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Review Article

Reading Nominal Apparent Labor Productivity Across Broad European Business Sectors: A Flag-Aware Eurostat Description, 2008-2020

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ABSTRACT

This paper asks what cross-country and cross-sector patterns are visible in nominal apparent labor productivity and employment across broad European business sectors, and how sensitive those descriptions are to Eurostat quality flags and statistical-unit changes. We analyzed Eurostat's annual enterprise statistics for special aggregates of NACE Rev. 2 activities (sbs_na_sca_r2), covering 36 individual geographies, 13 non-overlapping broad sections, and 2008–2020 as the principal period. We report unweighted medians, quartiles, cell counts, paired endpoint changes and flag-clean sensitivity results, without aggregate geographies, employment shares, causal models or economy-wide estimates. Across available country-section cells, median nominal apparent labor productivity was €37.70 thousand per person employed in 2008 and €39.20 thousand in 2020. Among 315 paired country-section observations, median changes ranged from −7.79% in accommodation and food services to 34.21% in manufacturing, with several section results changing when flagged endpoint observations are excluded. The paper contributes a reproducible, measurement-conscious baseline for broad-sector productivity comparison that keeps nominal valuation, employment definitions, missingness, and comparability breaks visible rather than treating apparent labor productivity as technical efficiency.

Keywords: Apparent Labor Productivity, Structural Business Statistics, NACE Rev. 2, Employment, Eurostat, Productivity Measurement.

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INTRODUCTION

Productivity indicators occupy an unusual position in performance management research. They are simultaneously measurement devices, inputs to benchmarking and objects of policy interpretation. A ratio such as value added per person employed is attractive because it is simple, widely available, and comparable across activity classifications. Yet its simplicity can encourage an expansive interpretation: an increase is sometimes described as improved efficiency, stronger management, or technological progress even though the ratio may also respond to prices, margins, product composition, outsourcing, labor composition, hours, capacity utilization, statistical-unit changes, and the treatment of intermediate inputs. A useful productivity study must therefore make the indicator's measurement boundary as visible as its numerical result.

This paper provides a reproducible descriptive analysis of Eurostat's annual enterprise statistics for special aggregates of NACE Rev. 2 activities (sbs_na_sca_r2). The analysis is deliberately narrower than a causal productivity study. It asks: what patterns of nominal apparent labor productivity and persons employed are observed across broad, non-overlapping NACE sections and individual country geographies during 2008–2020, and how much do those descriptive patterns change when Eurostat observation flags are treated conservatively? It does not ask whether a sector, employment change, or institutional intervention caused a productivity outcome, and it does not estimate technical efficiency, real productivity, or economy-wide productivity.

The source matters to the question. The supplied file is sbs_na_sca_r2, the special-aggregates table, rather than sbs_na_ind_r2, the detailed industry table. We therefore retain only broad sections: B, C, D, E, F, G, H, I, J, L, M, N, and S95. We exclude EU aggregate geographies and analyze 36 individual reporting geographies. Although the file contains 2005–2020, Eurostat's historical metadata states that NACE Rev. 2 is used from 2008 and that 2005–2007 NACE Rev. 2 values may be voluntary back casts or Eurostat estimates converted from NACE Rev. 1.1. Accordingly, 2008–2020 is the principal comparison window, and 2005–2007 is treated as supplementary rather than silently pooled into the main trend.

The study has three practical aims. First, it documents exactly what the SBS indicator means and what it does not mean. Second, it gives broad-sector descriptive results with explicit available Ns, paired endpoint Ns, and separate employment outcomes. Third, it demonstrates a reproducible flag-aware workflow that can be audited from the supplied compressed TSV to the figures and tables. The intended contribution is not a claim of novel causal discovery. It is a defensible template for performance comparison when the available source is an official aggregate business-statistics table rather than a firm-level production panel.

LITERATURE AND CONCEPTUAL FRAMING

Productivity is a Ratio, not a Complete Efficiency Measure

The OECD Manual treats productivity as the relationship between an output measure and one or more inputs and distinguishes single-factor productivity from multifactor productivity (OECD, 2001). This distinction is central here. Apparent labor productivity is a partial productivity measure: it indicates the value added associated with each measured person employed, but it does not isolate labor's marginal product or the joint contribution of capital, intermediate inputs, technology and organization. In growth accounting frameworks such as EU KLEMS, industry-level value-added growth is systematically decomposed into capital input, labor services and multifactor productivity (O'Mahony & Timmer, 2009). Apparent labor productivity conflates these distinct margins: the ratio

can rise from genuine technological innovation (multifactor productivity), capital deepening (more capital per worker), or substitution away from labor toward purchased intermediate materials and energy services.

Syverson's (2011) review of productivity differences likewise shows that measured productivity varies with both internal production practices and external operating conditions. Furthermore, the microeconomic productivity literature draws a fundamental line between physical productivity (TFPQ), which measures technical efficiency in physical units produced per unit of input, and revenue-based productivity (TFPR), which measures the monetary value of output per unit of input (Foster, Haltiwanger, & Syverson, 2008). When output is valued in monetary terms—as in Eurostat's value added at factor costs—variations in measured productivity across firms and sectors often reflect idiosyncratic price movements, mark-ups, product differentiation, and demand shocks rather than differences in physical efficiency. A sectoral ratio is therefore informative for description and benchmarking, but insufficient as a standalone explanation of operational efficiency.

The distinction is also directly relevant to performance management research. A manager or policymaker who sees a higher value-added-per-person ratio may reasonably ask whether production has become more efficient, but the aggregate statistic alone cannot answer that question. A higher ratio may instead reflect a change in output prices, market power, product mix, capital intensity, outsourcing, hours per person, or the composition of enterprises within the sector. The appropriate management use is consequently diagnostic: identify a pattern, then investigate its mechanisms with measures that match the decision being evaluated.

At the macro and industry levels, van Ark, O'Mahony and Timmer (2008) illustrate how measured productivity differences between Europe and the United States can be connected to information and communication technology, market services and knowledge-economy development, while still requiring careful structural decomposition. Their analysis supports the value of sectoral comparison but also demonstrates why a broad sector label is not itself a mechanism. This paper adopts the same caution at a more modest descriptive level: broad-sector patterns are documented without claiming that they reveal the underlying drivers or managerial competence.

Output Concepts, Prices and Sector Boundaries

The output concept fundamentally changes the interpretation of a productivity ratio. Industry productivity can be expressed using gross or sectoral output, value added, or other output measures depending on the analytical question. Eldridge and Price (2016) explain that value-added and sectoral-output approaches answer different questions because the treatment of purchased intermediate inputs differs. Value added is useful when the focus is on the income generated by primary factors, but it can change substantially with outsourcing, vertical disintegration, and changes in intermediate input intensity. In the SBS source, V91110 is based on value added at factor costs, not on a deflated physical output measure.

Nominal valuation is particularly consequential for cross-country and cross-sector comparisons. A nominal value-added measure combines volume and price movements, and value added includes operating-surplus components that can shift with rents, mark-ups, and market conditions. Secular trends in product market competition and mark-ups across European economies (De Loecker, Eeckhout, & Unger, 2020) imply that rising nominal value added can reflect expanding economic rents and pricing power rather than improved resource transformation. Hearne and Lewis (2024) demonstrate the danger of treating nominal and real labor productivity as interchangeable: the two can diverge markedly across sectors and regions due to differential inflation and deflator discrepancies. We therefore call V91110 "nominal apparent labor productivity" throughout and do not use words such as real growth, efficiency gain, or technological progress as synonyms for a higher ratio.

Service sectors add further conceptual challenges that intersect with structural change. Baumol's (1967) classic model of unbalanced growth highlights a fundamental divergence between technologically progressive sectors (such as manufacturing, Section C, where capital accumulation and technological automation continually expand physical output per worker) and stagnant personal service activities (such as accommodation and food services, Section I, where labor is an intrinsic component of the delivered service). Under Baumol's cost disease, stagnant sectors face rising relative costs and sluggish physical productivity growth, meaning that nominal value-added ratios in hospitality or personal services naturally diverge from automated manufacturing. Maroto-Sánchez (2012) reviews the broader measurement problems of service productivity, including intangible output, quality change, customer co-production and the difficulty of pricing heterogeneous service tasks.

Modern business services introduce an additional layer of measurement complexity related to intangible assets. In knowledge-intensive sectors such as information and communication (Section J) and professional, scientific and technical activities (Section M), firm assets increasingly take the form of software, databases, design, research and development, and organizational competencies (Corrado, Hulten, & Sichel, 2009; Haskel & Westlake, 2017). Because conventional business statistics have historically treated many intangible investments as intermediate expenses rather than gross fixed capital formation, nominal value added at factor costs can misstate the true economic contribution of knowledge-intensive activities. A low or declining nominal ratio in a service section cannot be interpreted without considering output quality, pricing, intangible accumulation, and shifting sector composition.

Labor Input, Hours, and Outsourcing

The denominator is equally important. Eurostat's SBS concept of persons employed includes employees, working proprietors, partners working regularly in the unit, and unpaid family workers. It is not equivalent to hours worked, full-time equivalents, or a quality-adjusted labor index. OECD methodological guidance identifies total hours actually worked as the preferred labor input for productivity analysis when it is available, while persons employed remain a useful but less preferred alternative for data-availability reasons (OECD, 2021). The supplied special-aggregates file supports persons employed and also contains hours-worked-related variables in some contexts, but the principal published indicator used here is explicitly per person employed.

Dixon and Freebairn (2009) show why persons and hours should not be treated as perfect substitutes. Quasi-fixed employment costs, fluctuations in overtime, and cross-country differences in average hours mean that an employment count can move very differently from labor services actually consumed in production. This limitation is material for broad sectors with high prevalence of part-time work, seasonal contracts and self-employment, such as retail trade (Section G) and food services (Section I). Furthermore, cross-country research utilizing micro-distributed firm data shows that sectoral aggregates mask wide and increasing dispersion between globally connected 'frontier' enterprises and domestic 'laggards' (Andrews, Criscuolo & Gal, 2016). When low-productivity laggards exit or when labor inputs shift toward more educated personnel, aggregate sectoral productivity can rise purely through compositional changes rather than within-firm improvements.

Outsourcing can create a second denominator distortion. Houseman (2007) documents how domestic outsourcing and international offshoring can inflate measured manufacturing productivity when core physical production remains associated with manufacturing value added while support workers (cleaning, logistics, security, IT) are recorded in administrative and support service activities (Section N). Eurostat's historical metadata similarly states that agency workers and personnel supplied by another enterprise are not counted as employees of the user unit. The present aggregate data cannot track these inter-sectoral labor flows, so outsourcing is treated as a plausible

measurement channel rather than asserted as an empirical explanation.

Sectoral Comparison as Performance Measurement

Sectoral comparison remains useful when it is explicit about its purpose. It can reveal where the published indicator is high or low, identify sections with divergent employment and productivity patterns, and help prioritize further operational inquiry. Ronzon *et al*. (2020) provide an EU example that combines employment and value added from SBS to monitor bioeconomy sectors. Their approach illustrates how official enterprise statistics can support policy-relevant monitoring, while also showing that derived sectoral indicators inherit the definitions and limitations of the underlying data. Grounding sectoral benchmarking in the performance management literature provides necessary discipline. Neely (2005) and Bititci *et al*. (2012) observe that performance measurement systems frequently falter when high-level macro indicators are unreflectively imported into organizational evaluation without contextualizing operational constraints, institutional incentives, and measurement boundaries. In benchmarking broad European sectors, treating nominal apparent labor productivity as an unadjusted performance scorecard risk rewarding sectors that benefit from market concentration or asset revaluation while penalizing labor-intensive service sectors constrained by cost-disease dynamics.

This paper's performance-management contribution is methodological: it treats a productivity ratio as a measurement construct rather than an unqualified efficiency score, reports sectoral performance with changing Ns, flags and paired-sample rules visible, and keeps employment outcomes separate from productivity outcomes when the denominator is employment. The resulting evidence is intended to support disciplined benchmarking and question formation, not to prescribe sectoral interventions from a single ratio.

Historical and Institutional Context

The institutional history of SBS explains why a 2008–2020 window is analytically preferable to an undifferentiated 2005–2020 trend. The earlier SBS framework was built around a common European legal basis for collecting statistics on business structure, activity, competitiveness and performance. The 2008 regulation recast that framework and established NACE Rev. 2 as the activity classification for the new reference period (Eurostat, 2009). This was not merely a relabeling exercise: the classification reorganized activities and extended the detail available for services. Eurostat's historical metadata consequently distinguishes the pre-2008 NACE Rev. 1.1 period, the 2008 double-reporting bridge and the later NACE Rev. 2 period. A descriptive trend that ignores that sequence would mix classification history with economic change.

The enterprise concept has a similar institutional implication. A legal unit is not always the same as the statistical enterprise that organizes production and allocates resources. When national statistical institutes moved toward the enterprise concept, internal transactions could be consolidated, and groups of legal units could become one observation. The resulting break may affect enterprise counts, value added, and employment simultaneously. In a productivity ratio, simultaneous numerator and denominator changes can either amplify or offset one another. We therefore do not treat the enterprise-unit transition as an explanatory variable or estimate a post-transition effect. Instead, we expose it through the metadata discussion, the break flags and the flag-clean sensitivity analysis.

This historical framing also clarifies the role of the country dimension. Eurostat harmonizes classifications and transmission requirements, but national statistical institutes compile SBS using combinations of surveys, business registers and administrative sources. Differences in source mix, estimation, imputation, and the timing of revisions are part of the observed data-generating environment. Cross-country medians are consequently useful as

descriptive summaries of published statistics, but they should not be read as if every country had identical survey designs or identical exposure to classification and enterprise-unit changes. The analysis treats comparability as graded rather than binary: 2008–2020 is the more defensible principal window, yet flags and national metadata remain necessary for interpretation.

Data and Institutional Definitions

Dataset and Scope

The source is Eurostat's dataset sbs_na_sca_r2, "Annual enterprise statistics for special aggregates of NACE Rev. 2 activities (2005–2020)" (Eurostat, 2024a). The official Data Browser identifies the online data code as sbs_na_sca_r2, supplies the dataset DOI 10.2908/sbs_na_sca_r2, and reports data coverage from 2005 to 2020. The supplied compressed TSV has 118,597 wide rows before reshaping, 33 indicator codes, 39 geography codes, and 16-year columns. These local counts are file-audit counts, not a claim about the number of cells in the official Data Browser custom view.

Historical SBS metadata describes market-oriented business activities and excludes agriculture, forestry and fishing, public administration and largely non-market education and health activities (Eurostat, 2023a). For the historical NACE Rev. 2 period, the relevant broad coverage is Sections B–N and Division S95, with special treatment and partial coverage for financial activities. The present analysis retains the broad section codes present in the supplied source for the core indicators: B mining and quarrying; C manufacturing; D electricity, gas, steam and air conditioning supply; E water supply, sewerage, waste management and remediation; F construction; G wholesale and retail trade and repair of motor vehicles and motorcycles; H transportation and storage; I accommodation and food service activities; J information and communication; L real estate activities; M professional, scientific and technical activities; N administrative and support service activities; and S95 repair of computers and personal and household goods.

This scope is intentionally non-overlapping at the section level. The file contains additional special aggregates and detailed codes, but those are not combined with the broad sections. Section K is not reconstructed from another dataset because the supplied file contains no broad K rows for the core variables used in the principal analysis. Aggregate geographies EU27_2007, EU27_2020 and EU28 are excluded. The retained geography codes are 36 individual reporting geographies: AL, AT, BA, BE, BG, CH, CY, CZ, DE, DK, EE, EL, ES, FI, FR, HR, HU, IE, IS, IT, LT, LU, LV, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, TR and UK. These include EU Member States, EFTA and candidate/potential candidate reporting geographies present in the file; they are not presented as a homogeneous EU aggregate.

Statistical Units and Definitions

SBS country-level statistics refer to enterprises. Eurostat defines the enterprise as the smallest combination of legal units that is an organizational unit producing goods or services and possessing a degree of autonomy in decision-making. The historical metadata cautions that many Member States used legal units as a proxy before implementing the statistical enterprise, with the transition producing breaks in some countries around 2017–2018. The analysis treats that transition as a comparability issue rather than as an observed productivity event.

The outcome V91110 is "apparent labor productivity (gross value added per person employed)" and is expressed in thousands of euros per person employed (Eurostat, 2023b). The underlying numerator V12150 is value added at factor costs in million euros; V16110 is persons employed, in number of persons. Value added at factor costs is

described in the historical definitions as gross income from operating activities after adjustment for operating subsidies and indirect taxes, without subtracting value adjustments such as depreciation. The analysis uses the published V91110 series and verifies it against the reconstruction:

$$ALP_calc(c,s,t) = [V12150(c,s,t) \times 1{,}000] / V16110(c,s,t).$$

The calculation returns thousands of euros per person because million euros divided by persons is converted by multiplying by 1,000. Among 5,291 country-section-year rows for which both published V91110 and the reconstructed measure were numeric, 5,289 agreed within 0.25 thousand euros per person (99.962%). This is a validation of units and rounding consistency, not an independent validation of the underlying national-statistical compilation. Employment is analyzed with V16110, persons employed. V91290, growth rate of employment, is retained in the audit and coverage tables but is not used to create the main outcome. The main employment display uses the level of V16110 and a section-specific index with the 2008 median set to 100. We do not construct an employment share and do not correlate it with ALP. This avoids a mechanically induced association between a productivity measure with employment in its denominator and a share that also uses employment.

Classification and Time Comparability

NACE Rev. 2 was implemented in SBS from reference year 2008. Eurostat's historical metadata reports that NACE Rev. 1 was used until 2001, NACE Rev. 1.1 from 2002, and NACE Rev. 2 from 2008. Key data were double-reported for 2008, while from 2009 only NACE Rev. 2 data were generally available. For 2005–2007, Member States voluntarily supplied NACE Rev. 2 back casts in some cases, and Eurostat estimated values from NACE Rev. 1.1 in others; activities absent from the earlier collection could not always be estimated. The principal sample therefore begins in 2008. The supplementary years are not discarded, but their distinct status is explicit in the reproducibility materials. Comparability is also constrained by revisions, confidentiality, national data sources and statistical-unit changes. Eurostat states that SBS data may be compiled from surveys, business registers and administrative sources, with grossing-up, model-based estimation and imputation depending on national practice. The historical metadata identifies country-specific breaks associated with the transition to statistical enterprise units. These features mean that a break flag is not merely a nuisance label: it is information about whether a change in the series may reflect a measurement boundary.

Observation and Confidentiality Flags

The analysis preserves the value and flag string for every selected source cell. Eurostat standard flags include ":" for not available, "b" for break in time series, "c" for confidential, "d" for definition differs, "e" for estimated, "p" for provisional, and "u" for low reliability (Eurostat, 2024b). The Data Browser's historical display may also show combined forms such as "be" and confidentiality markers. Nonnumeric, unavailable, and confidential cells are not converted to zero and are not imputed. Across the 29,760 selected cells for the four audited indicators and all 2005–2020 years, direct source-cell counts show 1,612 cells containing b, 222 containing e, 685 containing p, 24 containing u, 465 containing d, and 404 containing c. These counts are overlapping rather than mutually exclusive because combined flags can contain more than one letter. The exact profile is supplied in table_flag_profile.csv. The main descriptive sample retains numeric observations, but reports flagged coverage. A strict endpoint sensitivity analysis excludes any pair with b, e, p, u, d, or c on either ALP or persons employed at either endpoint.

Data-Generating Process and Quality Interpretation

SBS is produced within a distributed statistical system rather than a single survey instrument. Eurostat receives

annual transmissions from national statistical authorities, which may combine business registers, enterprise surveys, administrative records and estimation procedures. The resulting harmonization is valuable for cross-country analysis, but it does not imply identical national measurement processes. Fiscal-year practices, coverage thresholds, source revisions and the treatment of complex enterprise groups can differ. The historical metadata notes that SBS normally refers to the calendar year while, for many enterprises, the accounting period is the relevant source period. Such alignment decisions matter when a sector experiences rapid growth, contraction, or a sharp price movement near the reference-year boundary.

Quality flags are therefore part of the observation, not a formatting inconvenience. An estimated value can be numerically useful while carrying more uncertainty than a directly compiled value; a break flag cautions against level comparisons across years; a definition-difference flag limits cross-country comparability; and confidentiality can remove precisely the small or concentrated cells where sectoral structure is most distinctive. Because Eurostat supplies no common error variance, we do not assign ad hoc numerical penalties to flags: we preserve them, report their counts, and apply a transparent exclusion sensitivity.

METHODS AND MATERIALS

Research Design

Research Question and Estimands

The research question is descriptive: how did nominal apparent labor productivity and persons employed vary across broad NACE Rev. 2 sections and individual country geographies during 2008–2020, and how sensitive are observed comparisons to official quality flags and known statistical-unit changes? This wording limits the estimands to distributions and paired changes. It does not imply that sector, country, employment, or any observed event is a treatment. For each section s and year t, the primary descriptive estimand is the unweighted median of numeric V91110 across available country geographies. We also report the 25th and 75th percentiles and the number of available country cells. This is an available-cell statistic, not a population-weighted European productivity estimate. The pooled annual display combines all available country-section cells and reports its N so that changing coverage is visible. Section-specific lines in Figure 1 use the same unweighted median rule. For employment, we report the unweighted median of numeric V16110 by section and year and show a within-section index: 100 × median(V16110_s,t)/median(V16110_s,2008). The index is a descriptive level display. It is not an employment share, and it does not measure labor input intensity or hours.

Paired Endpoint Design

To provide a compact comparison over the principal period, we match each country-section observation in 2008 to the same country-section observation in 2020. For an outcome y, the paired percentage change is 100 × (y_2020/y_2008 − 1). The ALP endpoint sample requires numeric V91110 at both dates; the employment endpoint sample requires numeric V16110 at both dates. The combined table reports country-section pairs for which both outcomes are present at both endpoints, giving 315 pairs. Section Ns differ and are reported explicitly; construction, for example, has seven pairs. The paired design reduces the risk that a simple difference is driven entirely by comparing different geographies, but it does not remove measurement breaks, revisions, nominal-price movements, or selective missingness. Nor does it create a balanced country panel: the unit of observation is a country-section pair, and sections have different coverage. The interpretation is therefore “among observed pairs meeting the endpoint rule,” not “the typical European sector.”

Analysis and Reproducibility

The supplied Python program reads the compressed TSV with pandas, splits the first comma-delimited dimension field into frequency, NACE code, indicator, and geography, reshapes the annual columns to long form, parses leading numeric values, preserves trailing flags, applies the section and geography restrictions, and writes audit files. It then pivots the four indicators to a country-section-year panel, validates the published ALP, produces section-year summary tables, calculates paired changes, and writes three high-resolution PNG figures. No internet access is required to rerun the analysis after the supplied source file is present.

Assumptions, Estimand Discipline and Robustness Logic

Several assumptions define what can and cannot be inferred. The first is an observation assumption: a numeric cell is treated as an available published observation, not as evidence that the underlying sector is fully observed. Missing and confidential cells are left missing. The second is a comparability assumption: the broad section codes are treated as the same conceptual activity categories within the NACE Rev. 2 principal period, while breaks and definition-difference flags remain visible. The third is a denominator assumption: V16110 is treated as the source-defined persons-employed concept, not silently converted into hours, jobs, or full-time equivalents. The fourth is a weighting assumption: every available country-section cell receives equal weight in the median.

This is a deliberate descriptive choice, not a claim that a small economy contributes as much output as a large one. The median is selected because the observed country-section distributions can contain large level differences and outlying values, especially in activities such as mining, utilities, and real estate. It is not intended to estimate the mean productivity of the European business economy. A mean would be more sensitive to the scale and extreme values of large observations; an output-weighted aggregate would require a different estimand and careful treatment of aggregate geographies. By publishing the interquartile range and annual N alongside the median, the study makes dispersion and coverage part of the result rather than treating them as secondary diagnostics.

The paired endpoint estimand imposes a different assumption: the same country-section identity is matched across 2008 and 2020. This improves interpretive coherence relative to comparing two unrelated cross-sections, but it does not assume that the statistical unit, sector boundary, or price structure remained unchanged. The endpoint comparison is therefore a conditional descriptive change among observed pairs. Its robustness is assessed in two ways.

First, the published V91110 ratio is reconstructed from V12150 and V16110 to detect unit or scaling mistakes. Second, endpoint pairs carrying official b, e, p, u, d, or c flags are removed in the strict sensitivity sample. Agreement between inclusive and clean results is evidence of descriptive stability for that section; disagreement is evidence that the result depends materially on qualified observations.

No inferential p-values or confidence intervals are reported. The available-cell medians do not arise from a probability sample with a supplied sampling design, and the main purpose is measurement transparency rather than hypothesis testing. Likewise, no regression is estimated because the supplied data do not contain a defensible treatment, covariate set, or identification strategy for causal claims. This does not make the descriptive analysis theory-free: the estimands follow the literature's distinction between partial and multifactor productivity, while the robustness rules follow Eurostat's own flags and comparability metadata.

RESULTS AND FINDINGS

Sample Coverage and Verification

The selected scope contains 13 sections, 36 individual geographies, four audited indicators and 16 years, yielding 29,760 long-format cells before numeric and flag exclusions. The principal 2008–2020 period contains 6,084 possible country-section-year cells for each of V12150, V16110 and V91110 (13 × 36 × 13). V91290 has 5,967 selected cells because the employment-growth indicator is not available for every selected combination. In the principal period, numeric counts are 5,307 for value added, 5,261 for persons employed, and 5,224 for published ALP. The available published-ALP cells range from 329 in 2008 to 438 in 2019 and 425 in 2020. The internal formula check provides a useful audit of units. Published V91110 and the reconstruction from V12150 and V16110 are available together in 5,291 rows; 5,289 agree within 0.25 thousand euro per person. The two discrepancies are consistent with published rounding or source precision and do not justify replacing the Eurostat-derived series. The audit confirms that the reported unit is thousand euro per person employed, rather than euro per person or million euro per person.

Table 1

Pooled Descriptive Results

Year	ALP N	Median ALP (thousand €/person)	P25	P75	Employment N	Median persons employed
2008	329	37.70	20.30	67.60	333	78498
2009	354	34.95	18.73	68	358	84735
2015	412	42.85	21.35	81.50	414	84079
2019	438	40.65	21.82	77.20	438	71911
2020	425	39.20	21	73.30	438	71154

Note. Unweighted available country-section cells. ALP is nominal apparent labor productivity. Employment is reported separately; no employment share or correlation is calculated.

The pooled median nominal ALP was €37.70 thousand per person employed in 2008. It fell to €34.95 thousand in 2009, rose to €42.85 thousand in 2015, stood at €40.65 thousand in 2019, and was €39.20 thousand in 2020. The available ALP cell count increased from 329 in 2008 to 438 in 2019 before falling to 425 in 2020.

The median persons-employed cell value was 78,498 in 2008 and 71,154 in 2020. This latter statistic is the median size of an observed country-sector cell, not total sector employment and not the employment of the European business economy. The 2020 interquartile range runs from €21.00 thousand (P25) to €73.30 thousand (P75) around the €39.20 thousand median, so the pooled movement summarizes a wide cross-country spread rather than a common trajectory.

Figure 1 displays section medians rather than country-specific trajectories. The separation between sections is large relative to within-section year-to-year movements, but the lines should not be interpreted as a productivity frontier. High nominal value added per person can reflect price levels, operating surplus, capital intensity, and sector composition as well as production quantities. Service-sector comparisons are particularly vulnerable to quality and price measurement issues.

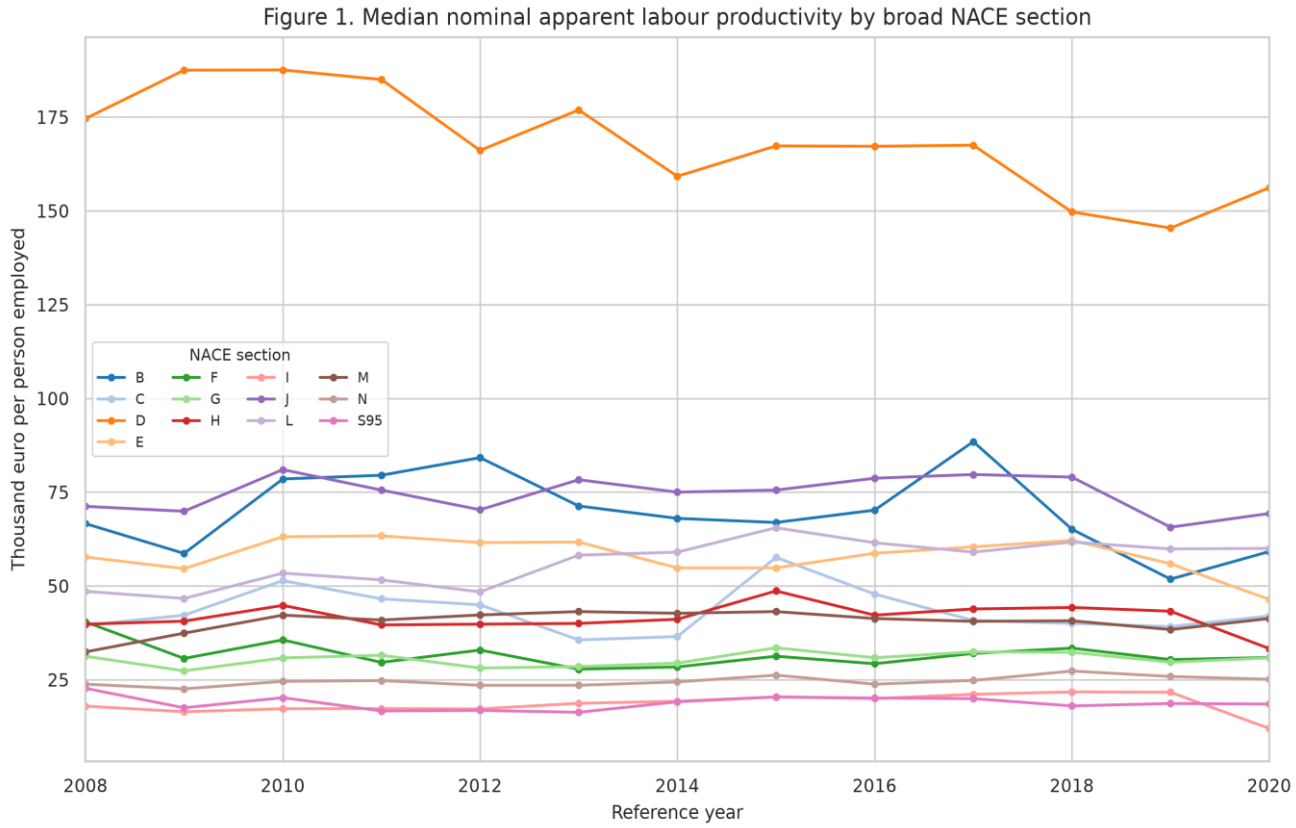

Figure 1

Median nominal apparent labor productivity by broad NACE section, 2008–2020. Lines are unweighted section medians across available country cells; annual Ns vary from 329 to 438 pooled ALP cells. Units: thousand euros per person employed.

Broad-Section Endpoint Changes

Table 2 reports paired median percentage changes from 2008 to 2020. Manufacturing (C) has a median ALP change of 34.21% across 26 pairs, followed by real estate (L) at 30.00% across 27 pairs and wholesale and retail trade (G) at 29.97% across 27 pairs.

Electricity, gas and related supply (D) is 24.87% across 24 pairs; water and waste (E) is 22.42% across 24 pairs; administrative and support services (N) is 21.01% across 27 pairs. Mining (B), transportation (H), professional services (M), information and communication (J), and S95 have medians between 2.75% and 8.90%. Accommodation and food services (I) is negative at −7.79% across 27 pairs. Construction (F) is 8.76%, but its paired N is only seven.

These contrasts are descriptive, not a league table: the manufacturing median rests on 26 observed pairs and a nominal ratio, and the accommodation and food result may reflect prices, business survival, labor composition, hours, or statistical reporting as well as output per person. A median from seven construction pairs also carries a different evidential base from a median from 27 pairs.

Table 2

Paired 2008–2020 Changes

Section	Broad activity	Paired N	ALP median change (%)	ALP P25 (%)	ALP P75 (%)	Employment median change (%)
B	Mining and quarrying	23	8.41	-30.76	40.61	-28.21
C	Manufacturing	26	34.21	17.07	65.48	-9.20
D	Electricity, gas, steam and air conditioning supply	24	24.87	5.08	62.46	4.38
E	Water supply; sewerage, waste management and remediation	24	22.42	10.90	44.21	12.28
F	Construction	7	8.76	-9.32	28.77	-7.48
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	27	29.97	15.63	46.53	-0.47
H	Transportation and storage	26	8.90	-5.17	36.92	-1.36
I	Accommodation and food service activities	27	-7.79	-20.68	9.86	10.30
J	Information and communication	26	6.96	-3.84	31.56	41.89
L	Real estate activities	27	30.00	4.17	64.37	20.66
M	Professional, scientific and technical activities	26	7.83	2.18	30.68	31.95
N	Administrative and support service activities	27	21.01	8.11	47.26	26.06
S95	Repair of computers and personal and household goods	25	2.75	-11.82	20.51	-15.55

Note. Country-section pairs with no missing V91110 and V16110 at both endpoints. ALP and employment changes are separate outcomes, not a correlation.

Employment changes are intentionally reported as a separate outcome. Median paired employment falls by 28.21% in mining and 9.20% in manufacturing, is close to zero in wholesale and retail trade (−0.47%) and transportation (−1.36%), and rises by 41.89% in information and communication, 31.95% in professional services, and 26.06% in

administrative and support services. Accommodation and food services have a 10.30% employment increase despite its negative ALP change. These contrasts demonstrate why the paper does not interpret ALP changes through an employment-share correlation or a mechanical denominator relationship.

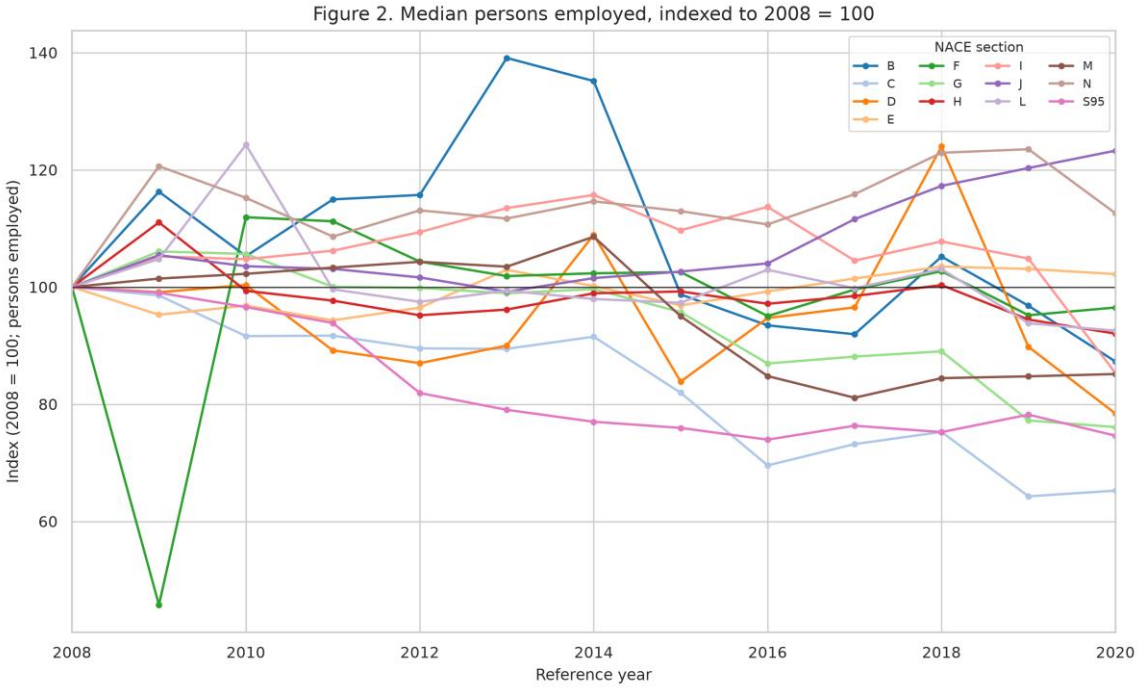

Figure 2

Median persons employed by broad NACE section, indexed to each section's 2008 median (=100). Annual cell availability varies from 333 to 438 pooled employment cells. This is an employment-level display, not an employment share.

Flag Sensitivity and Comparability

Table 3 compares the inclusive paired endpoint results with a strict flag-clean sample. The clean rule removes any country-section pair with a b, e, p, u, d, or c flag on ALP or persons employed at either endpoint. The clean sample is a diagnostic, not a claim that unflagged observations are error-free. It reduces N in every section. For manufacturing, electricity and gas, accommodation and food, information and communication, real estate and professional services, the median ALP change is unchanged to two decimal places. The result changes from 22.42% to 17.88% in water and waste, from 8.76% to 0.79% in construction, from 21.01% to 16.77% in administrative and support services, and from 2.75% to −0.45% in S95 repair activities.

The bundled strict rule conceals distinct data-quality mechanisms that deserve separate readings. A break (b) flag marks a change in series definition or statistical unit, so pairs removed on that ground differ structurally rather than in accuracy; provisional (p) and estimated (e) flags attach mainly to recent reference years and typically narrow as national institutes complete their revisions; a definition-differs (d) flag limits cross-country comparability; and confidential (c) or low-reliability (u) cells are generally not numeric outcomes at all. Where an inclusive-to-clean shift is driven mainly by b flags, it reflects a comparability boundary; where it is driven by p or e flags, it reflects reporting vintage. The excluded pairs carry no break (b) or estimated (e) flags at all. The construction (F) shift (8.76% to 0.79%) follows the removal of a single provisional (p) pair, Czechia; the water and waste (E) shift (22.42% to

17.88%) removes one provisional (p) pair (Czechia) and one definition-differs (d) pair (Italy); and the administrative services (N, 21.01% to 16.77%) and S95 (2.75% to −0.45%) shifts each remove the Czechia and Romania pairs, both flagged provisional (p). The sensitivity in these sections therefore reflects reporting vintage and definitional differences rather than series breaks. This pattern shows that a blanket conclusion such as "all sectors improved" would be inaccurate even before considering nominal valuation: some section results depend materially on qualified observations. Publishing both the inclusive result and the flag-clean diagnostic, with the exact rule and N visible, is the defensible reporting practice.

Reading the Sectoral Pattern Without Ranking Efficiency

The broad sections can be grouped descriptively, although the groups should not be interpreted as homogeneous technologies. Manufacturing (C) has the largest positive median endpoint change among the sections with substantial paired coverage: 34.21% across 26 pairs. Wholesale and retail trade (G), real estate (L), utilities (D), and water and waste (E) also have positive medians above 20%. These results indicate that the published value-added-per-person measure rose in the observed pairs, not that a common management practice produced the change. Manufacturing's simultaneous median employment change of −9.20% illustrates the denominator's role: a higher nominal ALP can coexist with fewer persons employed without revealing which mechanism produced it.

The service sections show a more differentiated pattern than a simple "services are low productivity" narrative. Real estate (L) has a 30.00% median ALP change, administrative and support services (N) 21.01%, and professional, scientific and technical activities (M) 7.83%. Information and communication (J) has a 6.96% ALP change but a 41.89% median employment change. Accommodation and food services (I) has a −7.79% ALP change alongside a 10.30% employment increase. These contrasts are consistent with the literature's warning that service output, quality, pricing, and labor composition are difficult to capture in a single nominal ratio. They also demonstrate why broad service classifications should not be treated as a single performance category.

The production and infrastructure sections are similarly heterogeneous. Mining (B) has an 8.41% ALP median change and a −28.21% employment median change, while electricity and gas (D) has a 24.87% ALP change and a 4.38% employment change. Transportation and storage (H) has an 8.90% ALP change and a −1.36% employment change. Construction (F) has an 8.76% inclusive ALP change, but only seven paired observations; its clean-sample median is 0.79%. The construction result is therefore best treated as a coverage-sensitive descriptive observation rather than as evidence of a sector-wide trajectory. At the distributional level, the pooled ALP median fell from 37.70 thousand euro per person in 2008 to 34.95 in 2009, then reached 42.85 in 2015 before ending at 39.20 in 2020. The interquartile ranges in Table 1 remain wide, which means that the median movement does not imply convergence across country-section cells. Annual available Ns also rise and fall. A reader interested in a particular country or section should therefore use the paired country-section CSV, not infer a national or EU-level trajectory from the pooled line.

Two observed pairs can illustrate the dispersion behind these medians. In manufacturing (C), nominal ALP in Bulgaria rose from €6.7 thousand per person in 2008 to €16.1 thousand in 2020 (+140.3%), and in Lithuania from €11.6 thousand to €27.1 thousand (+133.6%), while in Greece it fell from €39.5 thousand to €29.6 thousand (−25.1%). In accommodation and food services (I), Greece fell from €14.1 thousand to €2.3 thousand (−83.7%) and Cyprus from €24.5 thousand to €9.0 thousand (−63.3%), while Lithuania rose from €4.9 thousand to €9.7 thousand (+98.0%). Such examples ground the median and interquartile statistics in specific country trajectories without implying that any single geography represents its section.

Coverage Patterns and What Is Not Observed

Coverage differs by indicator as well as by year. In the principal period, the selected design permits 6,084 possible cells for each of value added, persons employed, and published ALP; the numeric totals are 5,307, 5,261, and 5,224, respectively. Employment growth has 5,967 possible selected cells and 4,787 numeric observations. Thus, the published productivity indicator is not missing only when one of its components is missing: Eurostat's derived-series availability and flag treatment also matter. This is one reason the analysis uses the published V91110 outcome for results while retaining V12150 and V16110 for unit validation.

The 315 endpoint pairs are similarly selective. They represent country-section observations with both ALP and employment available in both 2008 and 2020, not all potential country-section combinations. Paired Ns range from seven in construction to 27 in several service sections. The inclusion rule is applied consistently, but consistency is not the same as representativeness. A sector with fewer pairs may have a different pattern of missingness, confidentiality, or national coverage. The table therefore reports N next to every section median, and the discussion avoids treating the 13 sections as equally measured populations. The thin construction coverage reflects both confidentiality (c) suppressions and missing endpoint values for several geographies. The seven construction pairs are Cyprus, Czechia, Ireland, Italy, Luxembourg, Malta and Portugal, so the section's median excludes the large construction sectors of Austria, Germany, Spain, France, Poland and the United Kingdom, among others.

The audit also distinguishes numeric flags from unusable cells. In the selected source cells, b, e and p often accompany numeric values and are retained in the inclusive results; c and u commonly identify cells that are not usable as numeric outcomes. This does not mean that b, e, or p observations are automatically reliable, only that the official data provide a value and a qualification. The strict sample gives readers a conservative alternative without pretending that an empty flag string certifies measurement quality. That distinction is important for reproducible performance reporting, where deleting all qualified observations can itself create selection bias.

Table 3

Flag-Clean Sensitivity

Section	Broad activity	Inclusive N	Inclusive ALP change (%)	Clean N	Clean ALP change (%)
B	Mining and quarrying	23	8.41	21	9.86
C	Manufacturing	26	34.21	24	34.21
D	Electricity, gas, steam and air conditioning supply	24	24.87	22	24.87
E	Water supply; sewerage, waste management and remediation	24	22.42	22	17.88
F	Construction	7	8.76	6	0.79
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	27	29.97	25	29.17

H	Transportation and storage	26	8.90	23	5.50
I	Accommodation and food service activities	27	-7.79	25	-7.79
J	Information and communication	26	6.96	24	6.96
L	Real estate activities	27	30.00	25	30.00
M	Professional, scientific and technical activities	26	7.83	24	7.83
N	Administrative and support service activities	27	21.01	25	16.77
S95	Repair of computers and personal and household goods	25	2.75	23	-0.45

Note. Clean excludes b, e, p, u, d, or c flags on ALP or persons employed at either endpoint. It is a diagnostic sample, not an error-free sample.

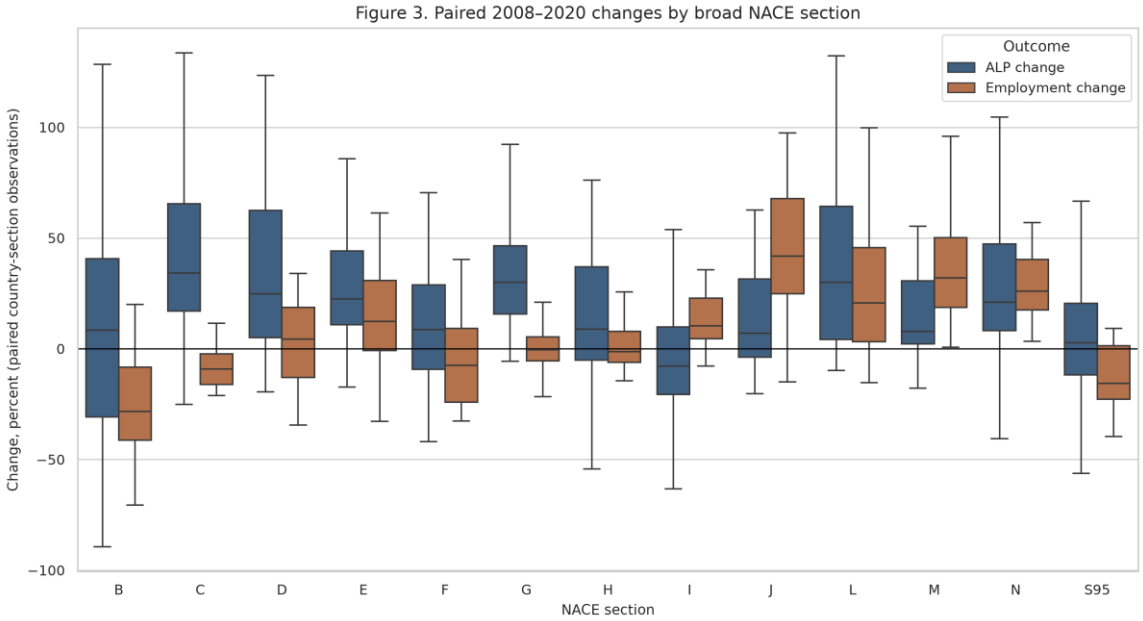

Figure 3

Paired 2008–2020 percentage changes. Boxes show country-section observations; outliers are hidden for readability. Section-specific paired Ns are in Table 2.

Figure 3 presents the distribution of paired percentage changes for ALP and employment as distinct outcomes. It does not draw a fitted relationship between them. The visual spread reinforces that section medians conceal country-level heterogeneity, and that a common period does not create a common response across broad activities. The widest boxes appear in manufacturing (C) and real estate (L), mirroring the wide interquartile ranges in Table 2 and reinforcing that section medians conceal large country-level dispersion.

Table 4

Coverage and Flag Audit

Audit item	Value	Definition
Source-wide rows	118,597	Rows before year-column reshape
Selected long cells	29,760	13 sections × 36 geographies × 4 indicators × 16 years
Main period	2008–2020	Principal comparable window
Individual geographies	36	EU aggregate codes excluded
Broad sections	13	B, C, D, E, F, G, H, I, J, L, M, N, S95
Numeric ALP cells, main period	5,224	Published V91110
Published/reconstructed ALP comparisons	5,291	Both published and reconstructed numeric
Agreement within 0.25 thousand €/person	5,289 (99.962%)	Reconstruction validation
Paired endpoint observations	315	No missing ALP and employment, 2008 and 2020
Flag b / e / p / u / d / c	1,612 / 222 / 685 / 24 / 465 / 404	Overlapping source-cell counts across selected 2005–2020 cells

Note. Flag counts overlap when combined flags occur. Complete machine-readable coverage and flag tables are supplied as CSV files.

DISCUSSION

What the Results Support

The results support three measured statements. First, nominal apparent labor productivity differs materially across broad NACE sections and varies over time within sections. Second, paired 2008–2020 changes are heterogeneous: some sections have positive medians, accommodation and food services has a negative median, and construction is too sparsely paired for a strong ranking claim. Third, the descriptive result is sensitive to official quality flags in several sections. These statements are directly tied to the published V91110 indicator and the stated sample rules.

The results do not support three stronger statements: that one sector is more technically efficient, because V91110 is a partial and nominal measure; that employment changes caused productivity changes, because the design is non-causal and the denominator is employment; or that the European economy as a whole became more or less productive, because SBS excludes agriculture and important non-market activities and the pooled statistics are unweighted available-cell medians.

Implications for Performance Measurement

For performance-management practice, the principal implication is to treat a published productivity ratio as a signal requiring decomposition rather than an uncritical efficiency verdict (Neely, 2005; Bititci *et al*., 2012). The divergent trajectories reported here, such as the −7.79% median in accommodation and food services (I) against the 34.21% median in manufacturing (C), are consistent with structural forces such as Baumol's (1967) cost disease, pandemic capacity restrictions and intangible asset expensing (Haskel & Westlake, 2017) as well as with operational practice. The correct response to a higher ratio is therefore not automatically to reward "efficiency" but to triangulate with

output volume, hours worked, capital deepening, quality adjustments, labor compensation and organizational boundaries. For policy analysis, broad sections can help locate structural patterns, but they should not be interpreted as policy counterfactuals. A policy evaluation would require a credible treatment definition, a comparison strategy, timing assumptions, and additional controls. The present paper instead creates an auditable descriptive benchmark from which such future designs could begin.

Implications for Research Design

The study also illustrates a boundary between data availability and methodological ambition. Official SBS data offer broad, repeated, cross-country observations at an activity level that is useful for mapping performance. They do not by themselves provide firm-level heterogeneity, capital services, worker skill composition, deflators matched to each activity, intermediate-input treatment, or outsourcing flows. Future work that seeks explanations should therefore add information rather than re-label V91110. Possible extensions include real value-added measures aligned to national accounts, hours-worked denominators, industry-level price indices, capital and intermediate-input data, enterprise demography and explicit handling of statistical-unit breaks. A second design implication is that sensitivity analysis should be planned before interpretation. In this source, removing flagged endpoint observations changes some section medians materially. A paper that reports only one cleaned sample can conceal the extent to which its conclusion depends on an arbitrary flag rule. Presenting inclusive and strict results is more transparent, particularly when the aim is descriptive performance comparison.

Alternative Explanations and Diagnostic Boundaries

Several alternative explanations could generate the same observed ALP pattern. A price and market-power explanation would arise if value-added prices or firm mark-ups changed differently across sectors or countries; expanding profit margins and product market concentration (De Loecker, Eeckhout, & Unger, 2020) mechanically inflate nominal value added, meaning nominal V91110 cannot be read as technical productivity. An intangible accounting explanation would arise in knowledge-intensive sectors (Sections J and M), where uncapitalized investments in software, R&D, and human competencies (Corrado, Hulten & Sichel, 2009) distort measured factor costs. A composition explanation would arise if enterprises entering, exiting, or altering their scale shifted the frontier-laggard dispersion within a sector (Andrews, Criscuolo, & Gal, 2016). A labor-input explanation would arise if average hours, part-time work, self-employment, or agency-worker arrangements changed while persons employed moved differently. An organizational explanation would arise if outsourcing shifted support staff into administrative services (Section N) while the manufacturing output remained intact (Houseman, 2007). Finally, a statistical explanation would arise from revisions, consolidation, or NACE and enterprise-unit breaks. The descriptive data do not discriminate among these mechanisms.

The analysis does, however, provide diagnostics that constrain careless explanations. The published-to-reconstructed ALP agreement makes a unit or scaling error unlikely in the reported ratio. The separation of ALP and employment results prevents a mechanical employment-share story. The paired design reduces changing-country composition at the endpoint, while the annual N and flag tables show that it does not eliminate missingness or comparability concerns. The clean-flag sensitivity identifies sections where qualified observations matter. These are boundary checks, not causal tests, but they are useful because they distinguish what the data can audit from what requires additional sources.

A stronger explanatory study would need to pre-specify mechanisms and add matching measurements. For

example, a real productivity design would require sector-appropriate deflators; a labor-services design would use hours and, ideally, labor composition; an outsourcing design would need employment-services or input-output information; and an efficiency design would require capital, intermediate inputs and a production framework. These extensions are compatible with the present descriptive baseline, but they cannot be recovered from sbs_na_sca_r2 alone.

LIMITATIONS

The study has five principal limitations. First, V91110 is nominal. Without activity-specific price deflators, changes cannot be interpreted as real productivity growth. Second, persons employed are a head-count input rather than actual hours worked or full-time-equivalent labor services. Cross-sector differences in working time and worker composition may therefore affect the ratio. Third, SBS covers the market-oriented business economy rather than the whole economy. Results do not apply to agriculture, public administration, or largely non-market education and health activities. Fourth, comparability is imperfect across time and countries. The 2005–2007 observations may be backcast or estimated, NACE revisions and national compilation practices differ, and implementation of the statistical enterprise can create breaks around country-specific years. The principal period reduces but does not eliminate these issues. Fifth, missingness, confidentiality, and changing country coverage produce an unbalanced available-cell base. Unweighted medians are transparent but do not represent output-weighted or employment-weighted European aggregates. These limitations constrain the claims, but they do not make the analysis uninformative. They define the appropriate use: a reproducible descriptive benchmark and measurement audit. The results should be combined with real-output, hours, capital, quality, and institutional data before making efficiency, welfare, or causal claims.

CONCLUSION

This paper has used the correct Eurostat special-aggregates source to describe nominal apparent labor productivity and employment across broad European business sectors. Across 36 individual geographies and 13 sections, the observed patterns are heterogeneous, the available cell base changes by year, and some endpoint comparisons are sensitive to official flags. The evidence is sufficient to support a transparent descriptive account, not a causal explanation or an economy-wide productivity claim. The central practical conclusion is simple: broad-sector productivity comparisons become more useful when the numerator, denominator, units, flags, missingness, and comparability metadata are shown together. V91110 can support benchmarking and question formation, but management and policy interpretation should not treat it as a pure efficiency score. By preserving the source, code, estimates, and audit rules, this package offers a reproducible basis for further work with real output, hours, capital, quality, and organizational data.

DECLARATION

Ethical Considerations: This study strictly adhered to the Declaration of Helsinki and relevant national and institutional ethical guidelines. All procedures performed in this study were consistent with the ethical standards of the Declaration of Helsinki. The study was conducted according to ethical and clinical standards for research. The study uses public regulatory documents and aggregate public statistics; no human participants were involved, and ethics approval was not required. No individual-level human participant data, interventions, interviews, or identifiable personal information were used; the analysis concerns published aggregate official statistics.

Conflict of Interest: M.M.T.B. leads Emissly, the organization that compiles the sustainability-reporting

rulebook used as the main data source. All entries used were reviewed and corrected against official sources, and the coded dataset and scripts are deposited. S.H. declares no competing interests.

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Authors' Contributions: M.M.T.B.: conceptualization, data curation, methodology, formal analysis, writing – original draft. S.H.: writing – review and editing, with contribution to the discussion and conclusion.

Reproducibility and Data Availability

The submission package contains the exact compressed source file, SHA-256 hash, executable Python analysis, processed panel, CSV result tables, PNG figures, a README, and a final-run summary. The analysis source is Eurostat sbs_na_sca_r2; the local file is named eurostat_sbs_2005_2020.tsv.gz. The official dataset landing page is: https://ec.europa.eu/eurostat/databrowser/view/sbs_na_sca_r2/default/table?lang=en and the dataset DOI is https://doi.org/10.2908/sbs_na_sca_r2. The package does not contain LFS, WBES, or other raw proprietary data. The coded dataset, codebook, and analysis scripts are available. World Bank indicators are public.

Use of Artificial Intelligence (AI)- Assisted Technology for Manuscript Preparation: No AI tools were used for data extraction, statistical analysis, result interpretation, or the generation of original scientific content. All analyses were conducted by the authors, and they take full responsibility for the integrity and accuracy of the manuscript; however, we used AI for our questionnaire alignments, yet no AI was involved in conducting the test for the analysis.

Similarity Index/ Plagiarism: The similarity index was checked, and it is well below the threshold value of 19%, whereas each source is less > 5%.

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