International Journal of Scientific Research and Modern Education (IJSRME)
Impact Factor: 7.137, ISSN (Online): 2455 - 5630
(www.rdmodernresearch.com) Volume 7, Issue 1, 2022

CROSS-BORDER DATA RESTRICTIONS AND PRODUCTIVITY SPILLOVERS THROUGH INTERNATIONAL SERVICES TRADE

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Cite This Article: Kannan Vishwanath & Lloyd Zulu, "Cross-Border Data Restrictions and Productivity Spillovers through International Services Trade", International Journal of Scientific Research and Modern Education, Volume 7, Issue 1, Page Number 132-144, 2022.

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Abstract:

This study examines whether aggregate digital services trade restrictiveness provides sufficient evidence to interpret regulatory divergence within debates on international services integration. Using 14 annual OECD Digital Services Trade Restrictiveness Index observations for Australia and Austria from 2015 to 2021, the analysis combines descriptive statistics, annual country comparisons, and assessments of component coverage and variation. Australia's aggregate index remained at 0.021, whereas Austria's increased from 0.021 to 0.162, producing a difference of 0.141 from 2018 onward. Within their observed subsets, infrastructure and connectivity restrictions and payment restrictions remained at zero, while electronic transaction restrictions remained at 0.021. Aggregate divergence therefore coexisted with constant recorded values across the three focal regulatory dimensions. This pattern establishes a distinction between changes in composite restrictiveness and observed variation in specific transaction channels. The study refines the application of transaction cost frameworks by separating aggregate regulatory measurement from channel attribution. For international policy monitoring and managerial market assessment, the findings support examining component coverage and underlying regulatory provisions alongside national index movements.

Key Words: Digital Services Trade; Regulatory Restrictiveness; Composite Indicators; Comparative Analysis; Regulatory Measurement

1. Introduction:

Restrictions on digitally enabled services trade can affect access to foreign expertise and production inputs, yet changes in regulatory restrictiveness do not themselves demonstrate changes in productivity. This distinction matters for governments assessing whether digital trade policies constrain economic integration and for firms procuring services across national borders. Digital technologies reduce search, replication, transportation, tracking, and verification costs, changing the conditions under which economic exchange occurs (Goldfarb & Tucker, 2019). Regulatory barriers may alter these advantages by restricting the movement of information or increasing the costs of international service transactions. Understanding their economic significance therefore requires distinguishing measured restrictions from the transactions they potentially affect and the productivity outcomes attributed to those transactions.

International services trade provides the substantive link between digital regulation and production. Services enter global value chains as final products and as inputs supporting manufacturing and other economic activities. Miroudot and Cadestin (2017) identify productivity gains associated with services specialisation and report a negative relationship between services trade restrictiveness and bilateral flows of services value added. Their findings establish why regulatory conditions affecting service inputs deserve attention beyond the services sector. Complementing this evidence, Benz and Jaax (2020) estimate policy-induced trade costs across five services sectors in 46 countries. Together, these studies support examining regulatory barriers as potential constraints on international production relationships while distinguishing evidence about trade costs and trade flows from evidence about productivity transmission.

A transaction-cost explanation connects these findings to digitally enabled exchange. Regulation that increases the costs of accessing networks, executing electronic contracts, or settling international payments may make foreign services more difficult or less commercially attractive to acquire. These channels concern different stages of a transaction and therefore require distinct analytical treatment. Infrastructure and connectivity restrictions concern the conditions enabling digital exchange. Electronic transaction restrictions concern the recognition and execution of electronic commercial processes. Payment system restrictions concern transaction settlement. Ferencz (2019) incorporates these domains into the OECD Digital Services Trade Restrictiveness Index, providing a common framework for comparing barriers affecting digitally enabled services. These regulatory dimensions identify potential sources of transaction friction; their index contributions do not directly measure realised transaction costs or productivity losses.

The closest productivity evidence indicates that exposure to electronic data shapes the economic relevance of regulatory restrictions. Ferracane et al. (2020) examine policies governing the cross-border movement and domestic use of electronic data using firm-level and industry-level observations. They find that

stricter data policies are associated with weaker productivity performance among downstream firms in sectors reliant on electronic data. The adverse relationship is stronger in countries with developed technology networks and among servicified firms. Their analysis links regulatory measures to economic performance through differences in data dependence. However, their data-policy index and disaggregated economic observations differ from a comparison based on national Digital Services Trade Restrictiveness Index scores. Their findings therefore do not establish that changes in individual components of that index represent equivalent changes in productivity.

This distinction places measurement at the centre of the research problem. Aggregate regulatory indices consolidate several policy domains, whereas productivity measures economic output relative to inputs. International productivity spillovers require evidence connecting foreign knowledge or services to domestic production. A regulatory score cannot independently establish that transmission process. Greco et al. (2019) explain that weighting and aggregation choices influence the interpretation of composite indicators and emphasise the importance of assessing their robustness. Applied to digital services regulation, this reasoning requires examining the coverage and variation of underlying components before assigning economic meaning to changes in an aggregate score. It also requires distinguishing a recorded zero, which represents no measured restriction within the relevant index category, from a missing observation.

The reviewed literature establishes complementary findings: digital technologies change transaction costs, services restrictions affect international exchange, and data-policy restrictions can be associated with downstream productivity performance (Benz & Jaax, 2020; Ferracane et al., 2020; Goldfarb & Tucker, 2019; Miroudot & Cadestin, 2017). These findings do not establish whether aggregate regulatory divergence in a particular country comparison is accompanied by observable variation in the components proposed as its economic channels. The present study addresses this narrower measurement question by examining the relationship between aggregate regulatory trajectories and their available component evidence. Its contribution concerns the interpretation of regulatory indicators within the services trade and productivity debate.

Australia and Austria provide the empirical setting. The supplied regulatory extract contains 14 annual aggregate observations covering the two countries from 2015 to 2021. The country-year is the unit of analysis. The comparison applies the common OECD measurement framework to national regulatory trajectories and the available infrastructure and connectivity, electronic transaction, and payment system components. The two countries constitute the available comparative extract rather than a representative international sample. Descriptive statistics, annual country comparisons, and assessments of component coverage and dispersion establish the scope of the analysis. This approach enables examination of regulatory divergence without assigning economic effects to index movements.

This study aims to examine how aggregate digital services trade restrictiveness differs between Australia and Austria and how those differences relate to the coverage and variation of three focal regulatory components. The research question is: How does aggregate digital services trade restrictiveness diverge between the two countries, and what component evidence supports its interpretation? Specifically, the study compares aggregate regulatory trajectories, examines infrastructure and connectivity restrictions, assesses electronic transaction restrictions, and evaluates payment system restrictions. These objectives align the analysis with the observed regulatory measures.

The comparison documents divergence in aggregate restrictiveness alongside constant values within the observed subsets of the three focal components. This finding demonstrates why aggregate regulatory change requires component-level scrutiny before it supports explanations involving particular transaction mechanisms. Relative to research estimating trade costs or productivity relationships, the study contributes a bounded assessment of the regulatory measurement underlying such interpretations. For policy monitoring, it supports examining component records and observation coverage when interpreting national index movements. The transferable insight concerns the interpretation of composite regulatory measures, while the observed trajectories remain specific to Australia, Austria, and the available observation period.

2. Theoretical Conceptual Framework and Hypotheses Development:

2.1. Theoretical Foundation and Transmission Mechanisms:

International services trade facilitates the transmission of knowledge, technological capabilities, and specialized production inputs across national economies. The economic significance of these exchanges derives from the ability of firms to combine domestic resources with foreign expertise and digital services. Baldwin, 2016, establishes that advances in information and communication technologies have transformed international production by reducing the costs of transferring knowledge across borders. Goldfarb and Tucker, 2019, further demonstrate that digital technologies reduce information processing, search, transportation, and verification costs. These mechanisms provide a theoretical basis for examining how restrictions on digitally enabled services trade may influence economic performance.

This analysis adopts a regulatory transaction cost perspective in which digital services trade restrictions influence the accessibility, cost, and reliability of international service transactions. The framework distinguishes three regulatory dimensions: infrastructure and connectivity restrictions, electronic transaction

restrictions, and payment system restrictions. Ferencz, 2019, identifies these dimensions within the OECD Digital Services Trade Restrictiveness Index, providing a comparable regulatory measurement framework. Miroudot and Cadestin, 2017, establish the importance of services inputs within global value chains, while Benz and Jaax, 2020, demonstrate that regulatory barriers impose substantial costs on international services transactions. The theoretical transmission mechanism operates through three interrelated channels. Infrastructure restrictions may reduce access to international digital networks and services. Electronic transaction restrictions may increase the costs of establishing and executing international commercial relationships. Payment restrictions may constrain the settlement of cross border transactions and increase operational uncertainty. These mechanisms may weaken access to foreign services and associated knowledge. However, regulatory restrictions can also pursue legitimate objectives related to security, transaction reliability, and institutional accountability. The expected relationship between restrictiveness and economic performance therefore depends on the balance between transaction costs and potential regulatory benefits.

2.2. Infrastructure and Connectivity Restrictions:

Infrastructure and connectivity restrictions represent regulatory barriers affecting the ability of service providers to access and use digital networks across national boundaries. Such restrictions may influence international service delivery by limiting network accessibility, increasing compliance requirements, and constraining cross border information exchange. Ferencz, 2019, identifies infrastructure and connectivity as a distinct component of digital services trade restrictiveness. The theoretical mechanism links regulatory constraints to higher transaction costs and reduced access to foreign digital services.

Restrictions affecting connectivity may reduce opportunities for domestic firms to obtain specialized international services and incorporate foreign knowledge into production. Baldwin, 2016, emphasizes the role of communication technologies in facilitating the international movement of knowledge, while Goldfarb and Tucker, 2019, explain how reductions in digital transaction costs expand economic opportunities. From this perspective, more restrictive connectivity conditions may be associated with weaker productivity performance when firms depend on internationally supplied digital services. Empirical research provides indirect support for this expectation. Miroudot and Cadestin, 2017, identify productivity gains associated with specialization in services within global value chains. Benz and Jaax, 2020, establish that services trade restrictions generate economic costs that may constrain international transactions. Nevertheless, these findings do not establish that every connectivity restriction reduces productivity. The relationship may depend on the effectiveness of domestic digital infrastructure and the extent to which regulation improves network reliability or security.

H1: Higher infrastructure and connectivity restrictiveness is negatively associated with productivity performance.

2.3. Electronic Transaction Restrictions:

Electronic transaction restrictions concern regulatory requirements that affect the establishment, recognition, and execution of commercial transactions through digital systems. Unlike infrastructure restrictions, which primarily influence access to digital networks, electronic transaction restrictions affect the institutional conditions under which firms conduct business electronically. Ferencz, 2019, incorporates electronic transactions into the measurement of digital services trade barriers, reflecting their relevance to international commercial activity.

The theoretical relationship operates through transaction efficiency and institutional compatibility. When electronic transaction regulations increase documentation requirements, restrict recognition of digital processes, or create incompatible compliance obligations, firms may incur additional costs when accessing international services. Goldfarb and Tucker, 2019, identify verification and information processing costs as central components of digital economic activity. Greater regulatory friction may therefore reduce the efficiency of international service procurement and constrain the incorporation of foreign expertise into domestic production. The expected relationship also reflects competing institutional mechanisms. Electronic transaction regulation can increase commercial certainty by strengthening transaction recognition and accountability. However, restrictive or incompatible requirements may increase the costs of international market participation. Miroudot and Cadestin, 2017, demonstrate the economic importance of services specialization, while Benz and Jaax, 2020, provide evidence that regulatory barriers increase international services trade costs. These findings support the expectation that more restrictive electronic transaction environments may be associated with weaker productivity outcomes, although the magnitude depends on the quality and compatibility of regulatory institutions.

H2: Higher electronic transaction restrictiveness is negatively associated with productivity performance.

2.4. Payment System Restrictions:

Payment system restrictions represent regulatory constraints affecting the execution and settlement of payments associated with digitally enabled international services transactions. These restrictions influence the financial completion of commercial exchanges rather than network access or electronic contracting. Ferencz,

2019, identifies electronic payment systems as a separate dimension of digital services trade restrictiveness, recognizing the importance of payment arrangements in international digital commerce.

The theoretical mechanism links payment restrictions to transaction completion costs, liquidity management, and market participation. Firms purchasing international services depend on payment arrangements that enable reliable settlement across jurisdictions. Restrictions that increase payment processing costs or limit access to international payment channels may reduce the economic attractiveness of foreign service inputs. Goldfarb and Tucker, 2019, explain the importance of transaction cost reductions in digital markets, while Baldwin, 2016, demonstrates the role of international knowledge exchange in modern production systems. Payment regulation may also improve transaction security and institutional confidence, creating potential benefits that counterbalance compliance costs. Nevertheless, excessive restrictions may reduce the efficiency of international commercial exchanges. Benz and Jaax, 2020, identify substantial economic costs associated with services trade barriers, while Miroudot and Cadestin, 2017, establish the importance of international services specialization for productivity. These contributions support the theoretical expectation that restrictive payment environments may constrain productivity performance by increasing the costs of acquiring international services.

H3: Higher payment system restrictiveness is negatively associated with productivity performance.

2.5. Conceptual Framework and Empirical Interpretation:

The conceptual framework identifies digital services trade restrictiveness as the regulatory construct, represented by infrastructure and connectivity restrictions, electronic transaction restrictions, and payment system restrictions. Productivity performance constitutes the proposed outcome construct. The three hypothesized relationships express negative theoretical associations between regulatory restrictiveness and productivity.

The OECD Digital Services Trade Restrictiveness Index provides observed regulatory indicators for the three dimensions. These indicators are components of a composite index and should be treated as observed regulatory contributions rather than independent latent constructs. The conceptual relationships represent theoretical expectations, not established causal effects. The analysis does not presume that the proposed relationships will necessarily be statistically significant or consistent across regulatory dimensions. The empirical interpretation must distinguish productivity performance from international productivity spillovers. Productivity indicators capture domestic economic outcomes, whereas identifying spillovers requires evidence of international transmission through services trade. Accordingly, associations between regulatory restrictions and domestic productivity cannot independently establish the existence or magnitude of cross border productivity spillovers.

3. Data:

This analysis establishes data provenance, sample coverage, variable measurement, and the empirical conditions required to examine digital services trade restrictions and productivity performance. The dataset provides annual regulatory observations for Australia and Austria, with documented limitations on the availability of corresponding productivity and international services trade measures.

3.1 Data Sources, Population, and Sample Construction:

The empirical framework draws on the OECD Digital Services Trade Restrictiveness Index and the World Bank World Development Indicators. The OECD dataset measures regulatory barriers affecting digitally enabled international services trade, while the World Bank indicators identify potential measures of productivity, economic performance, and international services transactions. Ferencz, 2019, establishes the OECD measurement framework, and Benz and Jaax, 2020; demonstrate the relevance of regulatory barriers to international services trade costs. The economic rationale for linking international services transactions to productivity follows Baldwin, 2016, Goldfarb and Tucker, 2019, and Miroudot and Cadestin, 2017.

The unit of analysis is the country year, with annual observations organized as a panel. The research period covers 2010 to 2021, comprising 12 calendar years. The accessible dataset contains Australia and Austria, producing 24 country year records. These countries represent the available extract rather than a statistically representative sample of the international population of economies participating in digital services trade.

The OECD regulatory extract contains 14 observations covering both countries from 2015 to 2021. The remaining 10 country year records do not contain regulatory observations. Although the dataset identifies World Bank productivity and international services trade indicators, their numerical observations have not been populated. Consequently, the regulatory dataset is balanced across the two countries for 2015 to 2021, whereas the intended joint regulatory and productivity estimation sample contains no complete observations.

The OECD source is identified by the dataset identifier DSD_STRI@DF_STRI_DIGITAL. The World Bank sources are identified through their respective World Development Indicators series codes. The attached workbook does not document an exact extraction timestamp, historical data release, or archived source version. Accordingly, the analysis treats the available values as a historical extract without attributing them to a particular release.

Table 1: Sample Construction and Empirical Coverage

Stage	Units	Observations	Reason or Rule
Accessible country year frame	2	24	Australia and Austria, 2010 to 2021
Records without observed Digital STRI	2	10	Regulatory observations unavailable for 2010 to 2014
Retained regulatory observations	2	14	Observed Digital STRI values for 2015 to 2021
Records without populated dependent variables	2	14	Productivity outcomes not extracted

The sample construction establishes the distinction between regulatory data availability and analytical eligibility. The 14 regulatory observations support examination of the measured restriction components, but they do not establish an estimation sample for productivity relationships. No additional country exclusions, model specific sample losses, or statistical selection procedures are documented.

3.2 Data Integration, Cleaning, and Quality Assurance:

The dataset organizes observations using country identifiers and calendar years. Australia and Austria are identified by ISO3 codes AUS and AUT, respectively. These identifiers provide the intended keys for integrating OECD regulatory indicators with World Bank economic indicators. The available workbook contains the common country year structure, but no completed integration of regulatory observations with productivity outcomes is documented.

The dataset preserves missing observations as blank cells rather than replacing them with zeros. This distinction is essential because the OECD regulatory index permits genuine zero values, indicating the absence of measured restrictions within a particular component. Missing observations, by contrast, provide no evidence regarding the underlying regulatory environment. Ferencz, 2019, supports the interpretation of the regulatory categories, while OECD measurement practices distinguish component contributions from the aggregate restrictiveness score.

The analysis identifies 24 country year records, of which 14 contain observed aggregate regulatory scores. The aggregate index is missing for 10 records. Component coverage differs from aggregate coverage: infrastructure and connectivity and electronic transactions each contain nine numerical observations, while payment systems contains seven. No numerical observations are available for the seven proposed productivity and international services trade indicators.

The dataset uses annual calendar observations. Regulatory indicators are dimensionless index contributions, while the proposed economic indicators use monetary values, productivity ratios, or percentage growth rates. These measures have not been combined or converted into common units. No currency conversions, deflation procedures, interpolation, imputation, winsorization, or outlier adjustments are documented.

The country year structure contains one record for each country and year, with no duplicate country year keys. However, the workbook does not establish independent source reconciliation, publication vintage verification, or cross source consistency testing. The retained observations therefore represent documented numerical coverage rather than a fully validated international panel.

Table 2: Data Completeness and Quality Assessment

Indicator	Observed	Missing	Coverage
Digital STRI overall	14	10	58.33%
Infrastructure and connectivity	9	15	37.50%
Electronic transactions	9	15	37.50%
Payment systems	7	17	29.17%
Intellectual property	7	17	29.17%
Other regulatory barriers	7	17	29.17%
GDP per person employed	0	24	0%
Services value added per worker	0	24	0%
Industry value added per worker	0	24	0%
GDP per capita	0	24	0%
Services value added growth	0	24	0%
Services exports	0	24	0%
Services imports	0	24	0%

These coverage differences limit the comparison of regulatory dimensions. Component level analyses cannot automatically use the same observations as aggregate index analyses. Furthermore, the absence of

economic outcomes prevents assessment of whether regulatory missingness is systematically associated with productivity or international trade performance.

3.3 Variable Measurement, Construction, and Validation:

The regulatory construct is measured using the OECD Digital Services Trade Restrictiveness Index. Higher values indicate greater measured regulatory restrictiveness. The aggregate index captures barriers affecting digitally enabled international services trade, while its components represent distinct regulatory domains. Ferencz, 2019, provides the underlying measurement framework, and Benz and Jaax, 2020, establish the economic relevance of regulatory barriers to services trade costs.

The conceptual framework identifies infrastructure and connectivity restrictions, electronic transaction restrictions, and payment system restrictions as the three principal explanatory dimensions. These variables are observed index contributions rather than separately estimated latent constructs. Their interpretation follows the OECD classification, without introducing additional weighting, normalization, or constructed subindices.

The proposed outcome measures represent different aspects of productivity and economic performance. GDP per person employed measures aggregate labour productivity, while services and industry value added per worker represent sectoral productivity. GDP per capita captures average economic output per resident, and services value added growth measures sectoral output expansion. These indicators are not interchangeable, and none independently identifies international productivity spillovers. Miroudot and Cadestin, 2017, provide the theoretical justification for examining services within international production systems, while Goldfarb and Tucker, 2019, explain the productivity relevance of digital transaction costs.

Table 3: Variable Dictionary and Operational Measurement

Variable	Analytical Role	Definition and Source Identifier	Unit and Frequency	Direction and Treatment	Available Observations
Digital STRI overall	Aggregate predictor	OECD DSD_STRI@DF_STRI_DIGITAL	Index, annual	Higher means more restrictive; original values	14
Infrastructure and connectivity	Predictor H1	OECD Digital STRI regulatory component	Index contribution, annual	Higher means more restrictive; original values	9
Electronic transactions	Predictor H2	OECD Digital STRI regulatory component	Index contribution, annual	Higher means more restrictive; original values	9
Payment systems	Predictor H3	OECD Digital STRI regulatory component	Index contribution, annual	Higher means more restrictive; original values	7
GDP per person employed	Proposed productivity outcome	World Bank SL.GDP.PCAP.EM.KD	Constant PPP dollars, annual	Higher means greater output per worker	0
Services value added per worker	Proposed sectoral outcome	World Bank NV.SRV.EMPL.KD	Constant dollar measure, annual	Higher means greater services productivity	0
Industry value added per worker	Proposed sectoral outcome	World Bank NV.IND.EMPL.KD	Constant dollar measure, annual	Higher means greater industrial productivity	0
GDP per capita	Proposed economic outcome	World Bank NY.GDP.PCAP.KD	Constant US dollars, annual	Higher means greater output per resident	0
Services value added growth	Proposed growth outcome	World Bank NV.SRV.TOTL.KD.ZG	Percent, annual	Higher means faster services output growth	0
Services exports	Proposed trade indicator	World Bank BX.GSR.NFSV.CD	Current US dollars, annual	Higher means greater services export value	0
Services imports	Proposed trade indicator	World Bank BM.GSR.NFSV.CD	Current US dollars, annual	Higher means greater services import value	0

The regulatory measures retain their original numerical scale. No logarithmic transformations, standardization, or constructed interaction terms are applied. Because the OECD components contribute to the overall index, simultaneous inclusion of the aggregate index and its components would introduce measurement redundancy. The available data do not justify a separate latent variable model or factor analysis.

Table 4: Descriptive Statistics of Available Regulatory Indicators

Indicator	N	Mean	SD	Median	Minimum	Maximum
Digital STRI overall	14	0.06979	0.06814	0.021	0.021	0.162
Infrastructure and connectivity	9	0.000	0.000	0.000	0.000	0.000
Electronic transactions	9	0.021	0.000	0.021	0.021	0.021
Payment systems	7	0.000	0.000	0.000	0.000	0.000

The aggregate index exhibits variation across the available observations, whereas the three focal component series are constant within their respective observed subsets. This absence of observed variation

prevents identification of separate relationships involving these components even if matching productivity outcomes were available for the same records. The descriptive statistics establish measurement coverage and dispersion but do not provide evidence of relationships between regulatory restrictions and productivity.

3.4 Analytical Framework, Identification, and Reproducibility:

The analytical framework is designed to examine associations between digital services trade restrictiveness and productivity performance across countries and years. The three regulatory dimensions correspond to infrastructure and connectivity restrictions, electronic transaction restrictions, and payment system restrictions. Their theoretical relationships with productivity follow the international services trade mechanisms discussed by Ferencz, 2019, Benz and Jaax, 2020, and Miroudot and Cadestin, 2017.

The available dataset supports descriptive analysis of regulatory restrictiveness but does not support estimation of the proposed productivity relationships. None of the five productivity and economic performance indicators contains numerical observations. The international services trade indicators are also unpopulated, preventing identification of the channels through which foreign services may transmit productivity benefits.

The aggregate regulatory index contains 14 observations, but the three focal regulatory components exhibit no variation within their respective observed samples. This limitation prevents estimation of their separate statistical associations with productivity using the available records. Accordingly, no regression coefficients, standard errors, confidence intervals, significance tests, or model fit statistics are reported.

The identification challenge extends beyond missing observations. International productivity spillovers require evidence connecting international services transactions to productivity outcomes. Aggregate domestic productivity indicators alone cannot distinguish productivity gains attributable to international services trade from those arising through domestic investment, technological change, labour composition, or other economic mechanisms. Baldwin, 2016, and Goldfarb and Tucker, 2019, establish the theoretical relevance of international knowledge transmission and digital transaction costs, but these mechanisms cannot be separately identified from the available extract.

No causal identification strategy, panel estimator, instrumental variable procedure, mediation analysis, or robustness specification has been implemented. The dataset does not contain the matched observations required for these procedures. The analysis therefore makes no causal claims and does not interpret theoretical hypotheses as empirically supported relationships.

Reproducibility is supported by the documented country identifiers, annual observation structure, regulatory component definitions, World Bank series identifiers, and source URLs. The original missing values are preserved, and the descriptive statistics are calculated directly from the available numerical observations. The absence of a recorded extraction timestamp and archived source release limits exact reconstruction of the original data vintage.

The resulting analytical dataset establishes the observed regulatory environment for Australia and Austria within the available period. It supports descriptive comparisons of digital services trade restrictiveness, while the proposed productivity relationships remain outside the estimable scope of the populated observations. The distinction between observed regulatory variation, unavailable economic outcomes, and unmeasured international transmission prevents unsupported inference about productivity spillovers.

4. Methods:

4.1 Research Design and Comparative Scope:

The study adopts a descriptive longitudinal design to compare digital services trade restrictiveness in Australia and Austria and examine the component evidence underlying aggregate differences. The unit of analysis is the country-year. The analytical period covers 2015 to 2021, corresponding to the available aggregate regulatory observations for both countries. The analysis examines the timing and magnitude of regulatory divergence and the observed variation within three selected policy domains.

The OECD Digital Services Trade Restrictiveness Index provides the common measurement framework. It records regulatory barriers affecting digitally enabled services trade rather than directly measuring transaction costs or productivity effects (Ferencz, 2019). Accordingly, annual country differences describe recorded regulatory conditions. Neither country serves as an untreated counterfactual, and the comparison does not identify causal effects.

The analytical quantities are annual differences between national aggregate scores, within-country changes over time, and descriptive summaries of available regulatory components. These quantities answer the research question by distinguishing aggregate divergence from the component evidence available to interpret it.

4.2 Analytical Measures and Calculation Rules:

The analysis retains the original numerical scales of the aggregate index and the infrastructure and connectivity, electronic transaction, and payment system contributions. Measurement definitions and analytical roles follow the variable dictionary in Table 3. Higher values indicate greater measured restrictiveness. The components represent observed contributions within the OECD framework rather than independently estimated latent constructs (Ferencz, 2019).

Descriptive statistics are calculated separately for each indicator using its available numerical observations. The arithmetic mean is the sum of observed values divided by their number. The sample standard deviation uses the observation count minus one as its denominator. Minimum and maximum values establish the observed range. The median is the middle-ordered value or the average of the two middle values when the observation count is even.

Annual country differences are calculated by subtracting Australia's aggregate score from Austria's score for the same year. Positive differences indicate greater recorded restrictiveness in Austria. These contrasts are expressed in index points.

Component statistics retain their respective observation counts. Because coverage differs across components, their means are not treated as a complete decomposition of the aggregate score. This interpretation reflects the importance of constituent measures, weighting, and aggregation when evaluating composite indicators (Greco et al., 2019).

4.3 Sample Alignment and Data Processing:

Sample eligibility follows the construction reported in Table 1. The aggregate comparison contains 14 country-year observations, comprising seven annual observations for each country. The aggregate panel is balanced over the analytical period. Infrastructure and connectivity and electronic transactions each contain nine numerical observations, while payment systems contain seven.

Country identifiers and calendar years provide the alignment keys. Annual aggregate comparisons match the two countries within each year. Component summaries use the numerical observations available for each indicator rather than imposing a common complete-case sample across all components. Consequently, each summary describes its documented observation subset.

Missing entries remain missing and are excluded only from the numerical calculation requiring that indicator. Recorded zeros remain valid observations. This distinction preserves the difference between an absent measurement and no measured restriction within a regulatory category. No imputation, interpolation, rescaling, logarithmic transformation, or outlier adjustment is applied.

Processing proceeds through identification of eligible records, assessment of numerical coverage, calculation of descriptive statistics, alignment of annual aggregate observations, and calculation of country differences. The supplied country-year structure contains no duplicate keys.

4.4 Analytical Checks and Replicability:

Analytical checks assess observation coverage, numerical dispersion, and consistency between reported statistics and their underlying samples. Observation counts distinguish complete aggregate coverage from incomplete component coverage. Minimum values, maximum values, and sample standard deviations establish whether each indicator varies within its observed subset.

Constant component values are interpreted as uniform recorded observations within the available subset. They do not establish uniform regulatory conditions across missing records. Aggregate movements are attributed to particular policy domains only where corresponding component evidence supports that interpretation. This approach maintains the distinction between composite measurement and substantive explanation emphasised by Greco et al. (2019).

Replication requires the supplied regulatory extract, country-year identifiers, measurement definitions in Table 3, and the calculation rules specified above. The analysis retains the numerical precision available in the extract and reports the observation count associated with each indicator. Its conclusions concern the documented regulatory trajectories and the component evidence supporting their interpretation. The method applies established descriptive procedures to a bounded comparison of digital services regulation.

5. Findings:

This analysis evaluates the three hypothesized relationships between digital services trade restrictiveness and productivity performance using the available country year observations. It examines regulatory variation, measurement coverage, and the empirical conditions required to estimate each relationship. The findings distinguish observed differences in regulatory restrictiveness from evidence capable of establishing productivity effects.

5.1. Sample Characteristics and Descriptive Findings:

The analytical dataset contains 24 country year records for Australia and Austria over 2010 to 2021. Fourteen records contain aggregate Digital Services Trade Restrictiveness Index observations, corresponding to seven annual observations per country from 2015 to 2021. The index measures regulatory barriers affecting digitally enabled international services trade rather than productivity itself. Ferencz, 2019, establishes the regulatory measurement framework, while Ferencz and Gonzales, 2019, demonstrate its relevance to international digital services markets. Ferencz and Nordås, 2020, further establish the importance of distinguishing composite regulatory measures from their constituent restrictions.

The aggregate Digital STRI has a mean of 0.06979, a standard deviation of 0.06814, and a median of 0.021. Its observed values range from 0.021 to 0.162. This dispersion establishes differences in aggregate

regulatory restrictiveness within the available sample. However, the three focal regulatory components exhibit no numerical variation within their respective observed subsets.

Table 1: Descriptive Statistics of Digital Services Trade Restrictiveness

Indicator	N	Mean	SD	Minimum	Maximum
Digital STRI overall	14	0.06979	0.06814	0.021	0.162
Infrastructure and connectivity	9	0.000	0.000	0.000	0.000
Electronic transactions	9	0.021	0.000	0.021	0.021
Payment systems	7	0.000	0.000	0.000	0.000

The aggregate regulatory sample is balanced across countries and years, but the component samples are incomplete. Infrastructure and connectivity and electronic transactions each contain nine observations, while payment systems contain seven. All five proposed productivity outcomes and both international services trade indicators contain no numerical observations. Consequently, descriptive analysis is feasible for regulatory measures, but joint analysis of regulatory restrictions and productivity is not.

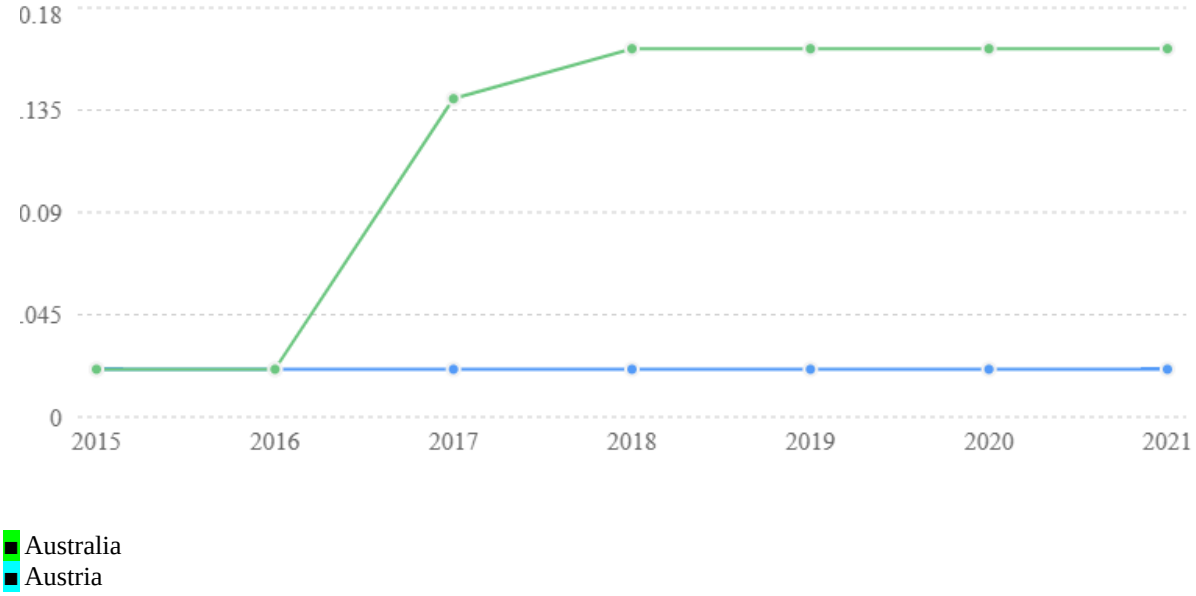
5.2. Cross Country Differences in Digital Services Trade Restrictiveness:

The annual observations establish different regulatory trajectories for Australia and Austria. Australia's aggregate Digital STRI remains constant at 0.021 throughout 2015 to 2021. Austria records the same value in 2015 and 2016, followed by an increase to 0.140 in 2017 and 0.162 in 2018. Its observed value remains at 0.162 through 2021.

Table 2: Annual Digital Services Trade Restrictiveness

Year	Australia	Austria	Difference
2015	0.021	0.021	0.000
2016	0.021	0.021	0.000
2017	0.021	0.140	0.119
2018	0.021	0.162	0.141
2019	0.021	0.162	0.141
2020	0.021	0.162	0.141
2021	0.021	0.162	0.141

Annual index values for Australia and Austria:



The observed difference reaches 0.141 index points from 2018 onward. This represents a measurable divergence in aggregate regulatory restrictiveness, not an estimated difference in trade costs or productivity. The distinction is important because regulatory barriers may influence international services transactions through several channels. Benz and Jaax, 2020, identify the economic costs of services trade barriers, while Miroudot and Cadestin, 2017, establish the importance of international services specialization for productivity. Goldfarb and Tucker, 2019, explain how digital technologies reduce transaction costs, and Ferencz and Gonzales, 2019, identify regulatory barriers affecting digitally enabled services trade. These contributions support the economic relevance of the observed regulatory divergence but do not establish its productivity consequences in the present sample.

5.3. Empirical Evaluation of H1: Infrastructure and Connectivity Restrictions:

H1 predicts a negative association between infrastructure and connectivity restrictiveness and productivity performance. The theoretical expectation is consistent with the role of digital connectivity in reducing information transmission costs and facilitating international services transactions. Goldfarb and Tucker, 2019, establish the economic importance of reduced digital transaction costs. Ferencz, 2019, identifies infrastructure and connectivity restrictions within the Digital STRI framework, while Ferencz and Gonzales, 2019, demonstrate the relevance of communication infrastructure barriers to digital services trade.

The dataset contains nine observations for infrastructure and connectivity restrictions, comprising seven observations for Australia and two for Austria. Every observed value equals zero. The component therefore has a mean of zero, a standard deviation of zero, and no measurable variation within the observed sample.

The absence of variation prevents estimation of a relationship between infrastructure restrictions and productivity, independently of the missing dependent variable observations. Furthermore, no productivity outcome is populated for any corresponding country year. The required covariance between the predictor and outcome cannot be calculated.

The distinction between theoretical expectation and empirical identification is important. Miroudot and Cadestin, 2017, identify productivity gains associated with services specialization, while Benz and Jaax, 2020, establish that services trade barriers impose economic costs. Neither finding supplies the missing observations or identifies the specific relationship proposed under H1.

5.4. Empirical Evaluation of H2: Electronic Transaction Restrictions:

H2 predicts a negative relationship between electronic transaction restrictiveness and productivity performance. The proposed mechanism operates through the costs of establishing, verifying, and completing international digital transactions. Goldfarb and Tucker, 2019, identify verification and information costs as central to digital economic activity. Ferencz, 2019, incorporates electronic transaction restrictions into the Digital STRI, while Ferencz and Nordås, 2020, establish the relevance of regulatory barriers to services market performance.

The available dataset contains nine electronic transaction observations. Each observation equals 0.021, producing a mean of 0.021 and a standard deviation of zero. The component therefore records a positive regulatory contribution but provides no variation across its observed country year records.

This result establishes the presence of a measured electronic transaction restriction contribution within the observed sample. It does not establish whether the restriction is associated with higher or lower productivity. A constant predictor cannot identify a separate regression coefficient in a model containing an intercept, and no populated productivity outcome is available for matching.

The theoretical relevance of electronic transaction barriers remains supported by the broader literature. Benz and Jaax, 2020, demonstrate that regulatory restrictions can increase services trade costs. Miroudot and Cadestin, 2017, identify the importance of services specialization within international production networks. Ferencz and Gonzales, 2019, further document regulatory impediments affecting digitally enabled services transactions. These findings establish plausible transmission mechanisms without providing empirical confirmation of H2 in the available observations.

5.5. Empirical Evaluation of H3: Payment System Restrictions:

H3 predicts a negative association between payment system restrictiveness and productivity performance. The proposed relationship reflects the importance of payment settlement, transaction reliability, and financial access in international services transactions. Ferencz, 2019, identifies payment systems as a regulatory component of the Digital STRI. Goldfarb and Tucker, 2019, establish the economic significance of transaction cost reductions, while Benz and Jaax, 2020, demonstrate the costs associated with services trade restrictions.

The available payment system component contains seven numerical observations, all belonging to Australia. Every observed value equal zero. Consequently, the component exhibits neither within country variation nor observable cross-country variation.

The absence of Austrian payment system observations prevents a direct comparison between the two countries. The absence of productivity observations further prevents estimation of the relationship between payment restrictions and economic performance. The observed zeros cannot be interpreted as evidence that payment regulation has no productivity effect.

The broader international services literature provides a theoretical rationale for the proposed relationship. Miroudot and Cadestin, 2017, demonstrate the economic relevance of services within global value chains. Ferencz and Gonzales, 2019, identify barriers affecting digitally enabled international transactions, while Ferencz and Nordås, 2020, establish associations between services trade restrictions and sectoral performance measures. These findings cannot substitute for matched observations of payment restrictions and productivity in the present dataset.

6. Discussion:

6.1. Structural Interpretation and Empirical Contribution:

Regulatory divergence in digital services trade does not necessarily translate into identifiable differences in productivity, particularly when aggregate restrictions and their underlying dimensions exhibit different patterns of variation. The findings in Tables 1 and 2 establish a divergence between Australia and Austria, with Austria's aggregate restrictiveness increasing by 0.141 index points relative to Australia, while the three focal regulatory dimensions remain constant within their observed samples. This distinction is analytically important because aggregate regulatory variation cannot be attributed to individual restrictions without corresponding component evidence. The findings therefore challenge the assumption that variation in a composite regulatory index necessarily provides sufficient information to identify its underlying economic transmission channels. This interpretation extends the measurement concerns raised by Costinot and Rodríguez-Clare, 2014, concerning the relationship between trade barriers and aggregate economic outcomes, and complements the analysis of digital transaction costs by Goldfarb and Tucker, 2019. Table 3 further demonstrates that the three hypothesized productivity relationships cannot be statistically identified because matched productivity observations are unavailable. The contribution lies in establishing the distinction between observable regulatory divergence and identifiable economic effects, rather than claiming a productivity relationship unsupported by the evidence.

6.2. Regulatory Mechanisms and International Productivity Transmission:

The economic significance of digital services regulation depends on whether regulatory barriers affect international connectivity, transaction execution, or payment settlement, and whether these changes subsequently influence domestic production. The three mechanisms imply different transmission processes. Infrastructure restrictions may constrain access to international knowledge networks, electronic transaction restrictions may increase contractual and verification costs, and payment restrictions may affect transaction completion. However, Table 3 indicates that the observed regulatory components contain no variation sufficient to distinguish these pathways empirically. Consequently, no mediation coefficients, indirect effects, or causal transmission estimates can be established. This distinction matters because theoretical mechanisms should not be interpreted as observed economic channels. Antràs and Chor, 2013, demonstrate that international production relationships depend on organizational and contractual structures, while Melitz and Redding, 2014, establish that trade responses depend on firm heterogeneity and market selection. These perspectives suggest that the productivity consequences of regulatory restrictions may differ according to firms' dependence on foreign services and their ability to adjust transaction arrangements. The available evidence identifies the regulatory measurement conditions under which these mechanisms would need to be evaluated, but it does not establish their relative importance.

6.3. Regulatory Decomposition and Theoretical Implications:

The contrast between aggregate restrictiveness and constant component observations raises a fundamental issue concerning the interpretation of composite regulatory indicators. Table 1 shows that infrastructure and connectivity restrictions have a mean of zero, electronic transaction restrictions have a mean of 0.021, and payment system restrictions have a mean of zero within their respective observed subsets. These values cannot be interpreted as relative contributions to productivity effects because the underlying components have unequal observation counts and no measured productivity relationships. Moreover, the increase in Austria's aggregate index cannot be decomposed reliably using incomplete component observations. This result is relevant to the broader literature on composite indicators, which emphasizes that aggregation can obscure differences in underlying dimensions. Greco et al., 2019, demonstrate that composite indicator construction involves consequential choices concerning weighting, aggregation, and interpretation. Similarly, Nardo et al., 2011, emphasize the importance of examining the structure and sensitivity of composite measures before drawing substantive conclusions. The present evidence reinforces the distinction between an index contribution and an estimated economic effect. It does not identify a dominant productivity transmission channel, but it establishes why aggregate regulatory scores should not automatically be interpreted as evidence of particular mechanisms.

6.4. Measurement Constraints and Structural Interpretation:

The principal empirical constraint is the absence of matched productivity and international services trade observations, combined with the lack of variation in the three focal regulatory components. Table 3 establishes that H1, H2, and H3 cannot be resolved through statistical estimation. These conditions prevent the calculation of regression coefficients, correlations between regulatory dimensions and productivity, and measures of statistical uncertainty. The distinction has implications beyond sample size. Even a larger number of observations would not identify separate component effects if the relevant predictors remained constant. Furthermore, domestic productivity indicators alone would not establish productivity spillovers without information linking international services transactions to domestic outcomes. This issue reflects the broader identification challenges discussed by Athey and Imbens, 2017, who emphasize the importance of research design and observable variation in empirical inference. It also relates to the measurement concerns examined by

Hummels and Schaur, 2013, whose analysis demonstrates that international trade costs operate through specific transaction mechanisms. The findings therefore establish a boundary between regulatory measurement and economic identification. They do not provide evidence that regulatory restrictions are economically ineffective, nor do they justify attributing observed regulatory changes to productivity outcomes.

6.5. International Relevance and Comparative Interpretation:

The divergence between Australia and Austria demonstrates that advanced economies can exhibit different trajectories of aggregate digital services trade restrictiveness despite sharing relatively developed institutional and technological environments. Table 2 identifies the emergence of this divergence after 2016, but the available observations do not establish its economic consequences. This result has international relevance because regulatory convergence cannot be inferred solely from similarities in economic development. The broader literature identifies several reasons why the consequences of trade restrictions may differ across economies. Fernandes et al., 2019, demonstrate the importance of international services trade for firm performance, while Borchert et al., 2014, document substantial differences in services trade policies across countries. López González and Jouanjean, 2017, further explain how digital transformation changes the conditions governing international trade. These contributions suggest that comparable aggregate regulatory scores may conceal differences in institutional implementation, sectoral exposure, and transaction costs. Nevertheless, the present sample cannot establish whether the observed regulatory divergence produces corresponding differences in productivity. Its international contribution is therefore limited to documenting a measurable regulatory contrast and clarifying the additional evidence required to interpret that contrast economically.

6.6. Implications for Regulatory Analysis and Future Research:

The findings support a practical distinction between monitoring regulatory restrictiveness and evaluating its economic consequences. Table 2 establishes that aggregate regulatory conditions can change substantially within a relatively short period, while Tables 1 and 3 show that incomplete component coverage prevents identification of the associated productivity mechanisms. Regulatory authorities should therefore interpret aggregate Digital STRI movements alongside their underlying component records before attributing changes to particular policy domains. Empirical assessments of productivity spillovers require matched observations of regulatory restrictions, international services transactions, and productivity outcomes at consistent country and time levels. This requirement follows the broader evidence on international knowledge transmission developed by Keller, 2010, and the role of services within global production systems examined by Timmer et al., 2014. The conceptual implication is that regulatory restrictiveness, international services exposure, and productivity performance represent distinct analytical constructs whose relationships cannot be inferred from aggregate regulatory scores alone. Future research should examine whether changes in specific regulatory dimensions are associated with changes in services trade exposure and whether those changes precede measurable productivity responses. Such analysis would clarify the conditions under which regulatory barriers constrain international productivity transmission without presuming causal relationships that the available evidence cannot establish.

7. Conclusion and Implications:

Global digital trade policy requires evidence that distinguishes regulatory change from economic consequences. This study shows that aggregate regulatory divergence can coexist with unchanged observations across selected underlying policy domains, making component coverage essential to interpretation. Its empirical contribution is the documented separation between national index movements and the specific transaction mechanisms those movements might appear to represent. The comparison of Australia and Austria establishes a bounded measurement insight relevant to international regulatory assessment: aggregate differences alone cannot identify the channels connecting policy to economic performance. This qualifies transaction-cost explanations by clarifying the evidence required to move from regulatory classification to economic inference. Managers can apply this distinction when screening international service markets, checking relevant regulatory provisions before using national scores to guide procurement or resource allocation. Policymakers can strengthen monitoring by publishing complete component records and documenting the measures responsible for aggregate changes. Operationally, consistent observation periods, explicit missing-data treatment, and traceable policy classifications would improve comparisons and reduce unsupported attribution. These practices can support more accountable decisions affecting firms and service users, although wider social benefits require separate evaluation. The broader implication is that credible digital trade governance depends on aligning the detail of regulatory evidence with the decisions it informs.

The comparative extract provides a basis for extending coverage across countries, sectors, and time. Matched productivity and services trade observations would enable testing of the proposed economic relationships. Complete component histories with sufficient variation would support assessment of distinct regulatory channels. Firm-level data could examine whether dependence on foreign services changes exposure to restrictions. Designs exploiting documented policy reforms could strengthen causal identification, subject to credible comparison groups and timing assumptions. Additional institutional measures could test conditional

relationships across regulatory environments. These extensions would assess whether the observed measurement pattern persists and clarify when regulatory divergence has measurable economic consequences.

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