DOI: 10.2507/37th.daaam.proceedings.xxx

FROM CLOUD SERVICES TO DIGITAL SALES: A REGRESSION-BASED STUDY OF EUROPEAN INDUSTRIAL ENTERPRISES

Berislav Andrlić, Ivan Jajić, Božidar Jaković, Petar Belko

Working Paper of 37th DAAAM Symposium

This Publication has to be referred as: Andrlić, B[erislav]; Jajić, I[van]; Jaković, B[ožidar] & Belko, P[etar] (2026). From Cloud Services to Digital Sales: A Regression-Based Study of European Industrial Enterprises, Proceedings of the 37th DAAAM International Symposium, pp.xxxx-xxxx, B. Katalinic (Ed.), Published by DAAAM International, ISBN 978-3-902734-xx-x, ISSN 1726-9679, Vienna, Austria
DOI: 10.2507/37th.daaam.proceedings.xxx

Abstract

This paper examines whether the operational use of paid cloud services is associated with digital selling in European industrial enterprises. The analysis combines open Eurostat statistics for enterprises with ten or more persons employed in NACE Rev. 2 sections C-E. Three samples are distinguished. The descriptive analysis first compares the use of cloud services across the 25 EU Member States in 2025. Changes between 2014 and 2025 are then examined for 24 countries with data available in both years. The regression analysis is conducted on 38 matched pairs of cloud and e-sales observations from six countries, with available cloud data from 2014 to 2023, and corresponding e-sales data from 2015 to 2024. Among the 24 matched countries, mean paid-cloud use increased from 15.04% in 2014 to 52.84% in 2025. In the regression panel, cloud use and e-sales are positively correlated (r=0.567). The preferred country- and year fixed-effects model gives a cloud coefficient of 0.359 (p=0.018), meaning that a 10-percentage-point increase in cloud use is associated with about 3.59 percentage points higher e-sales participation. Robustness checks preserve the positive direction, although longer-lag effects are less precise. The results support a usage-oriented view of cloud computing as business infrastructure rather than a stand-alone adoption indicator.

Keywords: cloud computing; digital sales; e-commerce; industrial enterprises; Eurostat; panel regression

1. Introduction

Cloud computing has become a core element of enterprise digital infrastructure because computing resources, storage and business applications can be accessed and scaled without maintaining equivalent local infrastructure. For industrial enterprises, however, a high cloud-use rate is not by itself evidence of business value. The more relevant information-systems question is whether cloud use is connected with observable digital business processes such as electronic selling. Recent DAAAM research also positions cloud solutions among relevant Industry 4.0 components in industrial enterprises [1], while broader digitalisation is increasingly reshaping organisational processes beyond the production floor [2].

Recent empirical studies associate cloud computing with future accounting performance, sustainable performance and productivity, especially when cloud services are integrated with complementary digital capabilities [3], [4], [5]. This paper therefore moves from simple technology uptake toward usage and business outcome. It uses harmonised Eurostat open data to examine whether countries in which industrial enterprises use cloud services more intensively also exhibit stronger participation in e-commerce sales.

• RQ1: How did paid cloud-service use change between 2014 and 2025, and how large were the differences among EU countries in 2025?

• RQ2: Is greater use of paid cloud services associated with a higher share of industrial enterprises conducting e-commerce sales?

• RQ3: Does the relationship remain positive after controlling for persistent country differences and common year effects?

2. Literature Review

Cloud computing research increasingly treats the technology as an organisational capability rather than only an adoption decision. Zheng et al. [3] report higher subsequent accounting returns among cloud adopters, Al-Sharafi et al. [4] connect cloud integration with financial, environmental and social performance in SMEs, and Katz et al. [5] identify direct and complementary effects of cloud use on firm performance. In industrial settings, cloud services form part of a wider Industry 4.0 architecture that links data, enterprise applications and operational processes [1].

The gap addressed here is narrower, there is limited evidence using harmonised, openly reproducible European industry statistics to connect cloud-service use with a specific digital business process - e-commerce selling. The study is intentionally explanatory but non-causal, and the regression design is used to test whether the association survives country and year controls.

3. Materials and Methods

3.1. Research design

The study uses a quantitative secondary-data design [10] based on public Eurostat statistics [6], [7], [8]. The unit of analysis in the regression is a matched country-period observation for enterprises with ten or more persons employed in NACE Rev. 2 sections C-E: manufacturing; electricity, gas, steam and air conditioning supply; and water supply, sewerage, waste management and remediation activities. The analysis examines statistical association and does not claim a causal effect. All calculations use published country-level percentages rather than firm-level microdata.

3.2. Open data sources and analytical sample

Cloud-use data are taken from Eurostat dataset isoc_cicce_usen2. The main indicator is E_CC, the percentage of enterprises purchasing paid cloud computing services. E-sales data come from the official Eurostat dataset isoc_ec_eseln2, using E_AESELL, the percentage of enterprises with e-commerce sales, for the same GE10 and NACE C-E population [6], [7], [8].

For the purpose of the analysis, three samples are employed. The first involves a description of cloud service usage in 2025 for the 25 EU Member States, with Belgium and Finland being omitted since no usable 2025 figure for NACE C-E was available. The second part looks at the change from 2014 to 2025 for 24 countries for which data are available for both years; in this case, Greece is also excluded as its 2014 value is missing.

The regression analysis is conducted using a smaller number of six countries - Austria, Bulgaria, Cyprus, Czechia, Germany, and Denmark. In these countries, the available observations on cloud services from 2014 to 2023 are combined with the corresponding e-sales observations available from 2015 to 2024. As a result, there are 38 matched country-period observations. Each observation includes information on one country for one matched period. Thus, there are seven observations for Austria because there are seven matched periods of cloud/e-sales data available. The 2025 cloud data are used only in the descriptive analysis because the corresponding later e-sales data are not yet available.

Construct	Eurostat dataset / code	Unit	Operationalisation
Paid cloud-service use	isoc_cicce_usen2; E_CC	PC_ENT	% of C-E enterprises purchasing paid cloud computing services
Advanced cloud use	isoc_cicce_usen2; E_CC1_SI	PC_ENT	% purchasing sophisticated or intermediate cloud services; sensitivity only
E-sales participation	isoc_ec_eseln2; E_AESELL	PC_ENT	% of C-E enterprises with e-commerce sales

Working Paper of 37th DAAAM Symposium

Construct	Eurostat dataset / code	Unit	Operationalisation
Population filter	GE10; NACE C-E	-	Enterprises with 10+ persons employed in industrial activities C-E

Table 1. Data sources, variables and operational definitions

3.3. Temporal alignment and data preparation

The cloud use statistic was recorded for the reference year by Eurostat, whereas the e-sales statistic pertains to sales conducted in the previous calendar year. Accordingly, the two datasets were matched such that both indicators referred to the same period in business operations. For instance, cloud use data from 2014 was matched with e-sales from 2015.

Country aggregates such as the EU and euro area were excluded from the regression. Only GE10, NACE C-E and percentage-of-enterprises observations were retained. Unavailable values were treated as missing, while published numeric estimates carrying Eurostat quality flags were retained. The merged dataset was kept as an unbalanced panel so that countries were not removed simply because some reference years were unavailable.

3.4. Measurement

The dependent variable, ESales, is the percentage of C-E enterprises making e-commerce sales. The main explanatory variable, Cloud, is the percentage purchasing paid cloud computing services. Both variables remain on the original percentage-point scale, so the estimated cloud coefficient can be interpreted directly. The advanced-cloud indicator E_CC1_SI is used only as a sensitivity check and is not entered together with E_CC because the two measures are highly correlated in the overlapping observations (r=0.973).

3.5. Regression specification

The relationship is estimated in three steps, pooled ordinary least squares, a model with year effects, and a preferred model with both country and year fixed effects [9]. Country effects control for persistent differences between countries, while year effects control for changes that affect all countries in a given year. The preferred specification is:

$$ESales_{i,t+1} = \beta_0 + \beta_1 Cloud_{i,t} + \mu_i + \tau_t + \varepsilon_{i,t} \quad (1)$$

In (1), i denotes country and t the cloud reference year. The country term captures time-invariant national differences and the year term captures common changes over time. HC3 heteroskedasticity-robust standard errors are reported because the regression sample contains only six countries. The coefficient is interpreted as an association in percentage points.

As an additional check, the model was re-estimated using the previous available cloud reference year instead of the aligned cloud value. This tests whether the positive relationship is also visible with a longer delay between cloud use and e-sales.

3.6. Robustness and reproducibility

Three robustness tests were carried out to test the reliability of the OLS result. First, the regression was run again replacing the variable for cloud computing usage with that of advanced cloud usage indicator. Secondly, cloud usage in the preceding available period was taken to test whether the effect would be positive even when there is a larger time gap between cloud use and e-sales participation. Thirdly, the preferred regression was re-estimated six times, each time excluding one country. These checks were used to determine whether the direction of the main result remained stable under alternative specifications.

4. Results

4.1. Cloud-service use in European industrial enterprises

Paid cloud use increased substantially between 2014 and 2025. The 2025 descriptive sample contains 25 EU Member States, excluding Belgium and Finland because their 2025 C-E value is unavailable in the extract. For the 24 countries that also have a 2014 value, the mean share of industrial enterprises purchasing paid cloud services rose from 15.04% in 2014 to 52.84% in 2025, an increase of 37.79 percentage points. Greece is included in the 2025 snapshot but not in the matched 2014-2025 comparison because its 2014 value is missing. The median for the matched countries increased from 12.17% to 52.47%, and every country in the matched set recorded an increase.

Working Paper of 37th DAAAM Symposium

Statistic	2014	2025	Change 2014-2025
Matched EU Member States	24	24	-
Mean paid cloud use (%)	15.04	52.84	+37.79 pp
Median paid cloud use (%)	12.17	52.47	+40.30 pp
Minimum / maximum country change	-	-	8.58 / 59.09 pp

Table 2. Matched-country change in paid cloud-service use, NACE C-E

Across the 25-country 2025 sample, the highest paid-cloud rates were Sweden (78.59%), Ireland (77.31%), Italy (76.14%), Malta (75.08%) and the Netherlands (69.90%). The lowest were Bulgaria (14.79%), Romania (21.44%), Greece (27.38%), Portugal (35.33%) and Slovakia (36.14%). The mean share purchasing sophisticated or intermediate cloud services was 45.50% (median 42.11%). These results answer RQ1 by showing that cloud services are widely used, but national differences remain substantial.

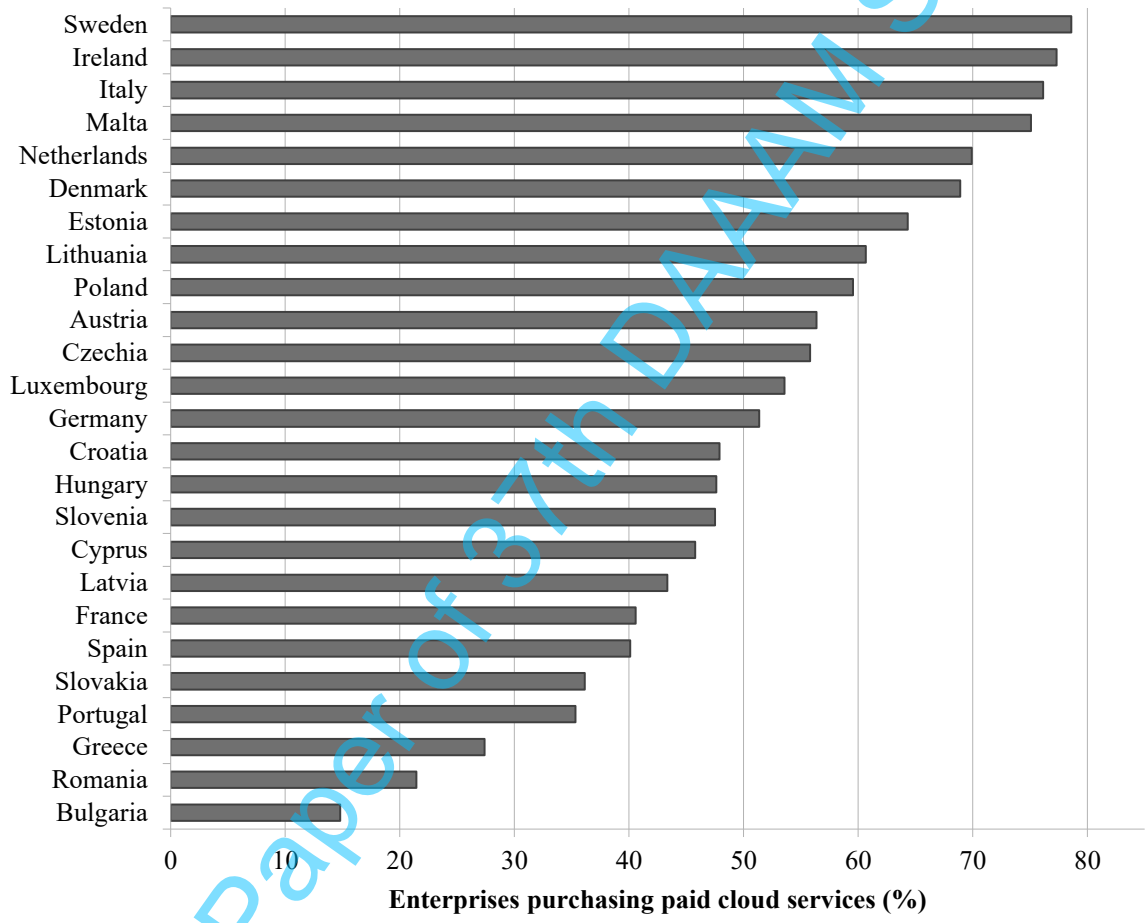

Fig. 1. Paid cloud-service use in C-E industrial enterprises in 25 EU Member States with available 2025 data (Belgium and Finland unavailable). Source: authors' calculations from Eurostat isoc_cicce_usen2

4.2. Cloud use and e-sales: bivariate evidence

The dataset used for the regression includes 38 country-period observations in total, covering Austria, Bulgaria, Cyprus, Czechia, Germany, and Denmark. This data consists of combined cloud data spanning 2014 to 2023 and corresponding e-sales data from 2015 to 2024. Within this sample, paid cloud use and e-sales participation are moderately and positively associated. Pearson's correlation is $r=0.567$ ($p<0.001$), while Spearman's rank correlation is $rho=0.554$ ($p<0.001$). Figure 2 presents the pooled relationship. The regression models are then used to check whether the association remains after differences between countries and reference years are taken into account.

Working Paper of 37th DAAAM Symposium

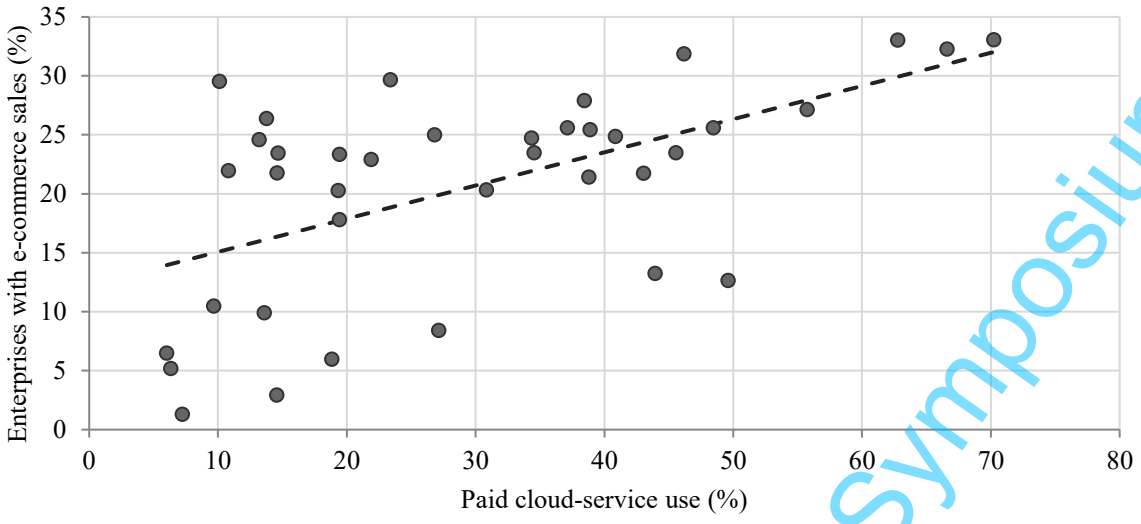

Fig. 2. Paid cloud-service use and e-sales participation for 38 matched country-period observations from six European countries - line: pooled OLS fit.

4.3. Regression results

Table 3 reports the main estimates. In pooled OLS (M1), a one-percentage-point increase in cloud use is associated with a 0.281 percentage-point increase in e-sales participation (HC3 SE=0.067; p<0.001). Adding year effects (M2) increases the coefficient to 0.377 (SE=0.064; p<0.001). Most importantly, the coefficient remains positive after both country and year fixed effects are introduced (M3): β=0.359, HC3 SE=0.152, p=0.018. On the original scale, a 10-percentage-point increase in paid cloud-service use is therefore associated with approximately 3.59 percentage points higher e-sales participation within the observed country-year structure.

Model	Cloud coefficient	HC3 SE	p-value	N	R^2	Country FE	Year FE
M1 Pooled OLS	0.281	0.067	<0.001	38	0.321	No	No
M2 Year FE	0.377	0.064	<0.001	38	0.422	No	Yes
M3 Country + year FE	0.359	0.152	0.018	38	0.907	Yes	Yes
M4 Previous-period cloud	0.184	0.187	0.326	32	0.919	Yes	Yes

Table 3. Regression estimates for e-sales participation

The preferred M3 estimate supports RQ2 and RQ3, the relationship is not only a cross-country level correlation, because it remains positive and statistically distinguishable from zero after controlling for persistent country differences and common year effects. The high R^2 in M3 largely reflects the fixed effects and should not be interpreted as predictive performance.

4.4. Robustness checks

Three robustness tests were conducted in order to test the stability of the OLS results. Firstly, the regression was re-run using the indicator of advanced cloud usage instead of the general cloud usage indicator. Secondly, the lagged regression was run using the cloud usage from the last available year. Thirdly, the original regression was run multiple times, each time omitting the observations of one country.

The advanced-cloud regression also showed a positive association with e-sales, although it was based on a smaller sample. The lagged regression still had a positive relationship between cloud usage and e-sales, however, it was not statistically significant. Finally, in the leave-one-country-out analysis, the cloud coefficient was positive in all specifications.

Working Paper of 37th DAAAM Symposium

5. Discussion

The central result is that cloud use is more informative when treated as an operational digital capability than when reported only as a technology-adoption percentage. The descriptive data show that cloud purchasing has become widespread across European industrial enterprises, but the cross-country range remains large. The regression evidence adds a business-informatics interpretation, within the six-country analytical panel, higher cloud use is associated with a larger share of industrial enterprises conducting e-commerce sales even after country and year effects are considered.

This pattern is consistent with prior firm-level evidence that cloud computing can support performance through scalable infrastructure and complementary digital capabilities [3], [5]. For industrial enterprises, the mechanism is plausible because cloud services can host databases, enterprise applications, customer-facing systems and integration services needed to execute electronic orders. In practice, cloud infrastructure enables industrial e-sales by linking the sales channels that face the customer with enterprise resource planning, customer relationship management, and inventory systems. Cloud-based enterprise resource planning systems can synchronise product availability, order processing and invoicing, while customer relationship management systems supply current customer and contract information. Dynamic pricing applications are able to alter prices in response to customer conditions, demand or inventory availability, and automated inventory interfaces can give buyers access to up-to-date stock and delivery information. Unlike the method of manual order entry or the more inflexible traditional electronic data interchange setups, these integrated cloud-based systems can reduce transaction delays, duplicate data entry and the coordination costs involved for business-to-business industrial customers. The findings do not imply that buying cloud services automatically causes digital sales. Organisational capabilities, product suitability, supply-chain integration, customer structure and national market conditions remain important complements.

The main limitation is that the regression sample is smaller than the descriptive sample. Cloud use can be described for 25 EU Member States in 2025, whereas the completed aligned regression dataset used in this paper contains six countries and 38 observations. The regression results should therefore be read as exploratory panel evidence rather than an EU-wide causal estimate. A second limitation is aggregation: country-level percentages cannot show differences between individual firms. Future work should extend the same model to the complete Eurostat C-E e-sales panel and, where possible, to enterprise microdata.

6. Conclusion

This paper examines cloud-service use in relation to an observable digital business process rather than treating cloud computing only as a technology-adoption indicator. For the 24 EU countries having available data for both years under consideration, the average percentage of paid cloud usage increased from 15.04% in 2014 to 52.84% in 2025. The regression results, which are based on 38 paired observations from six countries, show that there is a positive relationship between cloud usage and e-sales participation. In the preferred regression model, a 10 percentage point change in the cloud usage was connected with 3.59 percentage points higher e-sales participation (β=0.359, p=0.018). The additional checks generally confirmed the positive direction of the relationship, although the longer-lag result was not statistically significant. The practical implication is that cloud infrastructure should be evaluated through the business processes it enables, including customer transactions and digital sales, rather than through uptake rates alone. Further research should replicate the model on the complete European e-sales panel and investigate which specific cloud services are most strongly connected with industrial e-commerce outcomes.

7. References

[1] Vranakova, N. & Gyurak Babelova, Z. (2024). Insights into Industry 4.0 components and acceptance of new technologies in industrial enterprises, Proceedings of the 35th DAAAM International Symposium, pp.0292-0298, B. Katalinic (Ed.), DAAAM International, Vienna, Austria, DOI: 10.2507/35th.daaam.proceedings.040

[2] Vranakova, N. & Gyurak Babelova, Z. (2025). Transformation of HR areas as a result of digitization and automation: Analysis and findings, Proceedings of the 36th DAAAM International Symposium, pp.0169-0174, B. Katalinic (Ed.), DAAAM International, Vienna, Austria, DOI: 10.2507/36th.daaam.proceedings.022

[3] Zheng, M.; Huang, R.; Wang, X. & Li, X. (2023). Do firms adopting cloud computing technology exhibit higher future performance? A textual analysis approach, International Review of Financial Analysis, Vol. 90, 102866, DOI: 10.1016/j.irfa.2023.102866

[4] Al-Sharafi, M. A.; Iranmanesh, M.; Al-Emran, M.; Alzahrani, A. I.; Herzallah, F. & Jamil, N. (2023). Determinants of cloud computing integration and its impact on sustainable performance in SMEs: An empirical investigation using the SEM-ANN approach, Heliyon, Vol. 9, No. 5, e16299, DOI: 10.1016/j.heliyon.2023.e16299

[5] Katz, R.; Jung, J. & Goldman, M. (2024). Cloud Computing and firm performance: a SEM microdata analysis for Israeli firms, Digital Policy, Regulation and Governance, Vol. 26, No. 3, pp.295-316, DOI: 10.1108/DPRG-06-2023-0091

[6] Eurostat (2025). European businesses statistics compilers' manual for ICT usage and e-commerce in enterprises, 2025 survey, Publications Office of the European Union, Luxembourg, ISBN 978-92-68-34786-7, DOI: 10.2785/2641073

[7] Eurostat (2025). Cloud computing services by NACE Rev. 2 activity (isoc_cicce_usen2), statistical dataset, DOI: 10.2908/ISOC_CICCE_USEN2, Accessed: 2026-08-24

Working Paper of 37th DAAAM Symposium

[8] Eurostat (2026). E-commerce sales of enterprises by NACE Rev. 2 activity (isoc_ec_eseln2), statistical dataset, DOI: 10.2908/ISOC_EC_ESELN2, Accessed: 2026-08-24
[9] Wooldridge, J. M. (2025). Introductory Econometrics: A Modern Approach, 8th Edition, Cengage, ISBN 978-0-357-90016-1, Boston
[10] Saunders, M. N. K.; Lewis, P. & Thornhill, A. (2023). Research Methods for Business Students, 9th Edition, Pearson, ISBN 978-1-292-40272-7, Harlow

Working Paper of 37th DAAAM Symposium