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## Article

# Exploring the link between Asia and Europe connectivity and sustainable development

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## Exploring the link between Asia and Europe connectivity and sustainable development



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### ABSTRACT

Asia and Europe have made connectivity between people, businesses and institutions a top political priority in the frame of the Asia-Europe Meeting (ASEM) intergovernmental cooperation forum. In the ASEM context, policy leaders agreed that improving connectivity between countries should contribute to achieve the Sustainable Development Goals. Connectivity is a complex concept involving multiple dimensions. Yet in order to provide clear data-driven evidence to support policymaking on Asia-Europe sustainable connectivity, this concept calls for a measurement framework. The mismatch between the politically adopted definition of sustainable connectivity and existing metrics, led to the development of the two indexes described in this paper. Taken together, they help to explore and understand the relationship between connectivity and sustainability. The results suggest that connectivity and sustainability policy agendas have the potential to mutually reinforce one another. Higher values in connectivity are strongly associated with higher values in the social dimension of sustainability. There are evident gaps between European and Asian nations in terms of connectivity and sustainability. However, both continents are underpinned by the common challenge of reducing the environmental impacts of connectivity without neglecting economic/financial sustainability aspects, while at the same time ensuring that benefits will accrue to society at large.

### Introduction

Enhancing connections between Asia and Europe for peace, stability, economic prosperity and sustainable and inclusive development has become a major agenda item in high-level political and diplomatic forums between the two continents. Asia and Europe have made mutual connectivity between people, businesses and institutions a top political priority with a firm commitment to work towards Sustainable Development Goals (SDGs). Sustainable connectivity is the new name of the game. The concept has been coined in the frame of the Asia-Europe Meeting (ASEM) (InfoBoard, 2019), an intergovernmental process to foster political dialogue and cooperation between 51 European and Asian nations, including Australia and New Zealand and two institutional partners: the European Union (EU) and the Association of Southeast Asian Nations (ASEAN) (Box 1).

**Box 1** List of members of the Asia-Europe Meeting (ASEM). In 2017, political leaders endorsed a joint definition of connectivity (ASEM, 2017) underlying that Asia-Europe relations must contribute to the materialisation of the principles, goals and targets of the 2030 Agenda for Sustainable Development (United Nations, 2030). They also agreed to mainstream connectivity in political, economic, digital, institutional, and people-to-people dimensions, into all ASEM cooperation frameworks (ASEM, 2016). Moreover, the EU has put forward sustainable connectivity in its 2018 'Connecting Europe and Asia – Building blocks for an EU Strategy'. The EU strategy has set out an approach to connectivity which is sustainable, comprehensive and rules-based, with policies that should be economically, fiscally, environmentally and socially sustainable in the long term (European Commission, 2018).

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Connectivity strategies can be found in a number of other intergovernmental organisations. The Asia-Pacific Economic Cooperation (APEC) was one of the first to issue a formal connectivity strategy in 2015, the *APEC Connectivity Blueprint* (APEC, 2015), which aims “to reach a seamlessly and comprehensively connected and integrated Asia-Pacific through the pillars of Physical Connectivity, Institutional Connectivity and People-to-People Connectivity”.

Meanwhile, the Association of Southeast Asian Nations (ASEAN) has a *Masterplan on ASEAN Connectivity*, which aims “to achieve a seamlessly and comprehensively connected and integrated ASEAN that will promote competitiveness, inclusiveness, and a greater sense of Community” (ASEAN, 2025). It focuses on five key areas, sustainable infrastructure, digital innovation, seamless logistics, regulatory excellence, and people mobility. This is similar to the ASEM definition, although with arguably less focus on sustainable development, particularly in environmental and social aspects.

The Chinese Belt and Road Initiative (BRI) shows its multi-billion dollar grand plan to strengthen China’s connections to Asia, Europe and Africa. Although the BRI emphasises mutual gain, it is a Chinese investment programme rather than a multilateral connectivity agreement.

Connectivity, in the international context, is effectively a rebranding of globalisation and has become a buzzword for intergovernmental organisations. Globalisation became a hot topic from the late 1980s onwards, and several definitions can be found in the literature (Rennen and Martens, 2003; Mikalauskiene et al., 2016). The term globalisation was used to describe not only the process of intensification of external influences on economic, political, social and cultural domains, but also the formation of transnational structures and single global markets. Yet while globalisation has become a loaded term which is associated with aggressive capitalism and the homogenisation of cultures (Scholte & Scholte, 2005), the term “connectivity” is less associated by these issues.

Nevertheless, there are some drawbacks associated with connectivity. At the 2019 World Economic Forum, world leaders discussed the problems of an ever more connected world with perceived inequalities which have fuelled populism and distrust (Schwab, 2018). Moreover, the COVID-19 pandemic has clearly shown the risks of connectivity, and the need for safeguards and careful reflection on its impacts.

The politically adopted definition of connectivity for the Asia-Europe context (ASEM, 2017) is used as a basis for this study. It casts connectivity as a broad concept, ranging from physical infrastructure (transport, energy and information and communication technologies), financial cooperation and economic/trade links to political, institutional and human connectivity, including education and research, tourism and cultural exchanges. The definition underlines the link between connectivity and sustainable development, while upholding the spirit of peace, development, cooperation, mutual benefit, a level playing field, inclusiveness and fairness.

Clearly, connectivity is a complex concept, involving multiple dimensions which may vary from one definition to the next. Yet in order to support effective evidence-based international policymaking, connectivity must be explored and measured, to the extent possible. The tools used in this study, composite indicators (or indexes) are well-established approaches in policymaking, advocacy and public debate. They aim to measure complex multidimensional concepts which are not directly measurable and cannot be captured by a single indicator—well-known examples include the Human Development Index (United Nations Development Programme, 2018) and the Environmental Performance Index (Hsu & Zomer, 2016). Composite indicators make large and complex data sets accessible by summarising patterns across a number of indicators which may be otherwise invisible. They are complementary tools that provide a ‘big picture’ overview and can effectively stimulate public debate and policy discussions (OECD and JRC, 2008).

Composite indicators measuring globalisation and connectivity can already be found in the literature since at least the year 2000 (Martens et al., 2015). Among the most well-known of these are the A.T. Kearney/Foreign Policy Globalization Index (Kearney, 2006) and the KOF Index of Globalization (Gygli et al., 2018). Other globalisation indexes include the CSGR Globalisation Index (Lockwood & Redoano, 2005), the Maastricht Globalisation Index (Figge & Martens, 2014), the McKinsey Global Institute Connectedness Index (Manyika et al., 2014), the DHL Global Connectedness 2016 (Ghemawat & Altman, 2016), the New Globalisation Index (Vujakovic, 2009) and the A.T. Kearney Index of Global Cities (ATKearney, 2017). All of these indexes, with the exception of the latter, which focuses on cities, assess globalisation at the national level, with a particular focus on economic, communication and digital links, as well as movement of people in terms of tourism and migration. Political and institutional links are also present, but to a lesser extent, while social aspects such as culture, education and research are poorly addressed. Notably, the link to sustainable development is largely overlooked in existing indexes: the Maastricht Globalisation Index is the first to include the environmental domain, by including the Ecological Footprint of a country’s trade as a share of its biocapacity (Figge & Martens, 2014). The issue of sustainable globalisation is discussed in the literature (Borghesi and Vercelli, 2003; Martens and Raza, 2010), but specific measurement frameworks are still seldom addressed (Martens et al., 2015).

The mismatch between the politically adopted definition of connectivity and the existing globalisation indexes led to the development of a new assessment framework presented in this paper, consisting of a Connectivity Index and a Sustainability Index. These indexes aim to jointly measure sustainable connectivity with the following distinctions: a) they follow the broader ASEM definition of connectivity, which puts specific emphasis on political and institutional domains as well as on people-to-people connections; b) they link connectivity to sustainable development, in particular to the SDGs, and; c) they cover a specific group of European and Asian countries (ASEM) which have a particular interest in studying their interconnections—this led to the use of bilateral data specifying flows and connections between country pairs in the ASEM group. This indicator framework and indexes are interactively available at the *ASEM Sustainable Connectivity Portal*<sup>1</sup>, an online data platform. The present article aims to bring these tools to the attention of the academic community, as well as providing a deeper insight and analysis into the results. Specifically, the overall patterns of connectivity are investigated, and its relationship with sustainable development and other factors such as land area, wealth and economic output.

Overall, this work aims to support Asian and European countries with an overall picture and framework to support the ongoing policy debate on sustainable connectivity. This paper proposes a new assessment framework for sustainable connectivity and explores the relationship between connectivity and sustainability, including the SDGs. This is described in the following Methodology section, while in the Results section, the results are described and their implications analysed. Finally, some summary comments and relevant policy messages are given in the Conclusions section.

## Methodology

Given the multidimensional and non-measurable nature of sustainable connectivity, a composite indicator approach was used. Properly constructing a composite indicator is a delicate process, including a careful definition of the concept, a thorough review of existing indexes and available data, expert and stakeholders consultation, statistical analysis, robustness checks, visualisation and interpretation of results (OECD and JRC, 2008).

<sup>1</sup> <https://ec.europa.eu/asem-sustainable-connectivity>

Connectivity can be measured by using either *intensive* or *extensive* approaches. Intensive connectivity measures a country's connectivity in relation to its size, while extensive connectivity measures a country's connectivity in absolute terms. For instance, a country's trade in goods can either be measured in absolute terms by simply considering its imports and exports with other countries (extensive approach), or by accounting for its size by dividing these flows by its GDP (intensive approach). In order to have an objective comparison across small and large countries, the scaling of variables according to an appropriate size measure, e.g. population, income, etc., is usually required and this was the approach adopted in this study.

### Conceptual framework

The basis of sustainable connectivity is a definition which was agreed at high political level across Asia and Europe. By following this definition, the resulting framework is ensured to be politically aligned and therefore highly relevant to policymaking in the Asia-Europe context. Moreover, the framework and indicators that were eventually selected in this work were assembled with the engagement of a number of international experts and stakeholders who were invited to attend two dedicated consultation workshops. The experts were selected based on their expertise in particular fields of connectivity and sustainability, as well as to represent a balance between European and Asian countries, with the intention of including a variety of viewpoints and improving the robustness and acceptability of the framework.

The definition of connectivity includes economic, people-to-people, political/security, institutional and physical types of connectivity. Cutting across all of these concepts are the notions of fairness, openness, mutual benefits, and the fact that ASEM connectivity should contribute to the 2030 Agenda for Sustainable Development.

The inclusion of sustainability in the framework required careful consideration. The SDGs are very broad, and different forms of connectivity may contribute positively or negatively to SDGs. Indeed, some (arguably most) forms of connectivity may have a mixed effect, e.g. contributing positively to social sustainability but negatively to environmental sustainability. It is therefore very difficult to identify a basket of uniquely sustainable forms of connectivity. The final approach that was adopted was to separate connectivity and sustainability, and build two separate indexes—see [Table 1](#).

The Connectivity Index provides a standardized measure that captures a wide range of cross-border connectivity outcomes and facilitators. It is divided into physical, economic/financial, political, institutional and people-to-people domains, comprising a total of 30 indicators. Connectivity is measured relative to the size of each country (using e.g. value of trade per unit GDP) allowing an objective and policy-relevant comparison across small and large countries. The Sustainability Index, on the other hand, measures the state of a country's sustainability, and focuses on those aspects that are expected to be more strongly linked to connectivity and global challenges. The index is structured into three pillars following the 'triple bottom line' framework – environmental, social and economic/financial sustainability, including a total of 19 indicators. The Sustainability Index framework incorporates indicators related to 11 out of 17 SDGs ([Fig. 1](#)).

Together, the two indexes are used to assess where countries lie in terms of sustainable connectivity, and explore the relationship between connectivity and sustainability. This arrangement has the advantages that it avoids the controversial problem of defining which types of connectivity are sustainable, it delineates high levels of connectivity from high levels of sustainability and vice versa, and it allows an analysis of the relationship between connectivity and sustainability, which is not well explored in the literature. Indeed, it can form the basis of more detailed impact assessments of connectivity on sustainability.

The Connectivity Index was also compared to the *Sustainable Development Goals Index* and Dashboards (SDG Index) ([Sachs et al., 2018](#)) to give a detailed assessment of connectivity on individual SDGs. The SDG Index provides an assessment of countries' performance on each of the 17 SDGs using a total of 88 indicators. The SDG Index score reflects the countries' distance from achieving the SDGs and varies between 0 (worst performer) to 100 (best performer).

### Indicator selection and data collection

The selection of indicators and construction of the indicator framework was an extensive and iterative process, drawing on numerous international data sources and original research. Roughly, the process followed the schematic in [Fig. 2](#): starting from the ASEM definition of connectivity and a literature review, a pool of about 200 candidate indicators was identified. These were then checked against six criteria, as well as subjected to expert evaluation and statistical analysis.

The criteria that were used to accept or reject indicators for all pillars and both indexes (prior to expert opinion and full statistical analysis) were as follows.

- **Relevance:** Above all, indicators must be relevant to the concept of ASEM connectivity, to the index and to the pillar in which they reside.
- **Data availability and accessibility:** All indicators were required to have a high and recent data coverage that spans all or nearly all ASEM countries (at least 80%), and to be publicly available to the extent possible.
- **Value added:** Indicators should measure distinct concepts and overlap (conceptually) as little as possible. Having multiple overlapping indicators adds little information to the framework but increases its complexity and lowers its usefulness.
- **Data reliability:** Data should come from a reliable source, ideally with a transparent methodology behind its production.
- **Interpretability:** Indicators should be meaningful and interpretable in order to be an accessible tool for policymakers and researchers.
- **Differentiation:** The indicator should be able to differentiate between countries by having a range of values across countries (i.e. rather than having a large number of countries with the same value, for example).











In general, data was obtained for the latest available year, with the implication is that the indexes use data from different years (typically 2016/2017, with some few exceptions). This is necessary because aligning the data from the same year would involve discarding a considerable amount of relevant and recent indicators.

A particularity of measuring connectivity is that it suggests the use of bilateral data, i.e. data which measures connections between pairs of countries. This data can be analysed at the bilateral level ([Neves et al., 2019](#); [Becker, 2018](#)), but also integrated into the connectivity index—in total, 16 bilateral data sets were included. To include this data, it was necessary to build a unilateral indicator from each bilateral data set. This was done by summing the connections of each country with all other countries. In cases where the connections were directional (e.g. trade), the sum included connections in both directions, where inflows and outflows were weighted equally ([Becker, 2018](#)).

### Aggregation (denominators, outliers, normalisation)

Prior to aggregation, indicators are denominated, treated for outliers and normalised onto a common scale following the widely-accepted methodology of building composite indicators ([OECD and JRC, 2008](#)).

**Table 1**  
Description and structure of the ASEM Sustainable Connectivity Indexes.

Index	Domain	Description	Indicators
<b>Connectivity Index</b> 	 Physical	Measures physical infrastructure in terms of transport, energy and information and communications technology, mainly between countries rather than domestic infrastructure.	1. Logistics Performance Index 2. International flights passenger capacity * 3. Liner Shipping Connectivity Index 4. Border crossings 5. Trade in electricity * 6. Trade in gas * 7. Average connection speed 8. Population covered by at least a 4G mobile network 9. Trade in goods * 10. Trade in services 11. Foreign direct investment * 12. Personal remittances (received and paid) * 13. Foreign portfolio investment liabilities and assets 14. Embassies network * 15. Participation in international intergovernmental organisations 16. United Nations voting alignment *
	 Economic/ Financial	Measures the trade in goods and services and financial flows.	17. Cost to export/import 18. Mean tariff rate 19. Technical barriers to trade 20. Signatory of TIR (International Road Transports) Convention 21. Regional trade agreements * 22. Visa-free or visa-on-arrival *
	 Political	Measures political relations with other countries.	23. International student mobility in tertiary education * 24. Research outputs with international collaborations * 25. Patents with foreign co-inventor *
	 Institutional	Measures the regulatory environment, namely measures to facilitate trade and investment as well as agreements to facilitate the mobility of people.	26. Trade in cultural and creative services 27. Trade in cultural goods * 28. Tourist arrivals at national borders 29. Migrant stock * 30. Common language users *
	 People-to-people	Measures the mobility of people in education, tourism and migration, the collaboration in research and innovation, and the exchange of culture and communication.	31. Renewable energy in total final energy consumption 32. Primary energy use per capita 33. CO <sub>2</sub> emissions per capita 34. Domestic material consumption per capita 35. Net forest loss 36. Population living below the international poverty line 37. Palma Index 38. Tertiary graduates 39. Freedom of the press 40. Tolerance for minorities 41. Presence of international non-governmental organisations 42. Corruption Perceptions Index 43. Female labour-force participation 44. Women's participation in national parliaments 45. Public debt as a percentage of GDP 46. Private debt, loans and debt securities as a percentage of GDP 47. GDP per capita growth 48. Research & Development (R&D) expenditure as a percentage of GDP 49. Proportion of youth not in education, employment or training
<b>Sustainability Index</b> 	 Environmental	Measures the domestic environmental status of a country.	
	 Social	Measures elements related to poverty, inequality, education, gender balance and inclusive and open societies.	
	 Economic/ Financial	Measures financial sustainability, economic growth, research expenditure and youth unemployment.	

\*Indicators for which bilateral data is available, i.e. data which measures connections and flows between pairs of countries of the ASEM group.

Correspondence between the SDGs and the ASEM Sustainability Index				
<b>Environmental</b>				
<b>Social</b>				
<b>Economic/Financial</b>				

Fig. 1. Sustainable Development Goals addressed in the ASEM Sustainability Index.

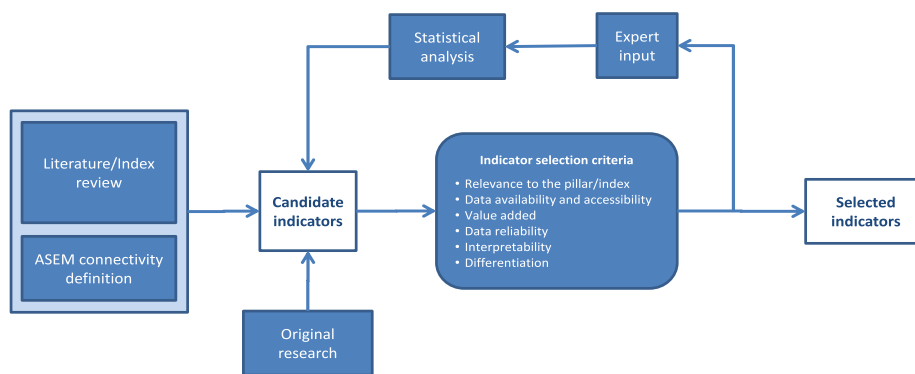


Fig. 2. Indicator selection flowchart.

Indicators were scaled so that each had a minimum of zero and a maximum of 100, in order to make them comparable. Finally, they were aggregated by taking weighted arithmetic means, following the hierarchical structure shown in Table 1. Equal weighting was used, following the ‘budget allocation’ method, in which the group of experts was engaged in specifying weights at the pillar level during a workshop. The results of this exercise revealed a fairly equal preference for each pillar.

Full details of the methodology applied to aggregate the indicators into an index can be found in Becker (2018).

*Statistical analysis*

A statistical analysis was performed on both indexes which aimed to (a) check the internal consistency of the data set using correlation analysis, and (b) assess the robustness of the resulting scores using uncertainty and sensitivity analysis.

Examining the correlations of indicators with the overall indexes, most connectivity indicators correlate well with the Connectivity Index, with the exception of Technical Barriers to Trade (TBTs) which is negative. On closer examination of the data, this is because EU countries have a large number of TBTs compared to other ASEM countries, which runs contrary to other indicators in the same pillar, such as import/export costs and visas. While this conflict of direction is not ideal from a statistical perspective, it was decided that TBTs are an important aspect of connectivity that should not be left out of the framework, so they were retained. Other indicators such as liner shipping connectivity index, foreign direct investment, personal remittances, and embassies network, have low or slightly negative correlations. Again, in the ideal case, all indicators would have a strong positive correlation. But recall that the indicator framework

here is not only for building aggregate measures, but also to inform users at the indicator level. For this reason, and the fact that the indicators were deemed to be important to the concept, the indicators were retained in the framework.

Throughout this study, correlations between indicators are frequently used to observe patterns and connections between different variables. Correlation is a statistical measure which measures the strength of the linear relationship between two variables. A high correlation value suggests that higher values of one variable are usually associated with higher values of the other, or vice versa.

This implies that there is a relationship between the two variables. It is important to be clear, however, that the existence of a relationship does not necessarily imply that one variable causes the other. Correlation may be evidence of such causal links, but it may also be due to the two variables causing or being caused by a third variable. In this study, correlations are taken to be hints that an underlying relationship may exist, while a more detailed causal analysis is left for future work.

**Results**

*Asia-Europe connectivity*

Fig. 3 presents a summary of the Connectivity Index scores, broken down into their different dimensions. European countries are more connected than Asian ones, with the notable exception of Singapore. This difference is the most stark in political connectivity, where European countries tend to participate more in intergovernmental organisations and are more aligned in their voting patterns in United Nations General Assembly. In Asia, only Japan and Korea achieve the same average score of European countries in the political domain, which is largely due to their extensive networks of embassies and the

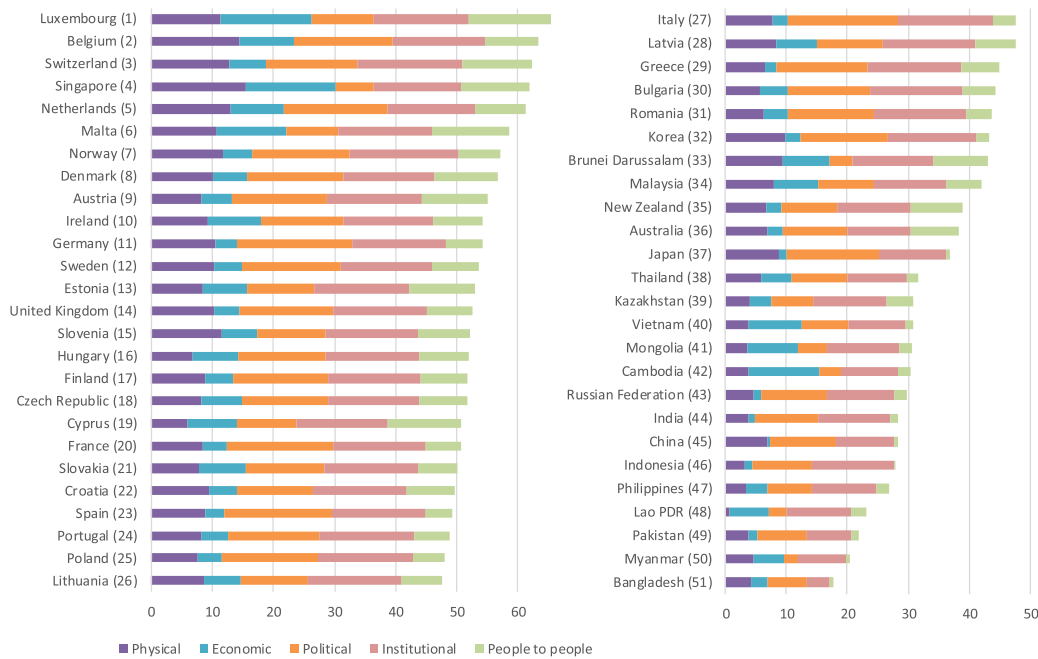


Fig. 3. Connectivity Index overall scores.

fact that they tend to vote more towards the unified European pattern in United Nations resolutions than other Asian countries.

In the institutional domain, European countries have similar high scores, as a result of lower barriers to trade in terms of costs and trade agreements as well as smoother flows of people thanks to visa policy arrangements. For EU Member States, this can be largely explained by the Single Market and the associated free movement of goods, services, capital and people. In Asia, only Korea and Singapore have comparable scores to European countries. In fact, Korea has the largest number of connections via trade agreements and Singapore scores high for its visa openness policy.

The most connected countries are small in population size and land area, with high income per capita, and typically European, with the exception of Singapore – see Fig. 4. The smaller internal markets of small countries compel them to look outwards for trade, labour and investment, while larger countries are more self-sufficient. Domestic markets in larger economies like Germany, United Kingdom, France, Italy, China, Japan and Korea play a very significant role, making larger countries relying less on international suppliers (Weiß et al., 2018).

### Connectivity and sustainability

Taken together, the Connectivity Index and the Sustainability Index help to understand the relationship between the levels of connectivity and sustainability of ASEM countries. While causal relationships will require further research, some patterns of association can be established.

Overall, higher levels of connectivity are associated with higher levels of sustainability ( $r = 0.57, 99.9\% \text{ sig.}$ ) – see Fig. 5. However, there are several exceptions. Singapore and Luxembourg are both intensively-connected countries with sustainability scores below the ASEM median, whereas Switzerland has a similar level of connectivity, but is also the most sustainable country. In Asia, some of the most connected countries (Malaysia and Brunei) also have very low sustainability scores, driven overall by low social sustainability but also little use of renewable energy. The two countries with the lowest connectivity scores, Myanmar and Bangladesh, have sustainability scores above

the ASEM median, mainly due to high environmental sustainability (low carbon dioxide emissions and domestic material consumption per capita).

Overall however, the positive relationship between connectivity and sustainability is largely driven by the social dimension of sustainability: the two are strongly correlated ( $r = 0.85, 99.9\% \text{ sig.}$ ). This implies that better connected countries are associated with better living conditions, more inclusive societies, greater levels of education, less corruption perception, more freedom of the press and more presence of international non-governmental organisations (NGOs).

On the other hand, the environmental dimension of sustainability shows no statistically significant relationship with connectivity. Although wealthier and more connected countries tend to have more progressive environmental policies, they also have higher per capita carbon dioxide emissions and domestic material consumption. If the analysis is exclusively focused on Asian countries, these relations are more pronounced, and connectivity is negatively associated with environmental sustainability. With respect to economic/financial sustainability, while better connected countries have greater research and development (R&D) expenditure and lower rates of young people not in education or unemployed, they also typically have higher rates of private debt and a lower rate of GDP per capita growth.

From a regional perspective, European countries tend to occupy the upper right quadrant of Fig. 5 (main plot), with higher connectivity and sustainability scores, while most Asian countries appear in the lower left quadrant, with lower connectivity and sustainability scores. The exception is Singapore.

Of the three sustainability dimensions, social sustainability has the largest gap in average scores between Asian countries (lower) and European (higher). The difference is largest in terms of poverty levels and freedom of the press. When considering the environmental and economic/financial sustainability dimensions, the average gap between the two regions closes. Asian nations like Myanmar, Pakistan, Bangladesh, Philippines and Laos take the lead in the environmental dimension, which are also the less connected countries according to the Connectivity Index. These countries present the lowest values of per capita CO<sub>2</sub> emissions and domestic material consumption. On the economic/financial dimension, Myanmar and Bangladesh are

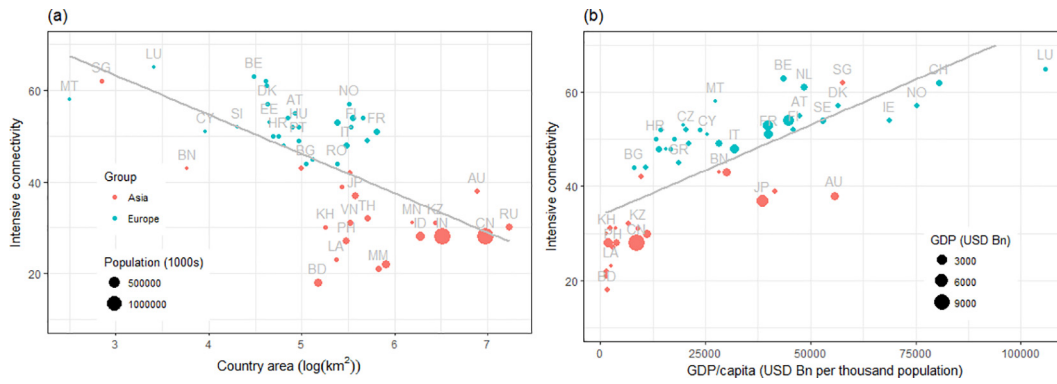


Fig. 4. Relationship between the Connectivity Index and a) Country area and b) GDP/capita.

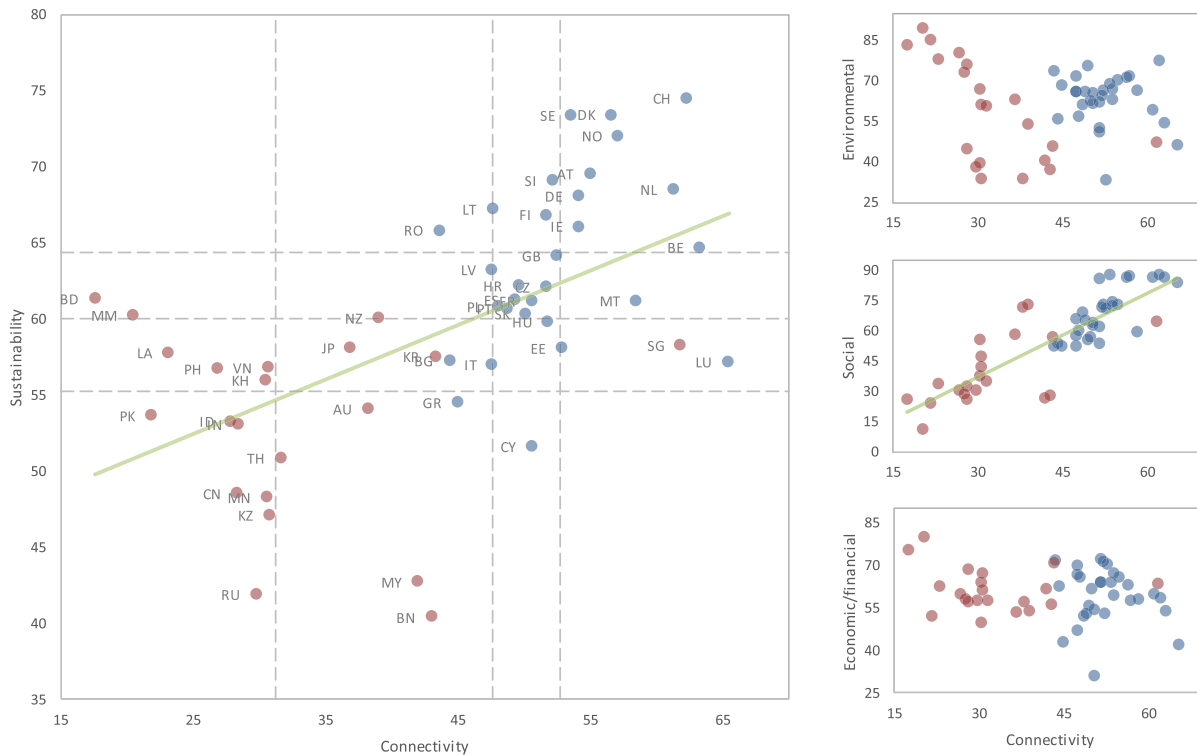


Fig. 5. Relationship between the Connectivity Index and the Sustainability Index and its constituents: Social, Environmental and Economic/Financial. (Dotted lines represent the median and 25th and 75th percentiles. Red dots refer to Asian countries, blue dots to European countries.) (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

ranked first, followed by European countries like the Czech Republic, Romania and Slovenia.

While the sustainability index here focuses on connectivity-related elements of sustainable development, the analysis can be extended by considering the Sustainable Development Goals Index and Dashboards (SDG Index) (Sachs et al., 2018), which considers all of the 17 SDGs. Table 2 shows that 11 out of 17 goals are positively and significantly associated with connectivity, with more than half of those referring to the social dimension of sustainability. There are three goals which are very strongly related to connectivity. This is the case for Goal 3: Good Health and Well-being, meaning that better connected countries are associated with better health conditions. Exceptions are for Australia, New Zealand, Japan and Korea which score above 90 points in Goal 3, but are in the bottom middle positions of the Connectivity Index. As for Goal 9: Industry, Innovation and Infrastructure, there are some

overlaps of indicators considered on both the Connectivity Index and on this particular goal (Logistics Performance Index, ICT-related infrastructure and scientific articles), which then explains the very high correlation. With respect to Goal 11: Sustainable Cities and Communities, the indicators considered on the SDG Index relate to air pollution, drinking water, public transport and household rent overburden, which leads to the observation that better connected countries are associated with better urban living conditions.

There is a highly negative association between connectivity and Goal 12: Responsible Consumption and Production, showing that better connected countries make greater impacts on the environment due to their consumption and production patterns. In particular, this goal includes indicators related to waste, wastewater and emissions (SO<sub>2</sub> and nitrogen from both production and embodied in trade). In fact, Luxembourg ranks first in the Connectivity Index, but takes the bottom

**Table 2**

Strength of association (correlation coefficients) between the ASEM Connectivity Index and the 17 Sustainable Development Goals included in the SDG Index.

SDG Index Goals	ASEM Connectivity Index
GOAL 1: No Poverty	0.52
GOAL 2: Zero Hunger	0.74
GOAL 3: Good Health and Well-being	0.87
GOAL 4: Quality Education	0.71
GOAL 5: Gender Equality	0.58
GOAL 6: Clean Water and Sanitation	–
GOAL 7: Affordable and Clean Energy	0.72
GOAL 8: Decent Work and Economic Growth	0.69
GOAL 9: Industry, Innovation and Infrastructure	0.77
GOAL 10: Reduced Inequality	0.5
GOAL 11: Sustainable Cities and Communities	0.81
GOAL 12: Responsible Consumption and Production	–0.77
GOAL 13: Climate Action	–
GOAL 14: Life Below Water	–
GOAL 15: Life on Land	–
GOAL 16: Peace and Justice Strong Institutions	0.68
GOAL 17: Partnerships to achieve the Goal	–

\*All correlations significant at the 99.9% level, except those marked with dashes.

position in Goal 12. The Philippines (47th place in the Connectivity Index) tops the list for Goal 12, scoring two times higher than Luxembourg.

## Conclusions

This paper presented an analysis of international connectivity between 51 countries following the definition adopted by ASEM partners, and its links with sustainable development. Overall, the study suggests that connectivity and sustainable development policy agendas have the potential to mutually reinforce one another. In particular, higher values in connectivity are strongly associated with higher values in the social dimension of sustainability. As a result, better connected countries are associated with lower levels of poverty, more students in tertiary education, more freedom of the press, are more inclusive to minorities, have a greater presence of NGOs and lower levels of corruption perception. The data also shows that smaller, wealthier countries are the most intensively connected—likely due to having fewer domestic resources, production and human capital. Therefore, sustainable connectivity policies should account for these differences in resources, needs and incentives, rather than adopting a “one size fits all” approach.

When turning to the environmental and economic/financial dimensions of sustainability, no statistically significant relationship was found overall, but increased connectivity is associated with higher carbon dioxide emissions and a greater domestic material footprint, and this is more pronounced in Asia. Clearly, connectivity has a complex relationship with sustainable development, and policy makers face significant challenges in strengthening connectivity, while addressing sustainability in all its dimensions.

Today, there are evident gaps between European and Asian nations in terms of connectivity and sustainability. European countries stand out in terms of institutional and political connectivity, which is largely due to the common policies and legislation on the European Single Market, one of Europe’s major achievements on the free movement of people, goods, services and capital. However, when it comes to the economic/financial domain of connectivity, Asian and European nations are relatively similar. Of the three sustainability dimensions, the social dimension has the largest gap in average scores between the two continents, with European countries scoring on average two times more on social sustainability than Asian countries. When considering the environmental and economic/financial sustainability dimensions, the average gap between the two regions closes.

This study, complemented by the ASEM Sustainable Connectivity Portal<sup>2</sup>, is an initial endeavour to define sound metrics to understand how countries are connected to each other and to identify in which domains countries need to scale up further action in line with the goals of the 2030 Agenda for Sustainable Development. By identifying gaps in sustainable connectivity, this research aims at contributing to the policy dialogue among policymakers and other stakeholders. As outlined by actors in the field (Neves & Becker, 2020), this work could benefit further from more focused studies and policy briefings to better bridge the gap between science and policy. Further efforts at international level would also be necessary to extend harmonised data collection processes so that more up-to-date data becomes available.

In the Asia-Europe context, addressing sustainable connectivity is and will continue to be a major agenda item in high-level political forums. The challenges of balancing sustainability with connectivity may need to be addressed by rethinking the concept of “sustainable connectivity”. Currently, in practice, this consists of promoting connectivity, with sustainability as an afterthought or added bonus rather than a requisite. Truly sustainable connectivity should promote and focus on forms of connectivity that are fundamentally sustainable, such as green investments, trade agreements containing rules on sustainable development, zero-carbon shipping, international aid, increased exchanges of research and renewed international cooperation on global issues such as climate change and marine pollution. These issues are currently not the focus of major connectivity issues. Connectivity should be used as an instrument for addressing global issues that contributes to narrow the sustainable development gaps among the world regions. For this, it also becomes essential that the civil society is involved in connectivity-related projects, so that their values and interest can be taken into account (Neves & Becker, 2020).

Meanwhile, the COVID-19 pandemic has exposed new dependencies on connectivity and has given fresh food for thought on how to build a connected world that is also robust and resilient to threats. Clearly, safeguard mechanisms are needed, and deeper institutional cooperation at political and scientific levels between countries to tackle such problems quickly and effectively. The time is right to bring science and policy together to build back better our economy and our societies within our planetary boundaries.

## CRedit authorship contribution statement

**William Becker:** Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing - original draft. **Marcos Domínguez-Torreiro:** Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing - original draft. **Ana Rita Neves:** Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing - original draft. **Carlos Tacão Moura:** Software. **Michaela Saisana:** Writing - review & editing, Supervision.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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