Appendix: For Online Publication

Contents

A Codebook

StanDat Codebook

A database on international standards

Table of contents

Overview

StanDat consists of several datasets that covers several aspects of the landscape of international standards. The database is based on data from the International Standardization Organization (ISO). For more information on ISO, visit www.iso.org. For more information on the dataset, see this paper.

The database is categorized into 'Standards', 'TC-membership', 'Historical' and 'Certifications', each category with 2-3 datasets.

Category	Time series	Description	Source and method	Comments
Standards	1951 - 2023	Data on specific standards, including which technical committee that developed them, the life cycle of their production, year they were published, edition, number of pages, whether they have been withdrawn, abstract, sustainability goals and ICS code.	www.iso.org. With sublinks to every standard. Collected through webscraping using rvest.	The data has been subject to significant amounts of data cleaning.
TC-membership	2002/4 - 2023	Data on actors' membership in technical committees. There is one dataset on the countries (i.e. national member bodies) and one on the organizations in liaison.	Wayback Machine. Collected through webscraping using wayback, rvest and httr.	Because there is only a selection of snapshots of webpages in the archive, the data is incomplete. Imputation methods based on the collected data replaces for some of the missing values. The cells that have been imputed are indicated. The data has been subject to significant amounts of data cleaning.
Historical	1947 - 2015	Data on the historical development of ISO. One dataset includes membership in ISO over time, including type of membership and function of membership. One dataset shows when different technical committees were established.	Membership parsed from pdf. TC establishment scraped from iso.org and missing categories were categorized using ChatGPT.	The data has been subject to moderate amounts of data cleaning.
Certifications	1993 – 2020, but varies depending on ISO series.	Data on certifications of ISO standards. This includes data on the year of the survey, number of certificated provided by accredited certification bodies per country, industry and ISO standard series. The ISO Survey covers a selection of the ISO standard series. An overview of coverage and time series per coverage is given below.	The ISO Survey. The survey data is parsed from excel files.	From ISO: 'Every year we perform a survey of certifications to our management system standards. The survey shows the number of valid certificates to ISO management standards (such as ISO 9001 and ISO 14001) reported for each country, each year. [...] The ISO Survey is not a database. The providers of the data are the certification bodies accredited by IAF members and they participate on a voluntary basis. The level of participation fluctuates from one edition of the survey to another and can impact the survey results especially at the country level. Interpretations of the results and any conclusions on the trends should be made with these considerations in mind. The data has been subject to moderate amounts of data cleaning.

Standards

Coverage: 1951 - 2023

These datasets have standards as units, and gives information on when standards were published, the status of the standard, how large they are (in pages), which edition the standard is on, their International Classification for Standards code (ICS) (see https://www.iso.org/standards-catalogue/browse-by-ics.html), abstracts, sustainable developemnt goals that the standard fulfills, and the life cycle of the standard.

Status

Variable	Definition
stdno	Standard number
name	Name of the standard
year	Year the standard was published (standards under development are `NA`)
title	Name of TC the standard was developed within
committee	ID of the TC the standard was developed within
status	If the standard is withdrawn, deleted, developing or published
publication_date	When the standard was published (if published)
edition	The edition of the standard
pages	Number of pages of the standard
abstract	Abstract of the contents of the standard
ics_name	Name of the ICS code the standard is categorized into (canbe more than one)
ics_id	ID for the ICS code the standard is categorized into (can be more than one)
link	Link to the webpage where the information was scraped

SDGs

This dataset shows the **sustainable development goals** (SDGs) that each standard is reported to address (if any).

Variable	Definition
stdno	Standard number
name	Name of the standard
year	Year the standard was published (standards under development are `NA`)
title	Name of TC the standard was developed within

committee	ID of the TC the standard was developed within
sgd_number	Number of the sustainability goal that ISO reports the standard to contribute to (if any).
sdg_text	Name of the sustainability goal that ISO reports the standard to contribute to (if any).
link	Link to the webpage where the information was scraped

Life cycle

Process of stages for standard, as given by https://www.iso.org/stage-codes.html . The units of observation in this dataset is a life cycle stage for a given standard.

Variable	**Definition**
stdno	Standard number
name	Name of the standard
year	Year the standard was published (standards under development are `NA`)
title	Name of TC the standard was developed within
committee	ID of the TC the standard was developed within
life_stage	The stage reported in the life cycle of a given standard
life_stage_code	The code of the stage reported in the life cycle of a given standard
date	Date that the standard was at this life cycle stage
link	Link to the webpage the data was collected from

TC-membership

Coverage: 2002 - 2023

These datasets include information on the actors' membership in technical committees, i.e. that may participate in the production of standards. Standards are produced in various technical committees (TC) that are established based on demand from stakeholders, and proposed by national member bodies. To establish a technical committee, a member body sends a proposal which is then circulated among the other ISO members. At least five other member bodies have to vote in favor for the TC to be established. Those in favor take the role of P-members, and usually, the country responsible for the proposal takes the secretariat. Proposal drafts are often, in the first place, requests from other national actors.

Countries (national member bodies)

There are three member categories – full member, correspondent member and subscriber member. Only full members can become P-members (participating members) in TCs, and only P-members are able to participate actively in the technical work of the committee. Observing members are allows to follow the process but are not able to participate.

Variable	Definition
country	Country name
sdo	Name of main standardization developing organization in the country
year	Year of membership
committee	Number of TC
title	Name of TC
membership	Type of membership, either participating (P-member), observing (O-member), secretariat or twinned secretariat
impute	Whether memberships were imputed from the previous year
sector	The sector that ISO categorizes the TC into

Organizations (liaison)

Among organizations in liaison, there are four member categories, A, B, C and D, depending on how involved the organizations are in the standardization process.

Using the acronym is more reliable than using the name, as the name has been more often subject to change as webpages change.

Variable	**Definition**
acronym	Organization's acronym
name	Name of organization
year	Year of liaison
country	Country where the organization is located (fetched from address)
committee	Number of the committee that the organization was in liaison with
title	Name of the committee that the organization was in liaison with
type	Type of liaison for the given organization
impute	Whether the membership in given committee was imputed
sector	The sector that ISO categorizes the TC into

Historical

Coverage: 1947 - 2023

These datasets show the development of the International Standardization Organization over time in terms of members and technical committees.

Members

Shows membership in ISO over time. There are three types of membership; Participating member, Correspondent member and Subscriber member. Only P-members can participate actively in technical committees.

Variable	**Definition**
year	Year
country	Country
continent	Continent of country
membership_status	Which membership status the country had in the given year. U = No membership, M = membership, C = Correspondent member, S = Subscriber member.
membership_role	If there were any particular changes to the membership in the given year. with = Withdrawn, sus = Suspended, council = Council.

Technical committees

Technical committees have been established throghout ISO's history. This dataset includes some unknown missings, as some TCs have been established and then disbanded.

Variable	**Definition**
year	Year of establishment
title	Name of committee
committee	ID of committee
sector	The sector that ISO categorizes the TC into

Certifications

Coverage: Varying

The ISO Survey of Certifications is an annual survey of the number of valid certificates to ISO management system standards worldwide. The providers of data are the certification bodies accredited by the IAF MLA Members.

Disclaimer: The ISO Survey is not a database. The providers of the data are the certification bodies accredited by IAF members and they participate on a voluntary basis. The level of participation fluctuates from one edition of the survey to another and can impact the survey results especially at the country level. Interpretations of the results and any conclusions on the trends should be made with these considerations in mind.

Survey coverage for all datasets

Number of standard family	Name of standard family	Country coverage	Industry coverage
ISO 9001	Quality management systems	1993-2020	1998-2020
ISO 14000	Environmental management	1999-2020	1998-2020
ISO/IEC 27001	Information security management	2006-2020	2006-2020
ISO 50001	Energy management	2011-2020	2015-2020
ISO 22000	Food safety management	2007-2020	–
ISO 13485	Medical devices - Quality management systems	2004-2020	–
ISO 22301	Security and resilience	2014-2020	2014-2020
ISO/IEC 20000-1	Information technology	2015-2020	2015-2020
ISO 28000	Specification for security management systems for supply chains	2016-2020	2016-2020
ISO 39001	Road traffic safety (RTS) management systems	2016-2020	2016-2020

Country certifications

Variable	Definition
country	Country name

year	Year of survey
certificates	Number of certificates as provided by accredited certification bodies in the ISO Survey
iso	Code of ISO management standards series
iso_name	Name of ISO management standards series

Industry certifications

Variable	Definition
industry	Aggregate industry level
year	Year of survey
certificates	Number of certificates as provided by accredited certification bodies in the ISO Survey
iso	Code of ISO management standards series
iso_name	Name of ISO management standards series

Country and industry certifications

Variable	Definition
country	Country name
year	Year of survey
industry	Aggregate industry level
ISO 9001	Number of certificates within the ISO 9001 series
ISO 14001	Number of certificates within the ISO 9001 series
ISO/IEC 27001	Number of certificates within the ISO/IEC 27001 series

B Data gathering process

Please find the complete code to produce the StanDat database on Github.

Following the construction of these datasets, I used a SQLite database to host the data, a widely popular, functional and easy-to-use database (Gaffney et al. 2022). The storing process is easily integrated into the workflow using the *RSQLite* package and the database can be hosted as a file in cloud platforms such as OneDrive or Dropbox. Moreover, storing the dataset in a SQLite database, it is relatively straight-forward to construct a fast and simple user interface with *R Shiny*. Such applications increase accessibility to the data for less technical users, and it has the advantage of storing all information pertaining to the dataset in one place, including data coverage, variable definitions and codebook (see Appendix A). While developers are free to use any deployment method they want, deployment in *R Shiny* is made increasingly simple through RStudio's *shinyapps.io*, although costs can follow if the traffic becomes substantial.

Standards datasets

The procedure to construct the "Standards" datasets relied on webscraping. All standards produced are listed on ISO's current webpage, including the ones that are withdrawn or deleted. Thus, this scraping process utilized the current webpage of ISO only. The process involved three steps:

1. **Downloading the webpages** to a local folder. This was done by appending the strings "https://www.iso.org/standard/", [number], "?browse=tc". In order to catch all relevant standards, I iterated through all numbers from 1 to 150000, downloading when a webpage matching the url was found.

2. **Extracting and parsing information** from the webpages. This included finding the relevant nodes of the variables and fetching these into separate vectors, then cleaning the information. For this process, I used the R-package *rvest* and string operations, including regex, creating separate data tables for the life cycle and the general standards information.

3. **Gathering data** so that each separate datasets is can be merged into one long dataset, ensur-

ing compatibility across all datasets.

Participation datasets

The procedure to construct the "Participation" datasets relied on webscraping. ISO purchased the domain "www.iso.org" in late 2001, thus, 2002 is when the time series for the participation data starts. Using the Wayback Machine API through the Wayback R-package, this scraping process is composed of three steps. Because ISO changed their webpage four times in the period 2002 to 2023, step 1 and 2 had to be done four times with separate links and parsing processes. The four phases of ISO's webpages are:

- First version: 2002 - 2007
- Second version: 2008 - 2012
- Third version: 2013 - 2016
- Fourth version: 2017 - 2023

The three steps in making the Participation datasets were:

1. **Downloading the webpages** to a local folder. This was done by finding the url on member countries in ISO, which included a list of which technical committees they participate in. Then I used Wayback to find all snapshots of this webpage. All snapshots available were downloaded.

2. **Extracting and parsing information** from the webpage, i.e. finding relevant nodes in the webpage, extracting them, and then parsing the data to get a tidy format. This was done using the R-package *rvest* and general string operations (including regex).

3. **Cleaning the data.** This step is again composed of four steps:

(a) **General cleaning** to make all four datasets from step 1 and 2 compatible, including removing whitespace, removing special letters, ensuring that names of countries and organizations are compatible across the time series, replacing numbers/acronyms with names where relevant, etc.

(b) **Adding secondary information** from a different source of information. This was only done with the country dataset. While I have used the country-pages to construct the dataset, i.e. webpages for each member country where the technical committees they participate in are listed, another option is to use the webpages on technical committees, which lists the member countries participating. In this way, I can fill out information where a snapshot was not taken of a particular country in a particular year, by doing step 1 and 2 on the webpages for technical committees and use them to fill out missing data in the country dataset.

(c) **Imputing missing information.** Random missing values follow from the uneven snapshots of webpages taken by Wayback. A rule was followed to impute the missing values on the Participant datasets (see section C).

(d) **Removing duplicates.** After imputation, some countries might have been listed as being an X-member in a technical committee while this is not the case, i.e. false positives. This can be ruled out where a country is listed as both P-member and O-member, but one is an imputation. In other cases, there are duplicates even though there are no imputations, likely a case of countries switching membership during the year. In this case, the membership in year Y+1 is chosen as the correct membership type. Lastly, a very small bunch of countries were duplicated for no obvious reason – there were imputed with O-membership as this is more common than P-membership. For countries holding the Secretariat, these tended to also be listed as P-members. I include them only as Secretariat holders.

Historical datasets

The "Historical" datasets are gathered from a PDF file, the first page shown in figure B8. The PDF file was not machine-readable, so I ran it through Adobe to construct an excel file of the PDF file, then did some manual cleaning. In the next step, I read the excel file into R and parsed the data in order to produce a tidy format.

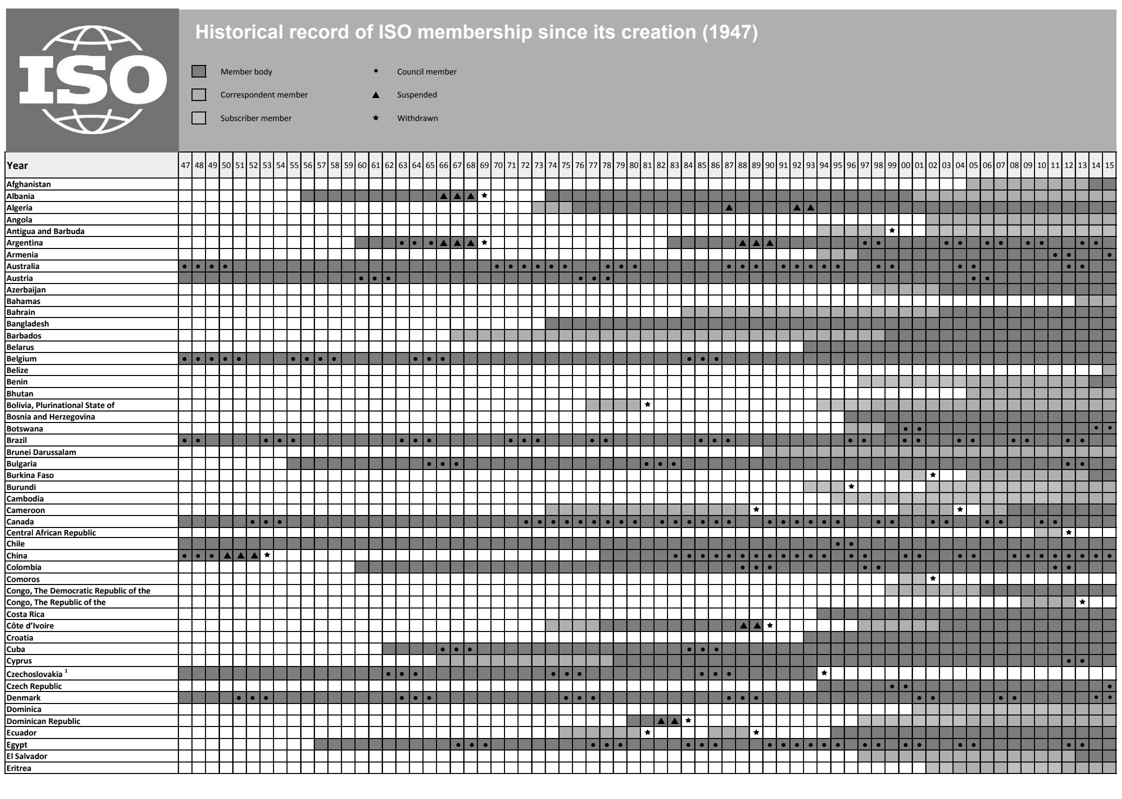


Figure B8: PDF file of historical membership in ISO.

Certification datasets

The "Certification" datasets are created from the ISO Survey. The ISO Survey is listed among ISO's public documents and are composed of several different excel files. The process thus included reading the excel files into R, parsing the data and cleaning to ensure consistency across years and make a tidy dataframe.

Per 2023, the surveys can be found at this link. The excel documents are composed of several sheets for each continent, and variously disaggregated by country, industry and country-industry over the years. Parsing thus ensures consistency as the datasets are gathered into three tidy dataframes - one for countries, one for industries and one for country-industries.

C Validation of the "TC-membership" datasets

For participation in technical committees for both countries (member bodies) and organizations (liaison), imputations have been made based on the following rule:

- If Country/Organization A has been an P-member in technical committee B in year Y-1 and Y+1, but year Y is missing, then impute for year Y that Country/Organization A is X-member of technical committee B.
- If Country/Organization A has been P-member in year Y+2 and O-member in year Y-2, then sequentially impute that A is O-member in Y-1, then P-member in Y+1, then O-member in Y, starting at the past values.
- If Country/Organization A is P-member in Y-1 but no other information is available, then do not impute anything.

This rule has the advantage of filling in space between two years where a country or organization is a member of a TC, but there are missing values in the middle. The rule is based on the assumption that missing values between two years of membership in the same TC are due to Wayback's uneven snapshot of webpages, and not due to the country or organization stepping out of the TC for the time period and then stepping back in. The assumption also holds that the country or organization switches membership halfway between two values if the membership type in Y-2 and Y+2 is different. While none of these assumptions are likely to hold true all the time, the validation below shows that the assumptions holds most of the time.

Face validity

Figure C9 and C10 show the amount of imputations for each country and organization over time. Separate files were made for each country and organization to view the imputations of TC membership and check for discrepancies. While face validity is a weak measure of validity in itself, it is a good first stage to gauge the validity of the imputations. The figures below show that the amount of imputations for the countries and organizations are not extreme. Because the number of organizations is a lot higher than the number of countries, names on the Y-axis were removed in the organization plot. Separate files for each country and organization are available upon request and show the same patterns as figure C9 and C10.

For the remaining two validation procedures, the country dataset has been validated as access to country membership is more available than organizations in liaison. However, given that the two procedures of gathering data are similar, the validity results should hold for both the country dataset and the organization dataset.

Figure C9: Imputation of countries' participation in technical committees for Wayback data.

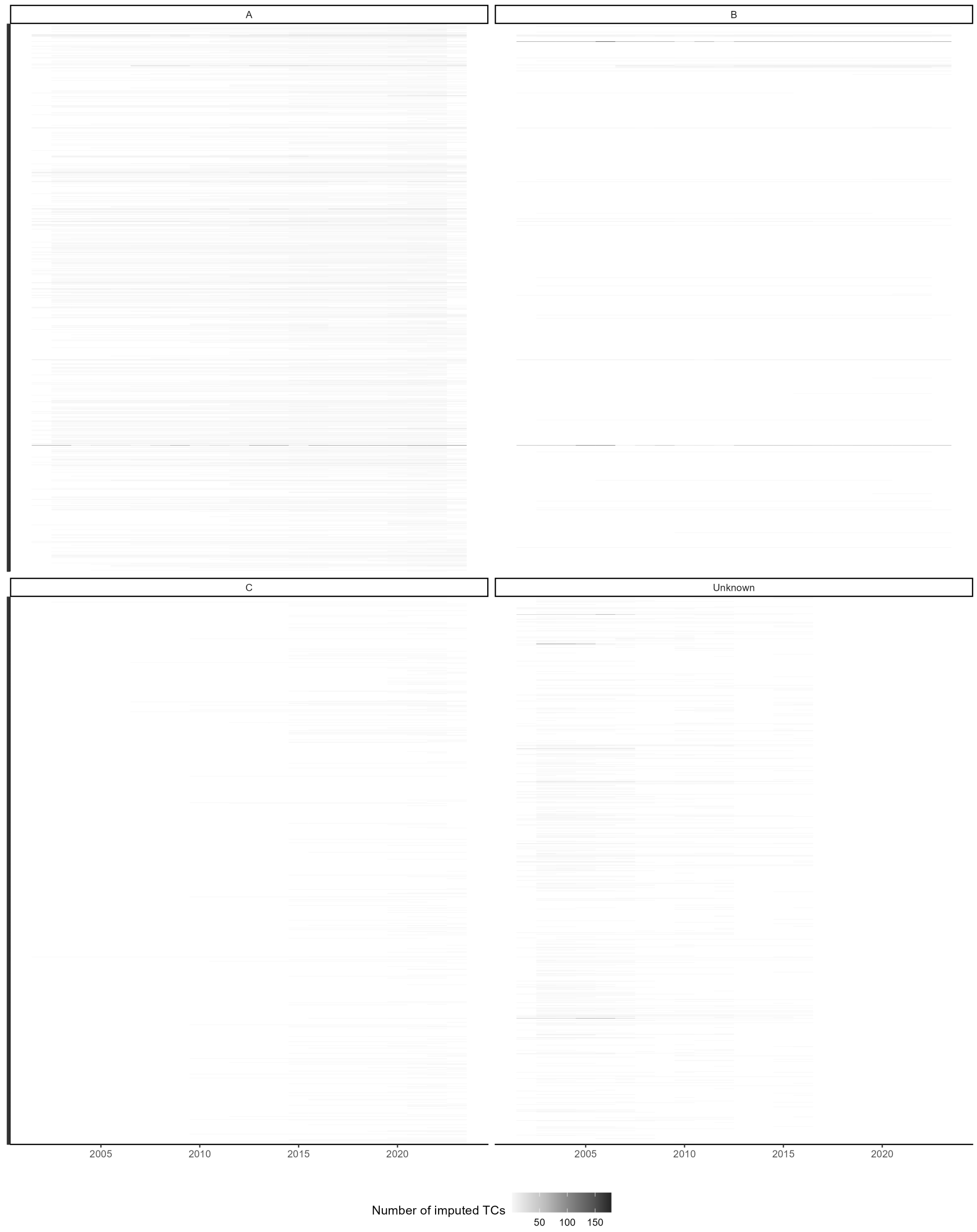


Figure C10: Imputation of organizations' participation in technical committees for Wayback data.

Validation against public documents

There are occasional documents on technical committees on the internet, for example public reports, papers or presentations prepared by the secretariat in relation to a meeting. I use a selection of five reports that I could find to validate the participation in various technical committees. These reports are:

- **2002:** A UN paper prepared for the *Eighth United Nations Conference on the Standardization of Geographical Names* from ISO/TC 211, Geographic Information Standards. Prepared by Olaf Østensen, Chairman ISO/TC 211 Geographic information/Geomatics, and Chairman, Joint Steering Group on Spatial Standardization and Related Interoperabiltiy (E/CONF.94/1).

- **2010:** A presentation prepared by Bob Page entitled "ISO Standards as a Contribution to Global Carbon Regimes (MRV)" for the 10th annual workshop on GHG training, specifically on TC 207.

- **2016:** A powerpoint presentation entitled "Report of the Secretariat of ISO/TC 34/SC 3 "Fruits and vegetables and their derived products". They list participants in TC 24/SC 3.

- **2016:** A paper entitled "Workplace air quality: International consensus standards" published in *J Occup Environ Hyg.* 13(7) by Eun Gyung Lee, Kevin Ashley, Dietmar Breuer, Michael J. Brisson, Martin Harper, and Christian Thom. They mention TC 146/SC 2.

- **2019:** A report prepared by Jouko Vaskimo entitled "ISO/TC 258, ISO Technical Committee for Project, Program, and Portfolio Management, convenes in Seoul, South Korea" published in PM World Journal. It lists participants in TC 258.

The results of the validation against these reports can be found in table C5. In general, the accuracy is above 80 percent. There are more false negatives in the beginning of the time series. Indeed, in 2002 there were only a few webpages to draw from and no imputations could be made, as there were no previous years to infer from. In the latter part of the time series, the risk is larger for false positives, as imputations might have caused some countries to be erroneously classified as participants (P-members or O-members) in a technical committee. However, the overall improvement in accuracy shows that the imputations usually are correct.

Technical committee	Year	Membership	False negative	False positive	Accuracy	Countries in committee
TC 211	2002	P-member	23	0	20.69	6
TC 211	2002	O-member	17	0	37.04	10
TC 207	2010	P-member	2	6	89.33	73
TC 207	2010	O-member	3	2	83.33	33
TC 146/SC 2	2016	P-member	0	0	100.00	23
TC 146/SC 2	2016	O-member	0	2	88.89	18
TC 34/SC 3	2016	P-member	1	1	91.67	23
TC 34/SC 3	2016	O-member	1	2	94.23	51
TC 258	2019	P-member	4	6	75.61	37
TC 258	2019	O-member	0	2	87.50	14

Table C5: Accuracy of StanDat based on checks against reports.

Validation against ANSI webpage - United States Secretariats

The United State standardization organization, ANSI, has comprehensive webpages. Using the Wayback Machine, I download ANSI's webpages showing US-held secretariats back to 2002. Figure C11 shows the secretariats that were listed in ANSI's webpages divided by whether they were captured in the StanDat database. In total, 1051 out of 1353 secretariats were captured throughout the timeseries, making an accuracy of 78,7. However, most of the missing secretariats are in the beginning of the time series, when data was scarce. Starting the time series from 2004 bumps the accuracy up to 85,8.

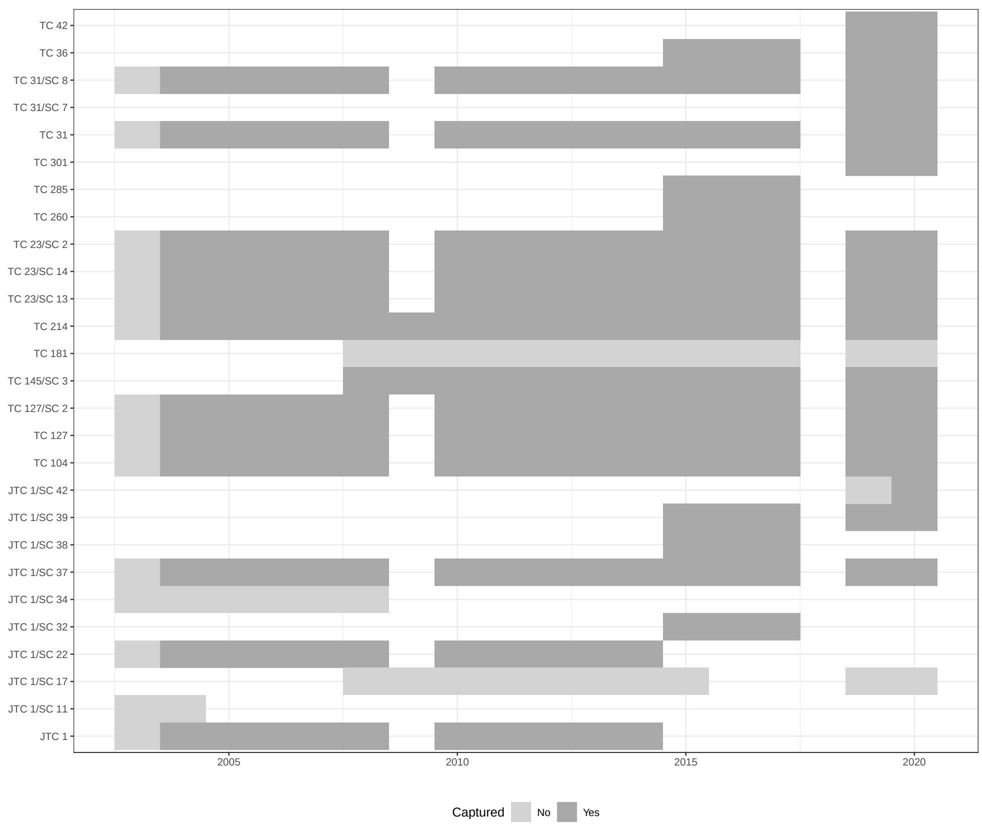
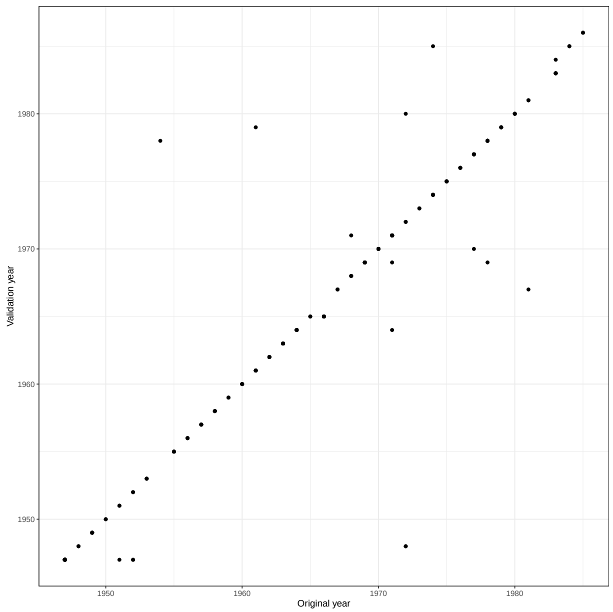


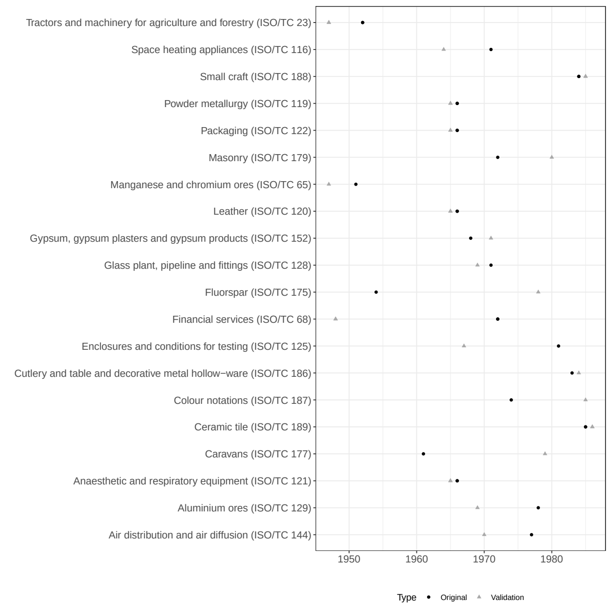
Figure C11: Secretariats listed at ANSI's webapges and captured in StanDat.

C.1 Validation of TC establishment

The dataset "TC establishment" under "Historical" was computed by extracting all technical committees ever reported both at ISO's webpage and from other sources. Then, to compute the year of establishment for sources that were not gathered through ISO, I use ChatGPT. This has the advantage of quickly computing the years for several TCs where the information is on the internet somewhere, without having to manually search for and add these years. However, the method is not without fault. Thus, here I validate the ChatGPT codings against a report from the U.S. Department of Commerce in 2000. The report contains a list of TCs and their establishment year. Of in total 1098 TCs in my dataset, the report mentions 296. Of these, 28 TCs were coded wrong. Of all the TCs, ChatGPT misses the mark by 0,14 years. Among the wrongly coded TCs, the average miss is 1,43 years. Table C12 gives an overview of the validation.



(a) Relationship between all TC establishment years in original dataset and validation dataset.



(b) Difference in year against the TCs where original and validation establishment year differs.

Figure C12: Validation of TC establishment year.

D Example of analysis assessing scope conditions of certifications

In 2001, Corbett and Kirsch (2001) published a study asking which factors that drive certification within the newly published ISO 14000 series on Environmental Management. Relying on interviews from practitioners, they hypothesized that variables such as a country's environmental orientation and previous certification in the older management standard series, ISO 9000 on Quality Management, would predict certification[15]. Using regression analysis, they found that more ISO 9000 certification (relative to GDP) is positively associated with more ISO 14000 certification (relative to GDP). Replicating this study using tree-based models, Vastag (2004) find similar patterns; ISO 9000 certification is an important predictor for ISO 14000 certification. A debate regarding the methodological choices ensued (Corbett and Kirsch 2004), but the data foundation was not discussed. This is understandable given the early date of these studies, where parsing the ISO Survey was possibly even more challenging, and few years were available to study. Their analysis stretches from 1993 to 1998, covering 63 countries. Using the StanDat database, I extend the analysis of Corbett and Kirsch (2001) to 230 countries over 28 years, and also include another ISO series; ISO/IEC 27001 on Information Security Management Systems. I use a fixed effects linear regression model employing many of the same control variables as Corbett and Kirsch (2001), and cluster the standard errors by country-year.

Table D6 shows the models. The first model reaffirms the patterns found by Corbett and Kirsch (2001) and Vastag (2004), even when extending the sample and including fixed effects, certification in ISO 9001 is significantly positively associated with certification in ISO 14001. However, as shown in the next two models, the association between ISO 9001 certification and ISO 14001 certification is weaker, and only previous certification within ISO 14001 is significantly and positively associated with ISO/IEC 27001 certification. This implies that the similarity between ISO 9000 and ISO 14000 found by Corbett and Kirsch (2001) does only partly extend to ISO/IEC 27001,

[15]Corbett and Kirsch (2001) study certification within the complete ISO 9000 series, not only the main standard ISO 9001. Yet, the series on Quality Management is mainly represented by ISO 9001 and Environmental Management by ISO 14001, which is why I refer to ISO 9001 and ISO 14001 in this article.

implying that the drivers or certification infrastructure may differ more between ISO/IEC 27001 and the other two. As pointed out by Fomin et al. (2008) when suggesting some explanations for a low adoption rate of ISO/IEC 27001 compared to ISO 9001, the latter often brings relatively clear benefits such as improved market share and reduced costs, while the first aims to prevent security failures and to mitigate their consequences, where the benefit is less obvious in a day-to-day practice.

However, the findings could partly be explained by the time difference between the publication of ISO 9001 (1993) and ISO/IEC 27001 (2006), which means that by the time ISO/IEC 27001 was introduced, many organizations were already ISO 9001 certified many years ago. Given the longer time series, this is something to take into account in the new models. Table D7 gives some credibility to this notion, showing that when using the *cumulative* number of certification as a share of GDP, ISO 9001 and ISO 14001 are both significantly and positively associated with ISO/IEC 27001 certification[16]. As such, this simple analysis may bring a humble addition to the literature on some of the most popular ISO series; ISO/IEC 27001, ISO 14001 and ISO 9001 (Culot et al. 2021; Heras-Saizarbitoria and Boiral 2013). More generally, this brief analysis shows how the StanDat database can help scholars extend analyses to a wider population, as well as investigating whether relationships found for one specific standard series holds for other series.

[16]Carry-over counts from previous years when counting the cumulative numbers of certifications leads to a slightly higher number of observations in table D7 than in table D6.

	Dependent variable: Certifications		
	ISO 14001	ISO 27001	ISO 27001
Certification in ISO 9001 (1 year lag)	0.157**	0.009	−0.011*
	0.041	0.006	0.004
Certification in ISO 14001 (1 year lag)			0.101***
			0.020
GDP per capita	180.561	9.580	9.975
	121.638	10.391	8.413
Exports per GDP (ln)	0.197**	0.054**	0.032**
	0.055	0.017	0.009
Industry value added (% of GDP)	−0.003+	0.000	0.000
	0.002	0.001	0.000
Num.Obs.	3769	2321	2321
RMSE	0.24	0.04	0.03
Time series	1999-2022	2006-2022	2006-2022

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table D6: Relationship between certification in T-1 and T for various ISO series.

	Dependent variable: Certifications		
	ISO 14001	ISO 27001	ISO 27001
Cumulative certification in ISO 9001 (1 year lag)	0.023***	0.024***	0.001
	0.003	0.005	0.005
Cumulative certification in ISO 14001 (1 year lag)			0.088***
			0.015
GDP per capita	−30.969	144.043	70.861
	42.336	89.780	48.630
Exports per GDP (ln)	0.048+	0.013	0.007
	0.028	0.033	0.023
Industry value added (% of GDP)	0.001	0.001	0.001*
	0.001	0.001	0.001
Num.Obs.	3771	2738	2738
RMSE	0.21	0.14	0.12
Time series	1999-2022	2006-2022	2006-2022

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table D7: Relationship between cumulative certification in T-1 and T for various ISO series.

E Example of analysis on standardization and patents

Much research has been conducted on the role of standards in innovation. One question entails whether standards have a positive or negative effect on innovation, finding that under certain conditions, standardization seems to enhance innovation (Acemoglu et al. 2012; Allen and Sriram 2000; Blind et al. 2017). There are indications suggesting a similar phenomenon with ISO standards as well (Manders et al. 2016), though there remains a need for further research examining cross-country variations in innovation and ISO certification (Lim and Prakash 2014; Mentel and Hajduk-Stelmachowicz 2020).

Yet another question asks not whether the adoption of standards enhances innovation, but whether standardization may be a goal for innovators. This question probes the motives of standardizers in enhancing patented technology, and may in fact be one of the reasons why countries want to participate in TCs (Blind and von Laer 2022). Many scholars have studied the role of standard-essential patents (SEP), i.e. when patented technology becomes an essential part of a standard (Lerner and Tirole 2015). However, the relationship between patented technology and participating in standardization is difficult to quantify, as studies suggest that there is a significant overdeclaration of SEPs, while at the same time, only a subgroup of patented technology relevant to a standard is usually reported (Depoorter et al. 2019). Thus, scholars have been working on other ways of mapping patents to standards (Baron and Pohlmann 2018; Brachtendorf et al. 2023).

One approach could be to map patent classification (IPC) to TCs. In this small illustration on exploring the relationship between standardization and innovation, I follow that approach. This example focuses on ICT technology, a fast-paced technology area where the role of standardization for innovation has been particularly questioned (Teece 2018). Using a detailed concordance table in an OECD report (Inaba and Squicciarini 2017), I map standards on ICT technology to ISO/IEC JTC 1, the most general TC within information technology. In doing this, I merge StanDat's TC-membership dataset with data on patents registered at the United States Patent and Trademark Office (USPTO) (Toole et al. 2021) by country-year[17]. The question is whether being part of this

[17]While there may be bias in data gathered from national patent offices, since application and granting processes

major TC within ICT is associated with more patent output in that technology area[18]. Patents are measured in fractional counts (Blind and von Laer 2022; Frietsch and Schmoch 2010).

The analysis in table E8 shows that membership in ISO/IEC JTC 1 is significantly associated with a larger output of patents within ICT technology. For example, for the United States in 2015, the estimated number of ICT patents if the country was not a member would be 6000, compared to an estimated 15500 upon being a member of ISO/IEC JTC 1. While the model includes country-year fixed effects, the direction of the causal effect may go both ways – innovation activity can lead to TC membership, and TC membership may enhance innovation activity. Interestingly, this relation is not distinguishable for P-members or O-members, indicating that being active in the process does not equate more patents – merely observing the negotiations might suffice.

vary (Frietsch and Schmoch 2010), the USPTO database has been found to be among the most reliable in terms of quantifying innovation activity (Kim and Lee 2015). Another advantage of this database is that it contains very recent data, allowing for long time series.

[18]The technology area includes high speed network, mobile communication, digital security, sensor and device network, high speed computing, large capacity high speed storage, cognition and meaning understanding, human interface, imaging and sound technology, information communication devices, electronic measurement, and a residual category.

	Dependent variable: Number of ICT patents	
	TC membership	Type of membership
Membership in TC	0.948**	
	0.367	
P-member in TC		0.347
		0.227
GDP per capita	0.000	0.000
	0.000	0.000
Industry value added (% of GDP)	−0.061*	−0.062*
	0.029	0.029
ICT % of service exports	0.033*	0.032*
	0.016	0.016
Num.Obs.	1107	936
RMSE	679.85	739.16
Time series	2004-2022	2004-2022

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Fixed effects: Country and year.

Clustered standard errors by country and year.

Model: Poisson.

Table E8: Relationship between membership in ISO/IEC JTC 1 and number of ICT patents.

F Robustness checks for Table 4

Table 4 showing control variables.

Table F9 shows all control variables for the main analysis.

	Dependent variable: ln(Dyadic trade) (UN Comtrade)				
	Baseline	Gravity	Gravity+R&D	Gravity+	Gravity++
ln(TC connections)	0.073***	0.084***	0.057***	0.036*	0.031
	(0.014)	(0.017)	(0.013)	(0.016)	(0.019)
Patents (exporter) as share of GDP			−0.013**		
			(0.003)		
Patents (importer) as share of GDP			−0.005**		
			(0.001)		
Regional trade agreement		−0.040	−0.093*	−0.069	−0.125+
		(0.042)	(0.040)	(0.041)	(0.056)
WTO dyad		−0.122**	−0.169**	−0.073	−0.112
		(0.040)	(0.044)	(0.061)	(0.110)
Democratic dyad				−0.002	0.008
				(0.026)	(0.027)
Preferential trade agreement				0.020	0.016
				(0.045)	(0.039)
Common currency				−0.172*	−0.178*
				(0.072)	(0.073)
Alliance					−0.022
					(0.076)
Strategic rivals					0.037
					(0.070)
Num.Obs.	402385	346684	229574	190173	125511
RMSE	1.38	1.38	1.26	1.25	1.14
Controls	No	Gravity	Gravity+R&D	Gravity+	Gravity++
Time series	2004-2022	2004-2021	2004-2021	2004-2015	2004-2011

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Fixed effects by dyad, country and year, clustered standard errors by dyad and year.
Zero imputation on dyads with missing on TC connections.

Table F9: Control variables for main analysis.

Table 4 using trade flow data from IMF

Table 4 made use of trade date from UN Comtrade. Table F10 shows that results are quite similar when using trade data from IMF instead, although this results in less data points, as the IMF data ends in 2020. The last two models give quite weak and insignificant coefficients, indicating that states' goodwill towards each other, measured in terms of democratic dyad, preferential trade agreements or common currency, may account for some of the effect of joint TC membership on trade.

	Dependent variable: ln(Dyadic trade) (IMF).				
	Baseline	Gravity	Gravity+R&D	Gravity++	Gravity+++
ln(TC connections)	0.051**	0.053**	0.035**	0.004	−0.016
	0.014	0.014	0.011	0.015	0.020
Patents (exporter) as share of GDP			−0.013***		
			0.003		
Patents (importer) as share of GDP			−0.008*		
			0.003		
Regional trade agreement		−0.072	−0.099*	−0.073	−0.129*
		0.045	0.043	0.045	0.053
WTO dyad		−0.053	−0.083+	−0.071	−0.125
		0.042	0.043	0.047	0.082
Democratic dyad				0.009	0.001
				0.032	0.029
Preferential trade agreement				0.004	0.002
				0.050	0.046
Common currency				−0.154*	−0.135
				0.068	0.074
Alliance					−0.053
					0.059
Strategic rivals					0.022
					0.084
Num.Obs.	298659	298659	205630	181238	118944
RMSE	1.29	1.29	1.18	1.18	1.07
Controls	No	Gravity	Gravity+R&D	Gravity+	Gravity++
Time series	2004-2020	2004-2020	2004-2020	2004-2015	2004-2011

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001
Fixed effects: Dyad, country and year.
Clustered standard errors by dyad and year.
Zero imputation on dyads with missing on TC connections.

Table F10: Using IMF trade data for dependent variable.

Table 4 using share of trade as dependent variable

Table 4 used as the dependent variable the total trade between countries in a given year (log transformed). Some scholars, e.g. Blind and von Laer (2022), use share of trade instead. Table F11 shows that the results are robust to such a specification.

	Dependent variable: Share of trade				
	Baseline	Gravity	Gravity+R&D	Gravity++	Gravity+++
ln(TC connections)	0.000 29*	0.000 30*	0.000 42*	0.000 50*	0.000 64*
	0.000 12	0.000 12	0.000 16	0.000 18	0.000 24
Patents (exporter) as share of GDP			−0.000 02+		
			0.000 01		
Patents (importer) as share of GDP			0.000 00		
			0.000 00		
Regional trade agreement		0.000 43*	0.000 52*	0.000 52*	0.000 62*
		0.000 16	0.000 20	0.000 19	0.000 22
WTO dyad		−0.000 11	−0.000 11	0.000 13	0.000 33
		0.000 22	0.000 26	0.000 35	0.000 19
Democratic dyad				−0.000 04	−0.000 04
				0.000 05	0.000 05
Preferential trade agreement				0.000 32	0.000 14
				0.000 45	0.000 35
Common currency				−0.000 10	0.000 03
				0.000 19	0.000 21
Alliance					0.002 33
					0.001 48
Strategic rivals					−0.005 18+
					0.002 54
Num.Obs.	402 385	346 684	229 574	190 173	125 511
RMSE	0.01	0.01	0.01	0.01	0.01
Controls	No	Gravity	Gravity+R&D	Gravity+	Gravity++
Time series	2004-2022	2004-2021	2004-2021	2004-2015	2004-2011

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001
Fixed effects: Dyad and year.
Clustered standard errors by dyad and year.
Zero imputation on dyads with missing on TC connections.

Table F11: Using share of trade as dependent variable.

Table 4 using a dichotomous independent variable

While the quantity of TC connections may be meaningful, another question is if sharing a TC membership in itself goes together with more trade. Table F12 shows that using TC membership as a dichotomous variable does not alter results.

	Dependent variable: Presence of TC membership (binary) (UN Comtrade)				
	Baseline	Gravity	Gravity+R&D	Gravity++	Gravity+++
Presence of TC connection	0.147***	0.177***	0.159***	0.137**	0.085+
	(0.031)	(0.038)	(0.029)	(0.033)	(0.041)
Patents (exporter) as share of GDP			−0.013**		
			(0.003)		
Patents (importer) as share of GDP			−0.005**		
			(0.001)		
Regional trade agreement		−0.037	−0.096*	−0.069	−0.124+
		(0.043)	(0.041)	(0.039)	(0.056)
WTO dyad		−0.116*	−0.169**	−0.072	−0.110
		(0.041)	(0.045)	(0.062)	(0.110)
Democratic dyad				−0.001	0.008
				(0.027)	(0.027)
Preferential trade agreement				0.018	0.016
				(0.045)	(0.039)
Common currency				−0.202*	−0.191*
				(0.072)	(0.078)
Alliance					−0.018
					(0.076)
Strategic rivals					0.031
					(0.070)
Num.Obs.	402385	346684	229574	190173	125511
RMSE	1.38	1.38	1.26	1.25	0.01
Controls	No	Gravity	Gravity+R&D	Gravity+	Gravity++
Time series	2004-2022	2004-2021	2004-2021	2004-2015	2004-2011

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Fixed effects: Dyad and year.

Clustered standard errors by dyad and year.

Table F12: Using a dichotomous independent variable.

Table 4 using country fixed effects

Table 4 used a rigorous high-dimensional fixed effects model which can be quite restrictive. Table F13 shows that the coefficients remain significant in the same direction when loosening up the fixed effects model by only controlling for country-year.

	Dependent variable: ln(Dyadic trade) (UN Comtrade)				
	Baseline	Gravity	Gravity+R&D	Gravity++	Gravity+++
ln(TC connections)	0.490***	0.383***	0.248***	0.149**	0.026
	(0.053)	(0.051)	(0.049)	(0.041)	(0.041)
Patents (exporter) as share of GDP			−0.015*		
			(0.005)		
Patents (importer) as share of GDP			−0.005*		
			(0.002)		
Regional trade agreement		2.105***	1.954***	2.362***	1.564***
		(0.149)	(0.151)	(0.157)	(0.140)
WTO dyad		0.371*	0.164	0.408*	0.752*
		(0.146)	(0.112)	(0.184)	(0.239)
Democratic dyad				0.193*	0.109
				(0.076)	(0.068)
Preferential trade agreement				0.823**	0.432+
				(0.227)	(0.225)
Common currency				1.125*	0.419
				(0.394)	(0.406)
Alliance					1.877***
					(0.154)
Strategic rivals					1.426*
					(0.499)
Num.Obs.	402385	346684	229574	190173	125511
RMSE	2.57	2.51	2.34	2.34	2.21
Controls	No	Gravity	Gravity+R&D	Gravity+	Gravity++
Time series	2004-2022	2004-2021	2004-2021	2004-2015	2004-2011

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Fixed effects: Country 1, country 2 and year.
Clustered standard errors by country 1, country 2 and year.
Zero imputation on dyads with missing on TC connections.

Table F13: Using country-year fixed effects, excluding dyad-fixed effects.

Table 4 using region fixed effects

In testing for an even less rigorous restriction, table F14 shows that the results hold also when controlling for region-year.

	Dependent variable: ln(Dyadic trade) (UN Comtrade)				
	Baseline	Gravity	Gravity+R&D	Gravity++	Gravity+++
ln(TC connections)	1.416***	1.263***	1.274***	1.076***	1.061***
	(0.052)	(0.037)	(0.065)	(0.038)	(0.037)
Patents (exporter) as share of GDP			−0.046		
			(0.029)		
Patents (importer) as share of GDP			−0.007		
			(0.004)		
Regional trade agreement		1.366**	1.434**	1.847***	1.423**
		(0.327)	(0.276)	(0.281)	(0.282)
WTO dyad		0.975**	0.431*	0.374*	0.413+
		(0.225)	(0.142)	(0.129)	(0.184)
Democratic dyad				−0.053	−0.052
				(0.147)	(0.116)
Preferential trade agreement				0.547+	0.216
				(0.240)	(0.143)
Common currency				0.924	0.505
				(0.588)	(0.631)
Alliance					1.198*
					(0.393)
Strategic rivals					1.940*
					(0.662)
Num.Obs.	399046	344892	229574	190173	125511
RMSE	3.27	3.22	3.02	3.10	3.06
Controls	No	Gravity	Gravity+R&D	Gravity+	Gravity++
Time series	2004-2022	2004-2021	2004-2021	2004-2015	2004-2011

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001
Fixed effects: Region for country 1, region for country 2 and year.
Clustered standard errors by region for country 1, region for country 2 and year.
Zero imputation on dyads with missing on TC connections.

Table F14: Using region-year fixed effects. Excluding dyad and country fixed effects.

Table 4 using 5-year period fixed effects

The results in table F15 further tests for over-controlling by using dyad-period-fixed effects. The results hold to this specification.

	Dependent variable: ln(Dyadic trade) (UN Comtrade)				
	Baseline	Gravity	Gravity+R&D	Gravity++	Gravity+++
ln(TC connections)	0.121**	0.145**	0.083**	0.073*	0.069
	(0.022)	(0.028)	(0.017)	(0.020)	(0.039)
Patents (exporter) as share of GDP			−0.014		
			(0.007)		
Patents (importer) as share of GDP			−0.009+		
			(0.003)		
Regional trade agreement		−0.084	−0.161+	−0.024	−0.162
		(0.080)	(0.063)	(0.041)	(0.080)
WTO dyad		−0.077	−0.132	−0.097	−0.039
		(0.089)	(0.097)	(0.098)	(0.112)
Democratic dyad				−0.064	0.004
				(0.052)	(0.047)
Preferential trade agreement				0.050	0.036
				(0.057)	(0.077)
Common currency				−0.225*	−0.302*
				(0.070)	(0.063)
Alliance					−0.026
					(0.094)
Strategic rivals					−0.028
					(0.197)
Num.Obs.	127945	99013	59849	70600	51975
RMSE	1.18	1.17	1.05	1.06	0.91
Controls	No	Gravity	Gravity+R&D	Gravity+	Gravity++
Time series	2004-2022	2004-2021	2004-2021	2004-2015	2004-2011

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Fixed effects: Region for dyad and 5-year period.
Clustered standard errors by dyad and 5-year period.
Zero imputation on dyads with missing on TC connections.

Table F15: Using region-dyad and 5-year period fixed effect.

Table 4 without zero imputation on dyads with missing on TC connection

Table 4 had imputations of zero on dyads that sported no TC connection. This is because when constructing a network, dyads with no edge will not be included in the dataset. Since the ISO webpage lists all countries that participate in TCs, it is natural to assume that they have no TC connection when this is missing. Table F16 runs the regression without imputations. The main results remain, except that the coefficient when controlling for R&D intensity becomes insignificant, as mentioned in the article.

	Dependent variable: ln(Dyadic trade) (UN Comtrade)				
	Baseline	Gravity	Gravity+R&D	Gravity++	Gravity+++
ln(TC connections)	0.059***	0.063***	0.029+	0.082**	0.060+
	(0.013)	(0.014)	(0.015)	(0.020)	(0.028)
Patents (exporter) as share of GDP			−0.014**		
			(0.004)		
Patents (importer) as share of GDP			−0.012**		
			(0.004)		
Regional trade agreement		−0.024	−0.026	−0.060	−0.176+
		(0.034)	(0.031)	(0.049)	(0.085)
WTO dyad		−0.135+	−0.167*	−0.095	−0.097
		(0.075)	(0.075)	(0.091)	(0.115)
Democratic dyad				−0.026	0.016
				(0.032)	(0.035)
Preferential trade agreement				0.010	0.010
				(0.049)	(0.045)
Common currency				−0.060	−0.060
				(0.061)	(0.061)
Alliance					−0.008
					(0.076)
Strategic rivals					−0.016
					(0.083)
Num.Obs.	176104	148518	129778	81490	46951
RMSE	1.05	1.06	0.99	0.94	0.84
Controls	No	Gravity	Gravity+R&D	Gravity+	Gravity++
Time series	2004-2022	2004-2021	2004-2021	2004-2015	2004-2011

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Fixed effects: Dyad and year.

Clustered standard errors by dyad and year.

Table F16: Without zero imputations on TC connection.

Table 4 with patents data from the World Intellectual Property Organization (WIPO)

The models in table 4 used data from PatentsView, which is based on data from the U.S. Patent & Trademark Office (USPTO). While USPTO is found to be the most appropriate patent database for studies on global innovation patterns (Kim and Lee 2015). However, as with any national registration office, it may be biased towards domestic residents or likewise. Therefore, table F17 illustrates how the results in models in table 4 are consistent using patent data from WIPO instead of USPTO.

	Dependent variable: ln(Dyadic trade) (UN Comtrade)				
	Baseline	Gravity	Gravity+R&D	Gravity+	Gravity++
ln(TC connections)	0.073***	0.084***	0.056***	0.036*	0.031
	(0.014)	(0.017)	(0.011)	(0.016)	(0.019)
Patents (exporter) as share of GDP			0.000		
			(0.001)		
Patents (importer) as share of GDP			−0.001		
			(0.001)		
Regional trade agreement		−0.040	0.004	−0.069	−0.125+
		(0.042)	(0.028)	(0.041)	(0.056)
WTO dyad		−0.122**	−0.082	−0.073	−0.112
		(0.040)	(0.060)	(0.061)	(0.110)
Democratic dyad				−0.002	0.008
				(0.026)	(0.027)
Preferential trade agreement				0.020	0.016
				(0.045)	(0.039)
Common currency				−0.172*	−0.178*
				(0.072)	(0.073)
Alliance					−0.022
					(0.076)
Strategic rivals					0.037
					(0.070)
Num.Obs.	402385	346684	141426	190173	125511
RMSE	1.38	1.38	1.02	1.25	1.14
Controls	No	Gravity	Gravity+R&D	Gravity+	Gravity++
Time series	2004-2022	2004-2021	2004-2021	2004-2015	2004-2011

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Fixed effects by dyad, country and year, clustered standard errors by dyad and year.

Zero imputation on dyads with missing on TC connections.

Table F17: With only Gravity controls, but same time series.

Table 4 with only Gravity controls, but same time series

The models in table 4 had a smaller time series when including control variables, due to the availability of data. To check whether the results might be driven by smaller time series rather than the inclusion of the extra control variables, table F18 shows models with shorter time series without the given control variables. The coefficient for TC connections is significant and positive across specifications, indicating that the coefficient is rendered insignificant in the primary models due to the control variables, and not the shorter time series.

	Dependent variable: ln(Dyadic trade) (UN Comtrade)				
	Baseline	Gravity	Gravity+R&D	Gravity	Gravity
ln(TC connections)	0.073***	0.084***	0.057***	0.071**	0.056*
	(0.014)	(0.017)	(0.013)	(0.017)	(0.021)
Patents (exporter) as share of GDP			−0.013**		
			(0.003)		
Patents (importer) as share of GDP			−0.005**		
			(0.001)		
Regional trade agreement		−0.040	−0.093*	−0.174**	−0.228**
		(0.042)	(0.040)	(0.055)	(0.055)
WTO dyad		−0.122**	−0.169**	−0.071	−0.085
		(0.040)	(0.044)	(0.051)	(0.093)
Num.Obs.	402385	346684	229574	228249	150324
RMSE	1.38	1.38	1.26	1.29	1.18
Controls	No	Gravity	Gravity+R&D	Gravity	Gravity
Time series	2004-2022	2004-2021	2004-2021	2004-2015	2004-2011

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001
Fixed effects by dyad, country and year, clustered standard errors by dyad and year.
Zero imputation on dyads with missing on TC connections.

Table F18: With patent data from WIPO.

Table 4 using a Generalized Methods of Moments model

The Generalized Method of Moments (GMM) models are often used for dynamic panel data where the number of groups is smaller than the time series, when the researcher wants to control for endogeneity. Because GMM models allows the moments conditions to exceed the number of parameters, the researcher can include lagged dependent variables as internal instruments along with lagged dependent variables as regressors, essentially controlling for the persistence of the dependent variable (Arellano and Bond 1991). This technique, though not immune to critique given its reliance on a set of strong assumptions, remains widely adopted by numerous researchers, particularly those within the field of economics, as a means to elucidate causal relationships when the dependent variable exhibits high persistence. In this specification, I use the System GMM estimator, as this has been shown to be more robust for unbalanced panels than the difference estimator (Blundell and Bond 1998).

Because the inclusion of time dummies sometimes creates a singular matrix which prevents the estimation, the second and third model incorporates only dyad-fixed effects. While many of the models do show a significant coefficient for TC connections, the direction of the coefficient varies. Moreover, only the Gravity++ model has remotely valid instruments, according to the Sargan-Hansen test[19]. In this model, the coefficients for TC connections are invalid, leading to the conclusion that there is no clear indication that causality goes from joint TC membership to larger trade volumes.

[19]Neither the model Gravity++, not any of the other models, actually pass the Sargan-Hansen test, having p-values above 0.05. This is typical for models with a high number of observations, and may not necessarily mean that the instruments are invalid (Kiviet and Kripfganz 2021), but should still be considered a weakness.

	Dependent variable: ln(Dyadic trade) (UN Comtrade)				
	Baseline	Gravity	Gravity+R&D	Gravity++	Gravity+++
Lag ln(Dyadic trade), 1	0.524***	0.638***	0.654***	0.181*	0.634***
	(0.006)	(0.004)	(0.004)	(0.091)	(0.010)
Lag ln(Dyadic trade), 2	0.237***	0.339***	0.377***	0.104***	0.366***
	(0.005)	(0.004)	(0.004)	(0.024)	(0.009)
ln(TC connections)	0.156***	0.082***	−0.049***	−0.008	0.011
	(0.009)	(0.010)	(0.011)	(0.013)	(0.016)
Lag ln(TC connections), 1	0.137***	−0.052***	−0.022*	−0.015	−0.030*
	(0.009)	(0.009)	(0.009)	(0.012)	(0.013)
Regional trade agreement		0.090***	−0.104***	0.040	−0.030+
		(0.012)	(0.008)	(0.038)	(0.015)
WTO dyad		0.393***	−0.247***	0.084+	0.003
		(0.032)	(0.026)	(0.046)	(0.012)
Patents (exporter) as share of GDP			−0.006***		
			(0.001)		
Patents (importer) as share of GDP			−0.003***		
			(0.000)		
Democratic dyad				0.038	−0.029**
				(0.025)	(0.009)
Preferential trade agreement				0.016	0.034+
				(0.016)	(0.019)
Common currency				0.008	−0.083***
				(0.041)	(0.018)
Alliance					0.004
					(0.019)
Strategic rivalry					0.067
					(0.043)
Num.Obs.	409627	473328	327762	82757	103584
Controls	No	Gravity	Gravity+R&D	Gravity+	Gravity++
Time series	2004-2022	2004-2021	2004-2021	2004-2015	2004-2011
Fixed effects	Dyad & Year	Dyad	Dyad	Dyad & Year	Dyad & Year
Sargan-Hansen p-value	< 2.22e-16	< 2.22e-16	< 2.22e-16	0.003	4.3781e-11
Autocorrelation test (2) p-value	< 2.22e-16	< 2.22e-16	< 2.22e-16	< 2.22e-16	< 2.22e-16

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Clustered standard errors by dyad and year.

Model: Generalized Methods of Moments (GMM)

Table F19: With a Generalized Methods of Moments model.

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