by Italy), while Central Europe dominates Specialized Employment due to Germany's large slope. Western Europe's lower averages are substantially influenced by France's weak short-run transmission. Importantly, standard deviations are large relative to mean elasticities. In Specialized Employment, the standard deviation (6,735 jobs) approaches the EU mean (7,557), implying wide prediction intervals around staffing forecasts. For cost management, this translates into non-trivial forecast uncertainty.

5.4. The Management Point of View

Table 14 translates the empirical findings into operational planning principles. The results indicate that permit elasticities should not be interpreted as uniform multipliers, but as context-dependent management parameters. Portfolio composition, national responsiveness, and post-2020 structural shifts materially influence staffing, liquidity exposure, and contingency design.

Table 14. Managerial Interpretation of Core Findings

Empirical Finding	Decision Rule	Cost Management Action	Primary Stakeholder
Smaller average project size is associated with higher turnover and employment intensity per unit area.	When permit growth is driven by numerous small or medium-sized projects, management should prioritize operational flexibility and rapid execution capacity.	Increase flexible labour arrangements, strengthen subcontractor networks, and optimize workflow standardization to manage higher activity density per m².	Construction Managers / Operations Directors
Large average project size reduces short-term labour and revenue responsiveness.	When average m² per dwelling rises, treat permit growth as capital-intensive rather than labour-intensive expansion.	Strengthen liquidity planning, tighten capital expenditure control, and limit premature workforce expansion during early project phases.	Financial Controllers / Project Finance Teams
Strong country-level responsiveness (e.g., Germany, Italy) versus weak short-run transmission (e.g., France).	Avoid uniform EU forecasting multipliers. Calibrate staffing, revenue, and realization assumptions according to national elasticity profiles.	In high-responsiveness markets, secure labour and supplier capacity early. In low-responsiveness markets, extend realization horizons and Increase liquidity and time-contingency buffers.	Multinational Strategy and Risk Units
Significant post-2020 structural shifts in permit elasticities.	Reassess historical conversion ratios periodically and incorporate structural volatility into planning models.	Integrate supply-chain indicators, financing conditions, and labour availability into rolling budget revisions and scenario planning.	Executive Management / Risk Management Teams
Large cross-country dispersion of elasticities relative to EU averages.	Interpret permit multipliers as probabilistic ranges rather than fixed parameters.	Implement scenario-based budgeting (conservative–baseline–optimistic) to manage forecast uncertainty.	Corporate Planning & Budgeting Departments
Permit responsiveness depends on regulatory timing and administrative efficiency (e.g., France vs. Germany contrast).	Policymakers should align permitting procedures with sectoral execution capacity to reduce timing gaps between authorization and realization.	Improve predictability of approval timelines, reduce administrative lag, and enhance transparency to strengthen the economic transmission of permits.	Policymakers / Regulatory Authorities

Source: Own processing based on empirical findings.

For multinational construction firms, the central implication is calibration rather than extrapolation. A permit increase in Germany does not carry the same short-term labour implications as a similar increase in France. The former demands immediate capacity securing, while the latter requires a slow-burn mobilization strategy. Likewise, pipelines dominated by smaller projects generate higher short-run labour intensity than portfolios concentrated in large-scale developments.

Permit data therefore remains a valuable forecasting tool, but only when embedded in adaptive cost management systems that incorporate country-specific elasticities, project mix, and updated post-pandemic responsiveness.

6. Conclusions

The research integrates thorough econometric findings with actionable managerial insights. The research shows that building permits act as strong leading indicators for next-year construction activity. Thus, providing important metrics for strategic construction management and cost planning (H1) if their predictive context (sector, region, and project composition) is fully utilized. When permit volumes rise, turnover, employment, and gross surplus predictably increase across Europe. In Building Construction, each additional Mm² of permits predicts about €1.8 billion more turnover and 8,500 extra jobs, while Specialized Construction yields around 7,600 jobs per Mm². Civil Engineering shows more modest but still significant gains of around 1,600 jobs per Mm². These elasticities show that permit impacts differ by subsector.

While turnover and employment rise sharply, Gross Surplus increases less steeply, revealing persistent cost management challenges. This suggests that even in high-demand cycles, firms face pressure on margins. Effective cost control thus becomes central to capturing permit-driven gains. Moreover, smaller average project size emerges as a core driver. In Building, 1 m² reduction in average size correlates with €129 million more turnover and 330 extra jobs per Mm² of permits (H3). Optimizing project composition can enhance output and labour returns, reinforcing the role of portfolio management in strategic planning. In management terms, this supports an optimal project portfolio approach. Numerous small or medium-sized projects can yield greater labour efficiency per m², enabling tighter overhead and trade cost control.

Cross-country analysis (H2) confirms striking divergence in responsiveness. Germany and Italy exhibit high elasticities. France shows minimal or even negative responses while Romania shows labour-intensive building growth. This further illustrate that permit impact depends on national market structure and regulatory management. From a cost management perspective, this level of country heterogeneity introduces substantial multinational planning risk. Reliance on EU averages becomes dangerous, as regulatory friction generates large indirect management costs, requiring country-specific contingency budgeting.

The post-2020 analysis identifies structural shifts in elasticity rather than a breakdown of predictive capacity. Interaction-based models indicate statistically significant slope increases in most Champion specifications. One plausible interpretation is that pandemic-related lockdowns temporarily compressed construction activity, generating backlog accumulation. As restrictions eased, deferred projects were activated alongside new permits, potentially intensifying short-run responsiveness. In this sense, stronger post-2020 elasticities may partly reflect catch-up dynamics rather than a permanent structural strengthening of transmission mechanisms. At the same time, changes in supply-chain conditions, financing environments, and project sequencing likely influenced the timing and magnitude of conversion from authorization to realized output. These dynamics reinforce the need for cost planning frameworks that periodically recalibrate permit multipliers instead of relying on fixed historical relationships.

While the two-way fixed-effects approach is robust, it presents several limitations that suggest future research directions. First, while we focused on predictive elasticities,

future studies could employ dynamic panel models (e.g., Arellano-Bond GMM) to explicitly model the persistence of construction activity via lagged dependent variables. Second, a formal forecasting competition utilizing RMSE/MAE metrics against an AR(1) benchmark would further quantify the incremental predictive value of permits. Third, although we identified a post-2020 structural break, future work should isolate specific drivers such as material inflation and interest rate volatility. Finally, expanding the geographical scope beyond the EU-28 would verify the broader applicability of the project-composition and subsector heterogeneity findings identified in this study.

These findings align with prior work identifying permits as leading indicators (Mpié Simba et al., 2023; Cortes and LaPoint, 2024; Parhusip and Iqbal, 2025; Low and Lau, 2019). Furthermore, extending it by disaggregating subsectors, capturing country heterogeneity, and identifying a post-COVID structural break. Including project composition offers a new lens on how permits translate into outcomes.

Building permits are not merely bureaucratic markers. They are multidimensional instruments for strategic construction planning and cost management. Leveraging their full potential requires disaggregating the signal by subsector, country, and by project composition. This nuanced approach shifts analysis from broad averages to an actionable, localized, and resilient view of Europe's construction dynamics.

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Appendix

Appendix A1. Detailed Data Sources and Processing Information

Indicator	Dataset Code	DOI / Source	Processing Notes
Building permits - dwellings	STS_COBP_A	https://doi.org/10.2908/STS_COBP_A	Lagged by one year (permits_dwellings_lag1)
Building permits - floor area	STS_COBP_A	https://doi.org/10.2908/STS_COBP_A	Lagged by one year (permits_area_lag1)
Turnover / Gross premiums (2005-2020); Net turnover (2021-2023)	SBS_NA_CON_R2; SBS_OVW_ACT	https://doi.org/10.2908/SBS_NA_CON_R2; https://doi.org/10.2908/SBS_OVW_ACT	Harmonized across structural break in reporting
Gross operating surplus	SBS_NA_CON_R2; SBS_OVW_ACT	https://doi.org/10.2908/SBS_NA_CON_R2; https://doi.org/10.2908/SBS_OVW_ACT	Harmonized for post-2020 definition change
Personnel costs / Employee benefits expense	SBS_NA_CON_R2; SBS_OVW_ACT	https://doi.org/10.2908/SBS_NA_CON_R2; https://doi.org/10.2908/SBS_OVW_ACT	Harmonized across reporting change
Employees	SBS_NA_CON_R2; SBS_OVW_ACT	https://doi.org/10.2908/SBS_NA_CON_R2; https://doi.org/10.2908/SBS_OVW_ACT	-
Gross investment in tangible goods / non-current assets	SBS_NA_CON_R2; SBS_OVW_ACT	https://doi.org/10.2908/SBS_NA_CON_R2; https://doi.org/10.2908/SBS_OVW_ACT	-
GDP index (2015=100)	NAMA_10_GDP	https://doi.org/10.2908/NAMA_10_GDP	Real GDP growth calculated as year-on-year % change
Derived variable	-	Own computation	BP_area_m2 / BP_dwellings_thousands

Source: All data were extracted from Eurostat and processed in R (version 4.5.1).

Note: The shift from turnover (2005-2020) to net turnover (2021-2023) reflects a Eurostat reporting update. No adjustment or re-scaling was required.

Appendix A2. VIF for Champion Models

Model	Permit Variable	VIF
Building Turnover	permits_area_lag1	1.003
Building Gross Surplus	permits_dwellings_lag1	1.002
Building Employment	permits_area_lag1	1.003
CE Employment	permits_area_lag1	1.003
Specialized Gross Surplus	permits_dwellings_lag1	1.002
Specialized Employment	permits_area_lag1	1.003

Source: Own processing

Appendix A3. Champion Models:Two-Year Lag Robustness Check

Outcome	Permit Predictor	Estimate	Std. Error	p-value	R^2 (within)	95% CI Lower	95% CI Upper
BC Turnover	permits_area_lag2	1,685.6	177.4	<0.001	0.699	1,338.0	2,033.3
BC Gross Surplus	permits_dwellings_lag2	33.91	4.60	<0.001	0.612	24.90	42.92
BC Employment	permits_area_lag2	5,608.9	945.4	<0.001	0.645	3,756.0	7,462.0
CE Employment	permits_area_lag2	1,144.2	186.6	<0.001	0.322	778.4	1,510.0
SC Gross Surplus	permits_dwellings_lag2	15.05	2.66	<0.001	0.113	9.84	20.26
SC Employment	permits_area_lag2	5,351.4	841.1	<0.001	0.305	3,703.6	6,999.2

Source: Own processing