

UDK: 006.83:005.6
339.564(497.11)"2022/2024"

DOI: 10.51204/Compliance_2608A

Pavle Medić*

IMPLEMENTATION OF ISO STANDARDS: EFFECTS ON PERFORMANCE AND EXPORT COMPETITIVENESS OF COMPANIES IN SERBIA

ISO management-system certification is widespread in Serbian manufacturing, but its performance associations remain uncertain. Using a stratified 2023 survey of 481 firms from five Serbian manufacturing industries (agrifood, rubber and plastics, metal products and machining, electronics and electrical equipment, and machinery), linked to 2022–2024 financial statements, this paper estimates weighted descriptive patterns and conditional associations for ISO 9001 and ISO 14001 certification profiles with survey-weighted OLS and IPWRA checks. Certification is uneven by firm size and sector, and ISO 14001 without ISO 9001 is rare. Conditional on observables, firms holding only ISO 9001 show higher export share than non-certified firms, while productivity, profitability, growth, and investment outcomes do not differ systematically. Joint certification shows no premium relative to non-certified firms, aside from weaker evidence of higher investment incidence. Relative to ISO 9001-only firms, jointly certified firms show higher productivity, higher gross margin per employee, higher investment incidence, and lower export share. Results are conditional associations rather than causal effects; future research should incorporate certification histories and measures of implementation depth and audit quality.

Key words: ISO 9001. – ISO 14001. – Management system certification. – Manufacturing firm performance. – Export intensity. – Capital expenditure.

1. INTRODUCTION

ISO management-system certification is widespread in Serbian manufacturing and is often treated as a prerequisite for participation in modern supply chains

* Teaching Assistant, University of Belgrade Faculty of Law, Serbia, pavle.medic@ius.bg.ac.rs.

This paper was prepared as part of the strategic research project „Problems of the Creation, Interpretation and Application of Law” for 2025, organized and conducted by the Faculty of Law, University of Belgrade.

and formal procurement processes. The World Intellectual Property Organization's Global Innovation Index 2025 country profile for Serbia reports that Serbia ranks second on the indicator ISO 14001 certificates per bn PPP\$ GDP and fourth on ISO 9001 certificates per bn PPP\$ GDP (World Intellectual Property Organization 2025, 208). The ISO Survey for 2024 also reports 3,770 ISO 9001 certificates, of which 643 are in manufacturing, and 2,186 ISO 14001 certificates, of which 277 are in manufacturing (International Accreditation Forum 2025). This prevalence matters for a small open economy seeking manufacturing modernisation, deeper integration into global value chains, and sustained export growth.

The expected benefits of certification are usually framed around market access and internal upgrading. Certification can function as a signal that reduces information asymmetries between suppliers and buyers in business-to-business transactions (Terlaak, King 2006, 580–582). It can also be linked to stronger internal discipline when certification is coupled with substantive implementation of management routines. These mechanisms suggest that performance outcomes may differ across standards and across market contexts. Evidence from firm-level studies of internationalisation likewise separates the effects of different ISO certificates and different export market conditions (Pacheco, Lobo, Maldonado 2022, 2). In environmental management, synthesis evidence reports average improvements but also stresses that effects vary with measurement choices and contextual moderators (Erauskin-Tolosa *et al.* 2019, 8–9).

Evidence on the performance implications of certification remains mixed, and research designs face strong selection concerns. Firms self-select into certification, and this selection can be related to pre-existing performance and unobserved heterogeneity, which complicates causal interpretation of certified versus non-certified differences (Terlaak, King 2006, 594, 599; Heras-Saizarbitoria, Molina-Azorín, Dick 2011, 2). The credibility of certification also depends on implementation depth and audit practices. Work on management-system standards stresses that third-party auditing and internalisation can vary and that certificates can be weakly tied to substantive practice, which is one central reason why performance effects may be absent or fragile (Boiral 2012, 35; Heras-Saizarbitoria, Boiral 2013, 13). These concerns can be more salient where the broader conformity-assessment environment is shaped by capacity constraints and mechanical policy transfer, which can weaken effective implementation (Ruso, Filipović 2020, 11–12). Audit stringency and implementation quality can also vary across certification bodies, which means certificates are an imperfect proxy for substantive organisational change (Heras-Saizarbitoria, Boiral 2013, 13).

This paper contributes evidence on firms in selected Serbian manufacturing industries by examining certification patterns within a single sampling frame. The descriptive analysis identifies four certification statuses: ISO 9001 only, ISO 14001 only, joint ISO 9001 and ISO 14001 certification, and no certification. This follows work that differentiates certification types and shows that their associations with firm performance vary across contexts and outcome measures (Pacheco, Lobo, Maldonado 2022, 5–6; Erauskin-Tolosa *et al.* 2019, 4–8). In the regression analysis,

however, the empirical comparison focuses on no certification, ISO 9001 only, and joint certification, because ISO 14001 without ISO 9001 is too rare in the sample for separate estimation. The Serbian institutional context is also relevant because national quality infrastructure and conformity-assessment laws shape how certification relates to procurement and market access. In Serbia, public contracting authorities may request quality-assurance and environmental-management certificates under rules that require equal treatment, proportionality, and acceptance of equivalent certificates and equivalent evidence.¹ Policy speeches and a survey of quality-management experts treat these elements as part of the policy environment that shapes accreditation and conformity assessment (Ruso, Filipović 2020, 8–9).

The empirical analysis draws on a stratified survey of 481 firms from five groups of Serbian manufacturing industries: Agrifood (Food and Beverage), Rubber and plastics, Metal products and machining, Electronics and electrical equipment, Machinery, and links survey responses to firm-level financial statements for 2022–2024. The paper reports weighted descriptive differences, survey-weighted OLS associations, and IPWRA robustness checks for productivity, revenue per employee, margins, profitability, export orientation, sales growth, and investment behaviour. Certification is treated as potentially endogenous, so the analysis emphasises adjusted and unadjusted associations rather than causal effects. In preview, the results suggest that ISO 9001-only certification is most clearly associated with export orientation, while joint ISO 9001 and ISO 14001 certification is more strongly associated with better operating outcomes within the already certified population.

The remainder of the paper proceeds as follows. Section 2 reviews the literature and sets out mechanisms and testable implications. Section 3 describes the survey design, linked data, variables, and empirical strategy. Section 4 reports descriptive patterns, baseline regression results, and robustness checks. Section 5 discusses the findings in light of signalling, implementation quality, and observable selection. Section 6 concludes.

2. LITERATURE REVIEW

ISO 9001 and ISO 14001 are management-system standards that specify requirements for quality management systems and environmental management systems, respectively. ISO 9001 certification requires a facility to demonstrate that it uses a quality management system intended to ensure consistent fulfilment of customer and applicable regulatory requirements, with compliance verified through an audit by an accredited third-party registrar (Terlaak, King 2006, 580). ISO 14001 is described as an internationally recognized environmental management system standard developed by the International Organization for Standardization (Arimura *et al.* 2011, 171). Certification is voluntary and is undertaken by certification bodies operating within an accreditation context, with regular audits intended to sustain the credibility of certificates (Guler, Guillén, Macpherson 2002, 209).

1 Law on Public Procurement, *Official Gazette of the Republic of Serbia*, Nos. 91/2019 and 92/2023 (consolidated text), Arts. 5, 126, 127.

2.1. Why firms certify

A substantial part of the literature treats ISO certification as a response to information asymmetries in buyer-supplier relationships, especially where buyers cannot directly observe supplier capabilities (Terlaak, King 2006, 581–582). In this view, certification functions as a signal of otherwise hard-to-observe organisational attributes. The signalling account predicts stronger benefits where buyers face greater difficulty in acquiring reliable information about suppliers, and evidence from a U.S. manufacturing panel associates ISO 9000 certification with higher post-certification growth under those conditions (Terlaak, King 2006, 583, 591–594).

A related mechanism concerns access to export markets and formal contracting opportunities. Firm-level evidence from Slovenia, based on propensity-score matching and difference-in-differences, reports post-certification increases in sales, exports, and employment among ISO 9000-certified firms (Javorcik, Sawada 2018, 10–11, 14–15). Survey responses in the same study indicate that firms also pursue ISO certification to improve tender prospects and obtain preferred-supplier status (Javorcik, Sawada 2018, 5). Evidence from Portuguese industrial SMEs likewise reports that export-market effects vary by certification type and destination, with stronger foreign-acceptance effects for European Union markets (Pacheco, Lobo, Maldonado 2022, 10). At a broader level, institutional accounts treat ISO certification as an organisational practice that diffuses unevenly across countries and industries, and the ISO 9000 diffusion literature discusses cross-national ties and competitive imitation as channels shaping diffusion patterns (Guler, Guillén, Macpherson 2002, 208, 216).

The literature also stresses that certification can be pursued and maintained for legitimacy-related reasons rather than for internal effectiveness. Boiral discusses decoupling between certification discourse and internalized practices (Boiral 2012, 35). The same systematic review notes recurring concerns about bureaucracy, paperwork, superficial integration, redundancy, and respondent bias in parts of the evidence base (Boiral 2012, 32–33). Heras-Saizarbitoria and Boiral similarly emphasise that ISO 9001 standardises procedures, duties, and roles rather than outcomes, and they identify a research stream on discrepancies between written documentation and daily practice, including ritualistic or symbolic adoption (Heras-Saizarbitoria, Boiral 2013, 3, 9). Operations-management research sharpens this distinction by separating installation of ISO practices from their actual day-to-day use. Naveh and Marcus define implementation in terms of installation and subsequent usage, where usage includes both daily practice and the use of the system as a catalyst for change (Naveh, Marcus 2005, 3).

This distinction between certification and substantive implementation helps explain why some studies report weak or null performance effects. Cross-sectional evidence from Australia and New Zealand finds no significantly positive relationship between ISO 9000 certification and organisational performance measures, which suggests that certification status alone is not sufficient to explain performance differences (Terziovski, Samson, Dow 1997, 12). Survey evidence from Slovenia likewise reports only minimal improvement in business-success indicators

after certification and links successful implementation more closely to management involvement and integration of the quality system into the firm's general organisation (Pivka, Uršič 2002, 38, 40). In Serbia, research on ISO 9001-certified industrial companies examines operational performance and employee performance (Spasojević Brkić *et al.* 2017, 36).

For ISO 14001 in particular, the literature often links certification to environmental management practices and supply-chain coordination. Facility-level evidence shows that ISO 14001-certified plants are more likely to assess suppliers' environmental performance and to require suppliers to undertake environmental measures (Arimura *et al.* 2011, 171). A meta-analysis of ISO 14001 and EMAS studies reports a positive average association between certification and corporate environmental performance, while also showing heterogeneity across indicators and larger effect sizes in studies that measure internalisation or implementation level (Erauskin-Tolosa *et al.* 2019, 8). Operating-performance evidence from the United Kingdom and Ireland uses an event-study design and reports improvements in manufacturing cost efficiency and employee productivity, but also diminishing returns for some operating indicators over longer horizons (Treacy *et al.* 2019, 323, 325–326).

2.2. What outcomes the literature studies

Studies of market outcomes commonly examine sales and exports. In Slovenian firms, ISO 9000 certification is associated with post-certification increases in sales and export activity (Javorcik, Sawada 2018, 12–13). Cross-country firm survey evidence for Latin America and the Caribbean links ISO certification to lower financial constraints, higher labour productivity, and lower cost of sales (Ullah, Wei, Xie 2014, 18, 21). Export-related effects can also differ by certification type and destination, and Portuguese SME evidence reports stronger internationalisation effects for European Union markets and for specific ISO certificates (Pacheco, Lobo, Maldonado 2022, 10).

Operational and process outcomes are often linked more closely to implementation depth than to certification status alone. The installation-versus-usage distinction is formalised in ISO 9000 research that relates usage in daily practice to operating and business performance (Naveh, Marcus 2005, 3). Review evidence reports mixed findings across operational, market, and financial dimensions and does not converge on a single performance conclusion (Sfreddo *et al.* 2018, 4). A review of ISO 9001 and business practice similarly evaluates evidence across product and service quality, customer satisfaction, operational performance, and financial performance, and treats findings as mixed across metrics and studies (Bakator, Čockalo 2018, 90).

Financial outcomes remain especially contested. A repeated-measures study of U.S. firms reports that ISO 9000 certification has only a limited impact on return on assets and that the effect dissipates quickly over time (Wayhan, Kirche, Khumawala 2002, 229). Sharma examines whether ISO 9000 certification is associated with improvements in operating efficiency, sales growth, and overall financial performance

(Sharma 2005, 151). Recent evidence reports that ISO 9001 and ISO 14001 certifications are not statistically significant in models of return on assets, return on equity, and Tobin's Q, while one specification indicates a negative association between ISO 9001 certification and EBITDA margin (Neves *et al.* 2024, 1657–1658). A study of Istanbul Stock Exchange-listed manufacturing companies finds a positive association between ISO 9001 and ROA and Tobin's Q, and a positive association between ISO 14001 and ROA (Durak Uşar 2024, 19–20).

The outcome set also extends beyond finance. Matched longitudinal evidence links ISO 9001 adoption to changes in employment-related outcomes for both employees and employers (Levine, Toffel 2010, 978). Innovation outcomes are treated as part of organisational upgrading, and ISO 9000 certification has been analysed in relation to product and process innovation performance in manufacturing, with statistically insignificant results for the former and significant results for the latter (Terziowski, Guerrero 2014, 203–205). Multi-standard adoption is also studied as an integrated strategy, and longitudinal evidence from Portugal reports consistent performance leverage for combinations that include ISO 9001, including ISO 9001 plus ISO 14001 (Hernandez-Vivanco *et al.* 2019, 386).

2.3. How studies identify effects and why results differ

Empirical designs range from cross-sectional surveys to longitudinal panel methods. The ISO 9000 diffusion literature describes certification as voluntary and performed by registrars operating under accreditation (Guler, Guillén, Macpherson 2002, 209). Survey-based studies often rely on perceived benefits and self-reported measures, and Boiral reports recurring reliance on questionnaires answered by managers, with concerns about redundancy and respondent bias across the evidence base (Boiral 2012, 32–33). Cross-sectional evidence from Slovenia uses questionnaire data and links implementation success to management involvement and integration into the company's general organisation (Pivka, Uršič 2002, 31, 40). Lithuanian survey work classifies adopters into distinct motive profiles, which indicates heterogeneity in adoption rationales and perceived effects (Vilkas, Vaitkevičius 2013, 373).

Selection and endogeneity are central concerns in this literature. A longitudinal study of Spain distinguishes selection from treatment by comparing financial performance before and after ISO 14001 certification and by benchmarking against non-certified firms (Heras-Saizarbitoria, Molina-Azorín, Dick 2011, 5–6). Panel and matching designs are often used to address non-random adoption, and the Slovenian evidence combines propensity-score matching with difference-in-differences to estimate post-certification changes (Javorcik, Sawada 2018, 10–11). At the same time, implementation depth remains a major source of heterogeneity. The installing-versus-using distinction formalises how certification can exist without routine use that meaningfully affects operations (Naveh, Marcus 2005, 3). The evidence base also contains credible null findings, including a large survey study that reports no significantly positive relationship between ISO 9000 certification and organisational performance measures (Terziowski, Samson, Dow 1997, 12).

Mixed results are therefore not surprising. Boiral describes possible decoupling between certification discourse and the extent to which practices are internalised, which provides one explanation for weak or inconsistent performance links (Boiral 2012, 35). A research-agenda review similarly argues that researchers should acknowledge the limits of certification as a measure and should evaluate how variation in implementation quality affects results (Heras-Saizarbitoria, Boiral 2013, 13). For ISO 14001, evidence also varies with measurement and timing. An event-study design reports both prolonged operating-performance effects and diminishing returns over time (Treacy *et al.* 2019, 323, 325–326), while meta-analytic evidence reports a positive average association between environmental certifications and environmental performance but also systematic variation across indicators and implementation-level measures (Erauskin-Tolosa *et al.* 2019, 8). Taken together, this literature suggests that differences across standards, adopters, implementation depth, and empirical design all matter for interpretation. That is precisely why it is useful to distinguish certification profiles within a single sampling frame and to report both weighted baseline associations and robustness checks for observable selection.

3. METHODOLOGY, DATA AND VARIABLES

3.1. Survey design, sampling frame, and fieldwork

The empirical analysis draws on a company-level survey carried out in March 2023 among manufacturing firms in Serbia. The sampling frame was constructed from the Statistical Business Register (status February 2023) and covers active firms that submitted a final financial report for 2022. The frame includes firms whose main activity falls into the following NACE Rev.2 two-digit divisions: 10 (manufacture of food products), 11 (manufacture of beverages), 22 (manufacture of rubber and plastics products), 25 (manufacture of fabricated metal products, except machinery and equipment), 26 (manufacture of computer, electronic and optical products), 27 (manufacture of electrical equipment), 28 (manufacture of machinery and equipment n.e.c.), 29 (manufacture of motor vehicles, trailers and semi-trailers), 32 (other manufacturing), and 33 (repair and installation of machinery and equipment). Eligibility criteria were defined *ex ante* to focus on economically active manufacturing firms. Firms were required to employ at least five workers according to the 2022 financial report and to operate under standard corporate legal forms such as limited liability companies, joint stock companies, or entrepreneurs. Within each sector, the frame excluded roughly 3% of the smallest entities by turnover, which yields a final sampling frame of 2,927 firms.

A stratified simple random sample was drawn with strata defined at the NACE two-digit level and proportional allocation across strata. The gross sample comprised 515 firms. Data collection relied on a pre-informed telephone survey (CATI). Respondents could request the questionnaire by email, and interviewers re-contacted firms when needed to verify information received in writing. The final number of interviews completed was 481, which corresponds to a response rate of 93.4%

and covers 16.4% of the sampling frame. Sampling weights supplied with the survey are used throughout the descriptive analysis and the baseline regressions, and variance estimation accounts for stratification.

3.2. Financial statements and data linkage

Survey responses were linked to firm-level financial statements obtained from the Serbian Business Registry Agency. Records were merged using a unique company identifier. The merged dataset contains balance-sheet and income-statement items for 2022, 2023, and 2024, which allows the analysis to examine outcomes in 2023 and medium-run changes through 2024.

Certification status is observed only at the time of the 2023 survey, and the dataset does not record certification dates. The design is therefore cross-sectional with respect to certification and does not support event-study or difference-in-differences approaches that rely on adoption timing (Levine, Toffel 2010, 986; Javorcik, Sawada 2018, 10–11). The empirical strategy focuses on conditional associations and robustness to observable selection. Several outcomes are analysed as natural logarithms (logs). Log outcomes are defined only for observations with strictly positive underlying values, and this induces outcome-specific sample sizes.

3.3. Variables

The analysis focuses on management-system certification and firm performance. ISO 9001 and ISO 14001 are the focal certificates because they are the most prevalent standards in the survey and because prior research often treats them as benchmarks for quality management and environmental management practices, respectively. The main certification measure used in regressions is a mutually exclusive profile indicator constructed from survey reports of ISO 9001 and ISO 14001. Firms are classified into three groups: (i) neither certificate, (ii) ISO 9001 only, and (iii) joint ISO 9001 and ISO 14001 certification. A small number of firms (7, 1.5%) report ISO 14001 without ISO 9001. This group is too small for separate regression analysis and is excluded from the certification-profile specifications.

The outcome set covers productivity, operating performance, margins, profitability, export orientation, sales growth, and investment behaviour. These dimensions align with outcomes frequently examined in studies of certification and management-system adoption (for example, see Ullah, Wei, Xie 2014, 11; Javorcik, Sawada 2018, 8; Neves *et al.* 2024, 1650). Outcomes are measured in 2023 unless stated otherwise, with sales growth measured over 2022–2024.

Baseline regressions are controlled for company size (log employment), capital intensity, firm age, ownership, and sector. Ownership comparisons exclude state-owned enterprises due to small subsample size (5, 1%). Industry controls use a five-sector grouping constructed from the sampling frame. Indicators for ERP and CRM adoption are available in the survey, but they are not included in the baseline specifications due to concerns about conditioning on capability-building practices that may be related to certification pathways. Table A1, which contains all the indicators (variables), is available in the Annexe.

3.4. Empirical strategy

3.4.1. Descriptive analysis

The descriptive analysis reports weighted prevalence of ISO 9001 and ISO 14001 and compares certification rates across sectors, firm-size classes, and ownership categories. It also reports weighted means of outcomes for certification profiles that include neither certificate, ISO 9001 (any), ISO 14001 (any), and joint ISO 9001 and ISO 14001. The „any” categories are not mutually exclusive because jointly certified firms fall into both ISO 9001 (any) and ISO 14001 (any). Each descriptive estimate reports a 95% confidence interval that accounts for sampling weights and stratification. Confidence intervals are wider for small groups, particularly for ISO 14001-only firms, which reflects limited cell sizes.

3.4.2 Baseline regressions (survey-weighted OLS)

Baseline regressions estimate conditional associations between certification profiles and outcomes using survey-weighted OLS with design-based (linearised) standard errors.

$$\text{Eq. 1 } y_i = \alpha + \beta_1 [\text{ISO 9001 only}]_i + \beta_2 [\text{Both}]_i + X_i' \gamma + \delta_s + \varepsilon_i$$

In equation (1), y_i denotes the outcome for firm i . The certification indicators correspond to mutually exclusive categories, with „Neither” as the omitted category. X_i includes firm size, capital intensity, firm age, and ownership. δ_s denotes sector fixed effects based on the five-sector grouping. State-owned enterprises are excluded from conditional models due to the aforementioned small subsample size.

Investment is examined using two outcomes: an indicator for strictly positive capital expenditures (CAPEX) and log CAPEX per employee among firms with positive CAPEX per employee. For these two investment outcomes, the baseline specification excludes capital intensity to preserve a parsimonious control set for investment behaviour within the same accounting year.

The incremental difference between joint certification and ISO 9001-only certification is reported using the linear contrast ($\beta_2 - \beta_1$). The coefficients do not have a causal interpretation under general conditions because firms self-select into certification, and unobserved capability differences can affect both certification and performance (Terlaak, King 2006, 594, 599; Heras-Saizarbitoria, Molina-Azorín, Dick 2011, 2, 8).

3.4.3 Treatment-effects estimators as robustness checks

Treatment-effects estimators are used as robustness checks to assess sensitivity to observable selection into certification. These estimators target the average treatment effect on the treated (ATET) by comparing treated firms with observationally similar control firms. Several studies in the ISO literature use matching-based and related reweighting approaches to address non-random selection into certification (Ullah, Wei, Xie 2014, 23; Levine, Toffel 2010, 986; Javorcik, Sawada 2018, 10–11).

Robustness checks are implemented as a set of binary comparisons derived from the certification profile. These include ISO 9001 only versus neither, joint certification versus neither, and joint certification versus ISO 9001 only. The ISO 14001-only group is excluded from these comparisons due to limited sample size. Treatment models use the same covariates as the baseline regressions. For the CAPEX comparisons, capital intensity is omitted to mirror the baseline CAPEX specification. Conditional models exclude state-owned enterprises, in line with the baseline OLS regressions.

Inverse-probability-weighted regression adjustment (IPWRA) combines a treatment model for certification with an outcome regression model and estimates ATET under inverse-probability weighting. The estimator is consistent if either the treatment model or the outcome model is correctly specified, provided overlap holds. Selection into certification is non-random and can be related to unobserved heterogeneity (Terlaak, King 2006, 594; Neves *et al.* 2024, 1652). IPWRA is implemented with sampling weights. The estimator does not incorporate the full survey design in the same way as the survey-weighted OLS models, so the IPWRA results are interpreted as robustness checks rather than as causal estimates.

Robustness checks are implemented for the same outcome set as in the baseline OLS specification: log productivity, log revenue per employee, log gross margin per employee, return on assets, export share, sales growth over 2022–2024, the probability of positive CAPEX, and log CAPEX per employee among firms with positive CAPEX.

3.4.4. Sensitivity and limitations

Certification timing is the first limitation. Without the date of first certification or recertification, the analysis cannot trace dynamic effects around adoption using event-study approaches or related lead-lag designs (Javorcik, Sawada 2018, 11; Heras-Saizarbitoria, Molina-Azorín, Dick 2011, 7). Treatment-effects estimates therefore remain conditional associations under selection on observables rather than estimates tied to a known exposure window.

Control measurement is the second limitation. Several controls are measured contemporaneously with certification status and outcomes in 2023, and they may not be strictly pre-treatment for firms that certified earlier. The baseline control set is interpreted as a set of scale and capital-intensity proxies that reduce observable differences across firms, but it does not resolve endogeneity concerns.

Unobserved confounding and reverse causality form the third limitation. More productive or more export-oriented firms may be more likely to certify, and certification may also follow performance shocks (Terlaak, King 2006, 591, 594). Some studies address these concerns using dynamic panel designs and instrumented specifications (Hernandez-Vivanco *et al.* 2019, 393–394; Durak Uşar 2024, 3, 18; Neves *et al.* 2024, 1652). The present dataset does not contain certification histories, which constrains feasible identification strategies.

Implementation depth and audit stringency are not observed. Prior research indicates that certification can be decoupled from internal practice and that performance effects vary with internalisation and maturity of management systems

(Boiral 2012, 35; Sfreddo *et al.* 2018, 9). The Discussion interprets null or weak associations in line with this possibility and in light of market-access and procurement incentives.

4. RESULTS

4.1. Prevalence of ISO certificates

Table 1 presents the overall prevalence of ISO 9001 and ISO 14001 certifications in the sample. Slightly more than one-half of manufacturing firms hold ISO 9001 certification, while approximately one-quarter have adopted ISO 14001. At the same time, close to half of firms operate without either standard, indicating that certification remains far from universal across the manufacturing sector. The table also shows that certification is most often structured around ISO 9001, either as a standalone standard or in combination with ISO 14001. Joint adoption of ISO 9001 and ISO 14001 accounts for nearly one quarter of firms, whereas ISO 9001 without ISO 14001 represents a similar share. By contrast, ISO 14001 without ISO 9001 is rare, accounting for less than 1% of firms. This distribution indicates that environmental management systems are typically adopted as extensions of existing quality management systems rather than independently.

Table 1: Prevalence of ISO 9001 and ISO 14001 certifications (weighted)

Certification status	Share of firms (%)	95% CI
ISO 9001 (any)	51.9	[45.4; 58.4]
ISO 14001 (any)	25.3	[20.4; 30.3]
Neither ISO 9001 nor ISO 14001	47.2	[40.7; 53.8]
ISO 9001 only	27.4	[22.2; 32.7]
ISO 14001 only	0.9	[0.3; 2.0]
ISO 9001 and ISO 14001	24.5	[19.6; 29.4]

Source: Survey results and Financial statements, Author's calculations

Table 2 shows a clear size gradient in the adoption of ISO management system certifications. ISO 9001 is reported by about one-half of micro and small firms (50.3% and 47.6%), and adoption rises in medium and large firms (71.9% and 82.5%). ISO 14001 shows a similar pattern, increasing from around one-fifth among micro and small firms (23.5% and 21.6%) to higher levels in medium and large firms (41.5% and 70.0%). Joint ISO 9001 and ISO 14001 certification is present in about one-fifth to one-quarter of micro and small firms (23.5% and 20.2%) and is higher among medium and large firms (41.0% and 70.0%). However, confidence intervals for micro, small, and medium firms overlap for all certification categories, so differences among these groups are not statistically clear at the 95% level. The contrast between large firms and micro or small firms is clearer in point estimates, but the confidence intervals remain wide for large firms. The share of firms with neither certification declines with size, from about one-half among micro and small firms (49.7% and 50.9%) to 27.5% among medium firms and 17.5% among large firms (Table 2).

Table 2: ISO 9001 and ISO 14001 certification by firm size (weighted)

Firm size by the number of employees	ISO 9001 (%)	95% CI	ISO 14001 (%)	95% CI	ISO 9001 & ISO 14001 (%)	95% CI	Neither (%)	95% CI
Micro (5–10)	50.3	[38.3; 62.3]	23.5	[13.8; 33.2]	23.5	[13.8; 33.2]	49.7	[37.7; 61.7]
Small (11–50)	47.6	[38.6; 56.6]	21.6	[15.4; 27.8]	20.2	[14.1; 26.3]	50.9	[41.9; 60.1]
Medium (51–250)	71.9	[61.5; 82.4]	41.5	[30.4; 52.7]	41	[29.9; 52.1]	27.5	[17.1; 38.0]
Large (250+)	82.5	[60.7; 100.0]	70	[46.0; 94.0]	70	[46.0; 94.0]	17.5	[0.0; 39.3]

Source: Survey results and Financial statements, Author's calculations

Table 3 shows substantial variation in certification patterns across manufacturing sectors. ISO 9001 adoption is lowest in agrifood, where fewer than one-third of firms are certified, and highest in electronics and electrical equipment, where certification is widespread. Machinery, rubber and plastics, and metal products and machining occupy intermediate positions, with meaningful differences in adoption rates across these sectors. ISO 14001 adoption is more unevenly distributed across sectors. Environmental certification is most prevalent in metal products and machining, machinery, and electronics, and in these sectors, it is almost always observed together with ISO 9001. Standalone ISO 14001 certification is rare across all sectors. In agrifood, most firms operate without either certification. One possible interpretation is that environmental management systems are more often adopted alongside quality management systems in industries with more complex production processes and greater regulatory exposure.

Table 3: ISO 9001 and ISO 14001 certification by sector (weighted)

Sector	ISO 9001 (%)	95% CI	ISO 14001 (%)	95% CI	Both (%)	95% CI	Neither (%)	95% CI
Agrifood	31.9	[19.1; 44.7]	9.4	[1.1; 17.6]	7.7	[0.0; 15.7]	66.4	[53.5; 79.3]
Rubber and plastics	57.1	[39.4; 74.8]	12.8	[5.2; 20.4]	12.2	[4.7; 19.7]	42.4	[24.6; 60.1]
Metal products and machining	53.9	[41.4; 66.4]	36.6	[26.4; 46.9]	36.3	[26.1; 46.5]	45.8	[33.3; 58.3]
Electronics and electrical equipment	74.6	[61.0; 88.3]	26.3	[10.2; 42.4]	26.3	[10.2; 42.4]	25.4	[11.7; 39.0]
Machinery	56.8	[46.5; 67.0]	26	[16.8; 35.2]	24.5	[15.5; 33.5]	41.7	[31.5; 52.0]

Source: Survey results and Financial statements, Author's calculations

Table 4 shows that certification prevalence differs only modestly across ownership groups. ISO 9001 adoption rates are similar for foreign-owned and private domestic firms, and their 95% confidence intervals overlap substantially. ISO 14001 adoption and joint ISO 9001 and ISO 14001 certification are somewhat higher among foreign-owned firms in point estimates, but the confidence intervals overlap,

so these differences are not statistically clear at the 95% level. The share of firms operating without either standard is also very similar across ownership categories, with overlapping confidence intervals.

Table 4: ISO 9001 and ISO 14001 certification by ownership (weighted)

Ownership	ISO 9001 (%)	95% CI	ISO 14001 (%)	95% CI	Both (%)	95% CI	Neither (%)	95% CI
Foreign-owned (FDI)	48.7	[35.0; 62.4]	29.6	[17.7; 41.5]	26.9	[15.3; 38.6]	48.6	[34.9; 62.4]
Private domestic	52.0	[44.9; 59.2]	24.7	[19.4; 30.1]	24.1	[18.8; 29.5]	47.4	[40.2; 54.5]

Source: Survey results and Financial statements, Author's calculations

Notes: State-owned enterprises are omitted from Table 4 because the subsample is too small for meaningful descriptive inference.

Taken together, Tables 1–4 show that ISO 9001 and ISO 14001 adoption is unevenly distributed across firms. Certification prevalence varies sharply by firm size and sector, and joint adoption of quality and environmental standards is concentrated among larger firms and specific manufacturing branches. At the same time, a substantial share of firms, particularly smaller enterprises and those operating in agrifood, remain uncertified. These patterns imply that simple comparisons between certified and non-certified firms may conflate certification status with underlying differences in firm characteristics. To address this issue, the next section examines the association between certification and firm performance using regression-based methods that account for observable differences in size, sector, ownership, and other firm attributes, alongside alternative estimators designed to reduce selection bias.

4.2. Raw comparisons

Table 5 shows that mean values for several accounting-based indicators are higher for certified firms than for firms with neither certificate, with the strongest values typically observed for jointly certified firms. Because the ISO 9001 and ISO 14001 columns refer to „any” certification status, these descriptive categories are not mutually exclusive. This pattern is most evident for log productivity, log gross margin per employee, and return on assets, where point estimates are higher for certified groups than for the non-certified group, although the overlapping „any” categories should not be read as a strict progression across mutually exclusive profiles. These differences reflect the fact that certified firms tend to be larger, more capital-intensive, and more frequently engaged in investment activity, characteristics that are correlated with higher average performance.

By contrast, market-based and dynamic indicators display less separation across descriptive certification groups. Mean operating revenue per employee is very similar across all groups shown in Table 5, with confidence intervals that almost fully overlap. Sales growth over the 2022–2024 period is higher on average among firms

holding ISO 14001 and among jointly certified firms, but the confidence intervals are wide and overlap across groups, and in some cases include zero. The width of these intervals is expected, given the short growth window, the volatility of firm-level growth rates, and the smaller effective sample sizes once log transformations are applied. Investment indicators show clearer differences in incidence rather than in magnitude. The share of firms reporting positive capital expenditure is substantially higher among firms holding ISO 14001 and among jointly certified firms, while average capital expenditure per employee varies less systematically across groups once sampling variability is taken into account. This pattern is consistent with investment being an episodic decision, where certification is associated with a higher likelihood of investing, but not necessarily with larger investment volumes in a given year.

Table 5: Raw mean outcomes in 2023 by ISO 9001 and ISO 14001 certification status indicators (weighted)²

Outcomes	Neither	ISO 9001 (any)	ISO 14001 (any)	Both
Log productivity	6.408 [6.161; 6.656]	6.596 [6.405; 6.788]	6.703 [6.428; 6.978]	6.707 [6.422; 6.991]
Log operating revenue per employee	8.914 [8.734; 9.094]	8.892 [8.783; 9.002]	8.936 [8.783; 9.089]	8.929 [8.774; 9.083]
Log gross margin per employee	5.825 [5.397; 6.254]	6.130 [5.889; 6.372]	6.341 [5.996; 6.685]	6.364 [6.011; 6.717]
ROA	0.060 [0.042; 0.078]	0.076 [0.057; 0.095]	0.087 [0.054; 0.121]	0.089 [0.055; 0.123]
Export share	0.167 [0.097; 0.237]	0.216 [0.175; 0.257]	0.192 [0.137; 0.248]	0.185 [0.129; 0.241]
Sales growth 2022–2024	0.045 [−0.051; 0.141]	0.042 [−0.015; 0.1]	0.106 [0.018; 0.194]	0.110 [0.019; 0.201]
CAPEX per employee	693.360 [421.4; 965.3]	573.2 [434.4; 712.0]	655.5 [452.4; 858.7]	667.7 [457.8; 877.6]
Share with positive CAPEX	0.810 [0.727; 0.894]	0.851 [0.795; 0.906]	0.928 [0.878; 0.978]	0.938 [0.888; 0.988]

Source: Survey results and Financial statements, Author's calculations

Further, we estimate a set of survey-weighted bivariate regressions in which each outcome is related to one certification indicator at a time: ISO 9001, ISO 14001, and, in a separate comparison, joint certification versus no certification. The outcomes include productivity, operating revenue per employee, gross margin per employee, return on assets, export share, sales growth over 2022–2024, capital expenditure per employee, and the probability of reporting any capital expenditure. Across these bivariate models, ISO 9001 shows no statistically significant association with any outcome (all $p \geq 0.187$). ISO 14001 is associated with a higher gross margin per employee ($\beta = 0.478$, $p = 0.040$) and a higher probability of positive capital expenditure ($\beta = 0.131$, $p = 0.001$). In the direct comparison of joint certification versus no certification, the probability of positive capital expenditure is higher

2 Note: „ISO 9001 (any)” and „ISO 14001 (any)” are not mutually exclusive categories. Firms with joint ISO 9001 and ISO 14001 certification are included in both columns.

for jointly certified firms ($\beta = 0.128$, $p = 0.010$), while gross margin per employee is higher at the 10% level ($\beta = 0.549$, $p = 0.052$).

4.3. Baseline survey-weighted OLS estimates

Table 6 reports survey-weighted OLS estimates for the baseline specification. The omitted certification category is „Neither“. The table also reports the linear contrast „Both – ISO 9001 only“, which captures the incremental difference between jointly certified firms and firms that hold only ISO 9001. Because certification timing is not observed, the coefficients should be interpreted as conditional associations rather than causal effects.

The baseline results point to a differentiated pattern across outcomes. For productivity, revenue per employee, and gross margin per employee, ISO 9001-only certification is not statistically related to performance. Joint certification is positively associated with log productivity and log gross margin per employee, but the level coefficients relative to non-certified firms are imprecise. The comparison between joint certification and ISO 9001-only certification is more informative. In that contrast, jointly certified firms show higher log productivity by 0.289 at the 10% level and higher log gross margin per employee by 0.465 at the 5% level.

Return on assets and sales growth do not show systematic differences by certification profile. ROA is not statistically related to either ISO 9001-only or joint certification, and the comparison between joint certification and ISO 9001-only certification is close to zero. Sales growth over 2022–2024 is also not statistically related to certification status.

Export orientation differs more clearly by certification type. Firms holding only ISO 9001 have a higher export share than non-certified firms, by 0.078 or 7.8 pp. Joint certification is not associated with a higher export share relative to non-certified firms. By contrast, the comparison between joint certification and ISO 9001-only certification is negative and precisely estimated at -0.113 , or -11.3 pp.

Investment results differ between the extensive and intensive margins. Joint certification is associated with a higher probability of positive CAPEX in 2023, while ISO 9001-only certification is not. The comparison between joint certification and ISO 9001-only certification is 0.152, which corresponds to 15.2 pp. Among firms with positive CAPEX, however, log CAPEX per employee is not statistically related to certification status, and the incremental contrast is close to zero. This suggests that the investment pattern operates through the incidence of investment rather than through investment intensity.

Table 6. Survey-weighted OLS estimates by outcome (baseline specification)

Outcome	ISO 9001 only	Both	Both – ISO 9001 only	ln(emp) 2023	ln(fA/emp) 2023	ln(age)	Private domestic	Rubber & plastics	Metal products	Electronics	Machinery	Constant	N	R-squared
Log productivity (ln_prod23)	-0.003 (0.150)	0.286 (0.177)	0.289* (0.154)	-0.074 (0.057)	0.547*** (0.044)	-0.213*** (0.072)	0.177 (0.153)	0.008 (0.211)	-0.093 (0.217)	0.047 (0.241)	-0.050 (0.184)	2.990*** (0.508)	432	0.443
Log revenue per employee (ln_rev_per_emp23)	-0.126 (0.116)	-0.001 (0.125)	0.125 (0.105)	0.067 (0.044)	0.252*** (0.036)	-0.051 (0.060)	0.124 (0.170)	-0.151 (0.163)	-0.135 (0.156)	0.058 (0.185)	-0.280** (0.141)	6.984*** (0.335)	465	0.228
Log gross margin per employee (ln_margin_per_emp23)	0.066 (0.300)	0.530 (0.352)	0.465** (0.224)	-0.046 (0.079)	0.482*** (0.085)	-0.356*** (0.122)	0.291 (0.273)	-0.031 (0.311)	-0.245 (0.451)	0.192 (0.373)	-0.001 (0.302)	3.115*** (1.031)	420	0.218
Return on assets (roa23)	0.014 (0.014)	0.022 (0.020)	0.008 (0.019)	-0.002 (0.007)	-0.005 (0.006)	-0.019** (0.008)	0.053** (0.022)	0.018 (0.021)	0.038** (0.017)	0.004 (0.024)	0.028 (0.019)	0.083 (0.058)	465	0.089
Export share (expshare23)	0.078** (0.037)	-0.035 (0.049)	-0.113*** (0.039)	0.126*** (0.018)	0.032*** (0.009)	-0.067** (0.028)	-0.215*** (0.058)	-0.032 (0.044)	-0.014 (0.049)	-0.023 (0.049)	0.004 (0.036)	-0.051 (0.109)	465	0.344
Sales growth 2022–2024 (sales_growth_22_24)	-0.020 (0.059)	0.040 (0.063)	0.060 (0.062)	-0.010 (0.032)	0.002 (0.021)	-0.107** (0.042)	0.047 (0.084)	0.095 (0.092)	0.134 (0.086)	-0.029 (0.119)	0.171** (0.084)	0.196 (0.219)	465	0.062
Positive CAPEX (capex_pos23)	-0.040 (0.064)	0.113** (0.055)	0.152** (0.061)	0.078*** (0.018)	NA	0.038 (0.040)	0.033 (0.066)	-0.133 (0.102)	-0.037 (0.069)	-0.125 (0.099)	-0.065 (0.067)	0.515*** (0.129)	467	0.076
Log CAPEX per employee, CAPEX>0 (ln_capex_emp23)	0.141 (0.264)	0.097 (0.246)	-0.044 (0.256)	0.162 (0.100)	NA	-0.007 (0.168)	-0.170 (0.383)	-0.948* (0.506)	-0.117 (0.242)	-0.754** (0.330)	-0.735** (0.291)	5.598*** (0.654)	392	0.047

Source: Survey results and Financial statements, Author's calculations

Notes: Each cell reports a coefficient with its survey-linearised standard error in parentheses. Stars denote significance at the 10%, 5%, and 1% levels, respectively (*, **, ***). The omitted categories are 'Neither' for certification, foreign-owned for ownership, and Agrifood for sector. All models are estimated using sampling weights and the survey design. FA denotes fixed assets. Models for ln_prod23, ln_rev_per_emp23, roa23, expshare23, and sales_growth_22_24 include ln (fixed assets per employee) in addition to the listed controls. Models for capex_pos23 and ln_capex_emp23 exclude ln (fixed assets per employee). The ln_capex_emp23 model is estimated on firms with positive CAPEX per employee.

4.4. Robustness checks using inverse-probability-weighted regression adjustment

Robustness checks assess whether the baseline associations are sensitive to observable selection into certification. Table 7 reports IPWRA estimates for the same outcome set as the baseline OLS specification. These estimates are reported as ATETs and are interpreted as robustness checks rather than as causal effects. Conditional models exclude state-owned enterprises.

For ISO 9001-only certification versus no certification, IPWRA reproduces the baseline export result. The ATET for export share is 0.072 (SE 0.035), while no statistically significant ATET emerges for log productivity, log revenue per employee, log gross margin per employee, return on assets, sales growth, the probability of positive CAPEX, or log CAPEX per employee (Table 7). This pattern confirms that the most stable association for ISO 9001-only certification concerns export orientation rather than broader accounting-based performance.

For joint certification versus no certification, the IPWRA results are weaker. The only statistically meaningful ATET in this comparison is the probability of positive CAPEX, with an estimate of 0.098 (SE 0.053), significant at the 10% level. The corresponding ATETs for productivity, revenue per employee, gross margin per employee, return on assets, export share, sales growth, and log CAPEX per employee are not statistically significant (Table 7). This indicates that joint certification is not associated with a broad performance premium relative to non-certification once observable differences (size, ownership, industry) are taken into account.

The most informative comparison is between joint certification and ISO 9001-only certification. In this within-certified comparison, joint certification is associated with higher log productivity, with an ATET of 0.532 (SE 0.201), some evidence of higher log revenue per employee, with an ATET of 0.185 (SE 0.098), higher log gross margin per employee, with an ATET of 0.670 (SE 0.232), and a higher probability of positive CAPEX, with an ATET of 0.183 (SE 0.070). At the same time, the export-share ATET is negative at -0.096 (SE 0.040). By contrast, return on assets, sales growth, and log CAPEX per employee remain statistically insignificant (Table 7).

The robustness checks therefore strengthen a differentiated reading of certification profiles. ISO 9001-only certification is most consistently associated with export orientation relative to non-certified firms. By contrast, joint certification does not appear to confer a broad performance premium relative to non-certification, with only weak evidence of a higher probability of positive CAPEX. The incremental addition of ISO 14001 within the certified group is associated with higher productivity, some evidence of higher revenue per employee, higher margins, and a higher probability of investment, but not with higher export intensity.

Table 7. IPWRA robustness summary for baseline outcomes

Outcome	ISO 9001 only vs Neither	N	Both vs Neither	N	Both vs ISO 9001 only	N
Log productivity (ln_ prod23)	-0.054 (0.153)	307	0.250 (0.178)	306	0.532*** (0.201)	255
Log revenue per employee (ln_rev_per_emp23)	-0.113 (0.120)	332	-0.007 (0.138)	328	0.185* (0.098)	274
Log gross margin per employee (ln_margin_per_ emp23)	-0.051 (0.284)	301	0.560 (0.371)	298	0.670*** (0.232)	245
Return on assets (roa23)	0.007 (0.013)	332	0.014 (0.021)	328	0.027 (0.022)	274
Export share (expshare23)	0.072** (0.035)	332	-0.051 (0.057)	328	-0.096** (0.040)	274
Sales growth 2022–2024 (sales_growth_22_24)	-0.081 (0.071)	332	-0.110 (0.126)	328	0.135 (0.089)	274
Positive CAPEX (capex_ pos23)	-0.039 (0.065)	334	0.098* (0.053)	330	0.183*** (0.070)	274
Log CAPEX per employee, CAPEX > 0 (ln_capex_ emp23)	0.396 (0.295)	268	-0.047 (0.266)	284	-0.159 (0.296)	236

Source: Survey results and Financial statements, Author's calculations

Notes: Each cell reports an ATET estimate with robust standard error in parentheses. Stars denote significance at the 10%, 5%, and 1% levels, respectively (*, **, ***). IPWRA uses sampling weights. Conditional models exclude state-owned enterprises. For log CAPEX per employee, the sample is restricted to firms with positive CAPEX.

5. DISCUSSION

5.1 Certification structure and selection into standards

The prevalence patterns indicate that ISO 9001 is the dominant entry point into management-system certification in the covered manufacturing industries in Serbia, while ISO 14001 is typically adopted as an add-on rather than a standalone standard. In the survey, 51.9% of firms report ISO 9001 and 25.3% report ISO 14001, while ISO 14001 without ISO 9001 is rare at 0.9% (Table 1). Certification prevalence increases with company size, as joint ISO 9001 and ISO 14001 certification rises from around one quarter among micro firms to about 70% among large firms (Table 2). Sectoral patterns also indicate that environmental certification concentrates in metal products and machining, machinery, and electronics, and mostly appears jointly with ISO 9001 (Table 3). This „ISO 9001 first, ISO 14001 second” profile is consistent with arguments that environmental and quality management systems generate complementarities and that joint adoption can yield synergies when quality-management routines are already established (Hernandez-Vivanco *et al.* 2019, 390).

The distribution across firm size and sectors is consistent with the organisational and market frictions that accompany certification. ISO certification relies on third-party audits by registrars, certificates are awarded for a limited period, and

the registration process requires both time and financial outlays (Guler, Guillén, Macpherson 2002, 209–210). These features imply fixed certification and verification costs that are easier to absorb in larger organisations and in firms facing more formalised buyer requirements. Certification can also be driven by external requirements rather than purely internal process needs. Evidence from adoption-timing work shows that firms invest in ISO certification to improve tender prospects and to obtain preferred supplier status (Javorcik, Sawada 2018, 5). The Serbian prevalence results are consistent with this incentive structure, because certification concentrates in firms and sectors where buyer scrutiny and formal procurement requirements are more likely.

Selection into certification is therefore a central interpretive constraint for performance comparisons. The descriptive gaps between certified and non-certified firms are likely to reflect differences in scale, capital intensity, and organisational capabilities as well as any effects of certification. Prior work that separates selection from treatment effects concludes that selection effects can plausibly account for much of the observed performance gap between certified and non-certified firms (Heras-Saizarbitoria, Molina-Azorín, Dick 2011, 8). The conditional regressions and treatment-effects checks in this paper should be read in that context.

5.2. ISO 9001 only and export orientation

The most stable performance association for ISO 9001-only certification concerns export orientation. In both the baseline survey-weighted OLS and the doubly robust IPWRA estimates, ISO 9001-only certification is associated with an export share that is higher by roughly 7 to 8 percentage points relative to non-certified firms (Tables 6 and 7). By contrast, neither the baseline nor the full IPWRA matrix yields statistically meaningful associations for productivity, revenue per employee, gross margin per employee, return on assets, sales growth over 2022–2024, the probability of positive CAPEX, or log CAPEX per employee in the ISO 9001-only versus non-certified comparison. Taken together, these results indicate that ISO 9001-only certification is most consistently associated with export orientation rather than with a broader operating or profitability premium.

This export pattern is consistent with a market-access interpretation of ISO 9001. The signalling perspective treats ISO 9001, and more broadly ISO 9000 family certification, as a mechanism that addresses asymmetric information and allows firms to signal superior but otherwise hard-to-observe attributes to buyers (Terlaak, King 2006, 580–581). Adoption-timing evidence also links certification to improvements in sales, exports, and employment after certification in matched difference-in-differences designs (Javorcik, Sawada 2018, 13–15). This pattern is consistent with certification operating through buyer acceptance and contracting channels rather than through immediate operational transformation. Destination-specific evidence further indicates that certification associations are strongest for exports to EU markets, while results for non-EU exports are weaker and depend on the certificate type (Pacheco, Lobo, Maldonado 2022, 8). In that context, an export-share association for ISO 9001 is plausible even if profitability and productivity effects are weak in cross-sectional comparisons.

The absence of robust associations between ISO 9001-only certification and accounting-based performance is also consistent with research that distinguishes certification from substantive internalisation. Prior work argues that standard adoption and routine use are conceptually distinct and that adoption alone is not sufficient to generate improvement (Naveh, Marcus 2005, 5). Review evidence also points to paperwork burdens, superficial implementation, and weak internal motivation as recurring issues in ISO practice (Heras-Saizarbitoria, Boiral 2013, 5). Qualitative evidence further documents decoupling between external certification narratives and internal practices, where compliance can be maintained for legitimacy rather than for operational learning (Boiral 2012, 35). Certification can therefore satisfy external requirements even when internal routines remain weakly embedded, which attenuates expected productivity or profitability differences (Boiral 2012, 35; Heras-Saizarbitoria, Boiral 2013, 13). Variation in implementation quality and third-party auditing also means that certification is an imperfect proxy for substantive organisational change (Heras-Saizarbitoria, Boiral 2013, 13). This matters in settings where quality-infrastructure policy-making, including standardisation, conformity assessment, and accreditation, is shaped by capacity constraints and fast-track legal alignment (Ruso, Filipović 2020, 3–5, 12). Overall, these mechanisms are compatible with a situation in which ISO 9001 supports access to export markets as an entry credential while average productivity and profitability remain dominated by other determinants.

5.3. Joint certification, exports, margins, and investment behaviour

Joint certification is associated with stronger performance patterns than ISO 9001 alone, but the evidence depends on the comparison group. Relative to non-certified firms, jointly certified firms do not show a broad and consistent performance premium. By contrast, within the certified group, the differences are clearer. Compared with firms holding only ISO 9001, jointly certified firms show higher productivity, some evidence of higher revenue per employee, higher gross margin per employee, and a higher probability of positive CAPEX. The increase in investment incidence is roughly 15 to 18 percentage points, depending on specification. At the same time, log CAPEX per employee among investing firms, return on assets, and sales growth do not differ in a statistically meaningful way. Taken together, the baseline and robustness results point to a pattern in which adding ISO 14001 is associated less with uniformly better outcomes against the full non-certified group and more with stronger operating performance within the already certified subpopulation. This does not contradict the weaker contrast between joint certification and non-certification. The two comparisons use different reference groups. The non-certified group is heterogeneous, whereas the within-certified comparison isolates the incremental association of adding ISO 14001 among firms that have already selected into ISO 9001.

Several mechanisms can rationalise this incremental association. The standards are often treated as complementary, because joint adoption can create synergies across managerial routines and documentation systems (Hernandez-Vivanco *et al.* 2019,

390). ISO 14001 is also linked to supply-chain environmental governance in settings where firms extend environmental requirements to suppliers. Evidence indicates that ISO 14001-certified facilities are more likely to assess supplier environmental performance and to require supplier environmental practices (Arimura, Darnall, Katayama 2011, 175). This supply-chain dimension fits particularly well with the investment result, because compliance and environmental upgrading often require episodic capital spending rather than continuous increases in investment intensity.

Operating-performance evidence on ISO 14001 is consistent with improvements in some settings, while effects remain heterogeneous across studies. Evidence from the United Kingdom and Ireland reports abnormal improvements in employee productivity and manufacturing cost efficiency around ISO 14001 certification, while some operating indicators show weaker gains over longer horizons (Treacy *et al.* 2019, 325–326). Meta-analytic evidence also documents heterogeneity and the role of moderators and measurement choices (Erauskin-Tolosa *et al.* 2019, 5–8). Together, these studies support a view in which ISO 14001 can correlate with operating improvements when implementation is substantive, while average effects remain uneven when implementation depth varies.

The export results point to a differentiated commercial profile rather than to a uniform advantage from adding ISO 14001. Joint certification does not appear to raise export share relative to non-certification, and relative to firms holding only ISO 9001 it is associated with lower export share. The auxiliary regressions on export value and domestic sales point in the same direction. Compared with ISO 9001-only firms, jointly certified firms appear less export-oriented and more domestically oriented in their sales structure. A plausible interpretation is compositional. ISO 14001 adoption may be driven by regulatory exposure, customer environmental requirements in domestic supply chains, or tender participation that is not primarily export-oriented. Destination-specific results show that export relationships vary by destination and by certificate type rather than operating uniformly across standards (Pacheco, Lobo, Maldonado 2022, 8). In addition, evidence on adoption motivations emphasises tenders and preferred supplier status, which can operate through domestic contracting as well as through export markets (Javorcik, Sawada 2018, 5). The negative export contrast should therefore be read as evidence of a different sales profile conditional on controls rather than as evidence that ISO 14001 itself reduces exports.

5.4. Null results for ROA and sales growth

The absence of systematic profitability and growth effects is consistent with the broader empirical record and with the design limitations of the dataset. In both the baseline OLS and the IPWRA robustness checks, neither ISO 9001-only nor joint certification is statistically related to return on assets, and sales growth over 2022–2024 is also not statistically related to certification status (Tables 6 and 7). Accounting profitability and short-window growth can be noisy, and certification timing is not observed. Without certification dates, it is not possible to align outcomes with pre- and post-certification windows, and certification costs can be front-loaded

while benefits accrue later. Evidence from earlier work on ISO 9000 reports that the effect on ROA is very small and dissipates quickly over time (Wayhan, Kirche, Khumawala 2002, 229). Recent evidence also reports specifications where ISO 9001 is associated with a negative EBITDA margin relationship (Neves *et al.* 2024, 1658). These patterns are compatible with the Serbian results, where certification appears more clearly connected to export orientation and investment incidence than to short-run profitability.

The possibility of symbolic or partial adoption also remains relevant when financial effects are weak. Decoupling between certification discourse and internal practices can attenuate performance links even when certificates are present (Boiral 2012, 35). This mechanism is particularly relevant in environments where certification is adopted for contracting legitimacy, tender access, or reputational reasons rather than for internal process learning.

5.5. Implications for interpretation and future research

The evidence supports a differentiated interpretation of ISO certification in the covered industries that depends on the certificate bundle and on the comparison group. ISO 9001 appears most consistently related to export orientation. By contrast, the incremental addition of ISO 14001 within the certified group is associated with higher productivity, some evidence of higher revenue per employee, higher gross margin per employee, and a higher probability of positive CAPEX, but also with lower export share. Relative to non-certified firms, joint certification does not show a broad and systematic performance premium, aside from weaker evidence for a higher probability of positive CAPEX. This pattern is consistent with substantial selection into certification. Prior evidence argues that selection effects can account for much of the observed performance gap (Heras-Saizarbitoria, Molina-Azorín, Dick 2011, 8). The presented results are in line with that concern.

Several extensions would strengthen inference and interpretation. Future data collection that records certification dates and recertification histories would allow outcomes to be aligned with adoption windows and would support dynamic designs. Measures of implementation depth, internal motivation, and audit stringency would help distinguish substantive internalisation from paperwork or formal compliance (Naveh, Marcus 2005, 5; Heras-Saizarbitoria, Boiral 2013, 5, 13). For ISO 14001 in particular, richer outcome measures would improve interpretation. Supply-chain environmental practices and environmental-performance indicators provide a closer mapping between the standard's content and observed outcomes (Arimura, Darnall, Katayama 2011, 175), while meta-analytic evidence indicates that effect sizes vary with measurement strategies (Erauskin-Tolosa *et al.* 2019, 5–8).

6. CONCLUSIONS

This paper examines how ISO 9001 and ISO 14001 relate to the performance of firms in five Serbian manufacturing groups: agrifood, rubber and plastics, metal products and machining, electronics and electrical equipment, and machinery, by

combining a stratified 2023 survey with company financial statements for 2022–2024. Its main contribution lies in distinguishing between ISO 9001-only and joint ISO 9001 and ISO 14001 certification within the same sampling frame, and in assessing those profiles through weighted descriptive evidence, survey-weighted OLS associations, and IPWRA robustness checks.

Certification is widespread in the covered branches of Serbian manufacturing, but it is distributed unevenly across firms. Around half of firms report ISO 9001, roughly one quarter report ISO 14001, and nearly half report neither standard, while ISO 14001 without ISO 9001 is rare. Prevalence rises strongly with firm size and varies across manufacturing branches, with joint certification concentrated among larger firms and specific sectors. This matters for interpretation, because any simple comparison between certified and non-certified firms risks conflating certification with underlying differences in firm structure.

The empirical results point to different roles for the two certification profiles. ISO 9001-only is most consistently associated with export orientation. Firms in this group have a higher export share than non-certified firms, and that result remains under IPWRA. By contrast, ISO 9001-only does not display robust advantages in productivity, revenue per employee, gross margin per employee, profitability, growth, or investment outcomes. In that sense, ISO 9001 appears less as a general operating-performance enhancer and more as a quality signal that supports buyer acceptance and access to export markets.

Joint certification is associated with a different performance profile. Relative to non-certified firms, it does not generate a broad and systematic performance premium, aside from weaker evidence on the probability of investment. One likely explanation is that environmental certification may trigger episodic upgrading and compliance-related capital spending even when broader performance differences remain blurred by the heterogeneity of the non-certified group. The more revealing contrast is therefore within the certified group. Compared with firms that hold only ISO 9001, jointly certified firms show higher productivity, some evidence of higher revenue per employee, higher gross margin per employee, and a higher probability of positive CAPEX. At the same time, they do not invest more intensively once they invest, and they do not show stronger export orientation. On the contrary, export share is lower than among ISO 9001-only firms. A plausible explanation is that adding ISO 14001 is associated with a more domestically embedded commercial profile, in which compliance, supply-chain requirements, or tender-related demand support process upgrading and investment without translating into greater export intensity. Taken together, these findings indicate that adding ISO 14001 is associated with a different organisational and commercial profile: more process- and investment-oriented, but less export-focused.

These results should still be read as conditional associations rather than causal effects. Certification timing is not observed, selection into certification remains important, and the data do not capture implementation depth or audit stringency. More broadly, self-selection, possible reverse causality, and unobserved heterogeneity mean that endogeneity remains a central limitation of the analysis. Even so, the

evidence supports a clear substantive conclusion. Within the covered manufacturing industries, ISO 9001 and joint ISO 9001 and ISO 14001 certification should not be treated as interchangeable markers of firm quality. ISO 9001 is most closely linked to export orientation, while joint certification is more closely linked to stronger operating performance within the already certified population. Future research would benefit from certification histories, richer measures of implementation quality, and outcomes that more directly reflect the environmental content of ISO 14001.

REFERENCES

- Arimura, Toshi H., Nicole Darnall, Hajime Katayama. 2011. Is ISO 14001 a gateway to more advanced voluntary action? The case of green supply chain management. *Journal of Environmental Economics and Management* 61: 170–182.
- Bakator, Mihalj, Dragan Čockalo. 2018. Improving business performance with ISO 9001: A review of literature and business practice. *The European Journal of Applied Economics* 15: 83–93.
- Boiral, Olivier. 2012. ISO 9000 and Organizational Effectiveness: A Systematic Review. *Quality Management Journal* 19: 16–37.
- Durak Uşar, Damla. 2024. Impact of ISO Certifications on Corporate Financial Performance: Evidence from Istanbul Stock Exchange-Listed Manufacturing Companies. *Sustainability* 16: 7021. DOI: 10.3390/su16167021.
- Erauskin-Tolosa, Artizar, Eugenio Zubeltzu-Jaka, Iñaki Heras-Saizarbitoria, Olivier Boiral. 2019. ISO 14001, EMAS and environmental performance: A meta-analysis. Published online (ahead of print). *Business Strategy and the Environment*: 1–15. DOI: 10.1002/bse.2422
- Guler, Isin, Mauro F. Guillén, John Muir Macpherson. 2002. Global Competition, Institutions, and the Diffusion of Organizational Practices: The International Spread of ISO 9000 Quality Certificates. *Administrative Science Quarterly* 47: 207–232.
- Heras-Saizarbitoria, Iñaki, José F. Molina-Azorín, Gavin P. M. Dick. 2011. ISO 14001 certification and financial performance: Selection-effect versus treatment-effect. *Journal of Cleaner Production* 19: 1–12.
- Heras-Saizarbitoria, Iñaki, Olivier Boiral. 2013. ISO 9001 and ISO 14001: Towards a Research Agenda on Management System Standards. *International Journal of Management Reviews* 15: 47–65.
- Hernandez-Vivanco, Alfonso, Pedro Domingues, Paulo Sampaio, Merce Bernardo, Claudio Cruz-Cázares. 2019. Do multiple certifications leverage firm performance? A dynamic approach. *International Journal of Production Economics* 218: 386–399.
- International Accreditation Forum. 2025. *ISO Survey of Management System Standard Certifications – 2024 results*. IAF CertSearch (online database). <https://www.iafcertsearch.org/services/iso-survey>, last visited 20 December 2025.
- Javorcik, Beata, Naotaka Sawada. 2018. The ISO 9000 certification: Little pain, big gain? Accepted manuscript. *European Economic Review*. DOI: 10.1016/j.euroecorev.2018.03.005
- Levine, David I., Michael W. Toffel. 2010. Quality Management and Job Quality: How the ISO 9001 Standard for Quality Management Systems Affects Employees and Employers. *Management Science* 56: 978–996.
- Naveh, Eitan, Alfred Marcus. 2005. Achieving competitive advantage through implementing a replicable management standard: Installing and using ISO 9000. *Journal of Operations Management* 24: 1–26.

- Neves, Maria Elisabete Duarte, Sofia Reis, Pedro Reis, António Gomes Dias. 2024. Impact of ISO 14001 and ISO 9001 adoption on corporate performance: Evidence on a bank-based system. *International Journal of Productivity and Performance Management* 73: 1641–1667.
- Pacheco, Luís, Carla Lobo, Isabel Maldonado. 2022. Do ISO Certifications Enhance Internationalization? The Case of Portuguese Industrial SMEs. *Sustainability* 14: 1335.
- Pivka, Marjan, Duško Uršič. 2002. The impact of ISO 9001 certification process on Slovenian companies. *Journal for East European Management Studies* 7: 27–45.
- Ruso, Jelena, Jovan Filipović. 2020. How do Public Policy-makers Perceive National Quality Infrastructure? The Case of Serbia as an EU Pre-accession Country. *European Review* 28: 276–293.
- Sfreddo, Leonardo Stertz, Guilherme Bergmann Borges Vieira, Gabriel Vidor, Carlos Honorato Schuch Santos. 2018. ISO 9001 based quality management systems and organisational performance: A systematic literature review. Published online (ahead of print). *Total Quality Management & Business Excellence*, DOI: 10.1080/14783363.2018.1549939
- Sharma, Divesh S. 2005. The association between ISO 9000 certification and financial performance. *The International Journal of Accounting* 40: 151–172.
- Spasojević Brkić, Vesna, Zorica Veljkovic, Nada Stanojevic, Snezana Pavicevic. 2017. Operational and employees performance of Serbian industrial companies with ISO 9001 certificate. *Journal of Engineering Management and Competitiveness* 7: 35–43.
- Terlaak, Ann, Andrew A. King. 2006. The effect of certification with the ISO 9000 Quality Management Standard: A signaling approach. *Journal of Economic Behavior & Organization* 60: 579–602.
- Terziovski, Milé, Danny Samson, Douglas Dow. 1997. The business value of quality management systems certification: Evidence from Australia and New Zealand. *Journal of Operations Management* 15: 1–18.
- Terziovski, Milé, Jose-Luis Guerrero. 2014. ISO 9000 quality system certification and its impact on product and process innovation performance. *International Journal of Production Economics* 158: 197–207.
- Treacy, Raymond, Paul Humphreys, Ronan McIvor, Chris Lo. 2019. ISO14001 certification and operating performance: A practice-based view. *International Journal of Production Economics* 208: 319–328.
- Ullah, Barkat, Zuobao Wei, Feixue Xie. 2014. ISO certification, financial constraints, and firm performance in Latin American and Caribbean countries. *SSRN working paper*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2557156, last visited 20 December 2025.
- Vilkas, Mantas, Sigita Vaitkevicius. 2013. Typological Models of Motives and Effects of Adoption of ISO 9000 Series Standards. *Engineering Economics* 24: 373–384.
- Wayhan, Victor B., Elias T. Kirche, Basheer M. Khumawala. 2002. ISO 9000 certification: The financial performance implications. *Total Quality Management* 13: 217–231.
- World Intellectual Property Organization. 2025. *Global Innovation Index 2025: Innovation at a Crossroads*. Geneva: WIPO. <https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2025-en-global-innovation-index-2025-innovation-at-a-crossroads.pdf>, last visited 20 December 2025.

Pavle Medić

Saradnik u nastavi, Univerzitet u Beogradu – Pravni fakultet, Srbija

IMPLEMENTACIJA ISO STANDARDA: UTICAJ NA PERFORMANSE I IZVOZNU KONKURENTNOST PREDUZEĆA U SRBIJI

Rezime

Sertifikacija sistema menadžmenta prema ISO standardima široko je rasprostranjena u prerađivačkoj industriji Srbije, ali njena povezanost sa performansama preduzeća ostaje neizvesna. Na osnovu stratifikovane ankete iz 2023. godine na uzorku od 481 preduzeća iz pet grana prerađivačke industrije Srbije (prehrambena industrija, guma i plastika, metalni proizvodi i mašinska obrada, elektronika i električna oprema i mašine), povezane sa finansijskim izveštajima za period 2022–2024, u radu se ispituju profili sertifikacije ISO 9001 i ISO 14001 primenom ponderisane OLS regresije i IPWRA provere robusnosti. Sertifikacija je neravnomerno raspoređena po veličini i sektorima, a ISO 14001 se retko javlja bez ISO 9001. Kada se kontroliše za posmatrane karakteristike, preduzeća sa samo ISO 9001 imaju veći intenzitet izvoza od nesertifikovanih, dok se produktivnost, profitabilnost, rast i investicioni ishodi ne razlikuju sistematski. Zajednička sertifikacija ne pokazuje širu prednost u odnosu na nesertifikovana preduzeća, osim izvesne prednosti u verovatnoći investiranja. U odnosu na preduzeća sa samo ISO 9001, zajednički sertifikovana preduzeća pokazuju veću produktivnost, veću bruto maržu po zaposlenom, veću verovatnoću ulaganja i niži intenzitet izvoza. Rezultate treba tumačiti kao uslovne povezanosti, a ne kao uzročne veze. U buduća istraživanja trebalo bi uključiti vremensku dimenziju sertifikacije, kao i mere dubine implementacije i kvaliteta revizije.

Ključne reči: ISO 9001. – ISO 14001. – Sertifikacija sistema menadžmenta. – Performanse preduzeća u prerađivačkoj industriji. – Intenzitet izvoza. – Kapitalni izdaci.

ANNEXE

Table A1. Main variables and constructions

Construct	Variable(s)	Definition and construction	Source/year
ISO 9001 certification	iso9001	Indicator equal to 1 if the firm reports holding ISO 9001 at the time of the survey	Survey (2023)
ISO 14001 certification	iso14001	Indicator equal to 1 if the firm reports holding ISO 14001 at the time of the survey	Survey (2023)
Certification profile (regressions)	cert3	0 = Neither; 1 = ISO 9001 only; 2 = Both (ISO 9001 and ISO 14001). Firms with ISO 14001 only are excluded from profile regressions	Derived from survey (2023)
Productivity	ln_prod23	Log productivity indicator for 2023, defined as GVA per employee, used only when the underlying measure is positive	Financial statements (2023)
Operating revenue per employee	ln_rev_per_emp23	$\ln(\text{op_rev23}/\text{emp23})$, defined only if operating revenue and employment are positive	Financial statements (2023)
Gross margin per employee	ln_margin_per_emp23	$\ln((\text{op_rev23} - \text{op_cost23})/\text{emp23})$, defined only if gross margin and employment are positive	Financial statements (2023)
Profitability	roa23	Return on assets in 2023 (ratio reported in the dataset)	Financial statements (2023)
Export intensity	expshare23	Export share in 2023 (ratio reported in the dataset)	Financial statements (2023)
Sales growth	sales_growth_22_24	$(\text{op_rev24} - \text{op_rev22}) / \text{op_rev22}$	Financial statements (2022–2024)
Any positive CAPEX	capex_pos23	Indicator equal to 1 if CAPEX in 2023 is strictly positive	Financial statements (2023)
CAPEX intensity among investors	ln_capex_emp23	$\ln(\text{CAPEX per employee})$ in 2023, defined as the natural logarithm of the difference of Fixed assets in 2023 and 2022, net of depreciation in 2023, divided by the number of employees. The results are estimated only for firms with CAPEX per employee > 0	Financial statements (2023)
Firm size	ln_emp23	Natural log of employment in 2023	Financial statements (2023)
Capital intensity	ln_fa_per_emp23	$\ln(\text{fixed_assets23}/\text{emp23})$, defined only if fixed assets and employment are positive	Financial statements (2023)
Firm age	ln_age	Natural log of firm age in years at the time of the survey	Survey / register
Ownership	ownership	Three-category ownership: SOE, FDI, private domestic. Conditional models exclude SOEs	Survey (2023)
Sector	sector5	Five-sector grouping: Agrifood, Rubber and plastics, Metal products and machining, Electronics and electrical equipment, Machinery	Derived from NACE frame
Sampling weights	ponder	Sampling weights reflecting the stratified design	Survey (2023)