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Research Article

An Overview of Challenges in Measuring Digital Trade

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Abstract

The increasing reliance on digital technologies has significantly influenced the organization and scale of international trade, placing digital trade at the forefront of contemporary economic analysis. Despite this growing relevance, there is still no consensus on how digital trade should be conceptualized and empirically measured. This paper examines existing approaches to digital trade measurement with the aim of identifying their main methodological and practical limitations. The analysis is based on a structured review of relevant literature and follows a deductive analytical framework. Attention is given to challenges related to data availability, the classification of digitally enabled transactions, and differences in regulatory practices across countries. The paper also reviews recent initiatives and methodological proposals designed to improve the accuracy and comparability of digital trade statistics. The findings indicate that measurement efforts remain constrained by fragmented data sources, uneven regulatory implementation, insufficient standardization, and the increasing presence of digital protectionist policies. By critically assessing current measurement practices, this paper contributes to ongoing academic and policy discussions on improving the reliability and consistency of digital trade statistics.

Keywords: digital trade, digital transactions, regulatory framework, measurement challenges

JEL classification: F10, F13, L81, O33, C80

Introduction

Digital economy is developing at a fast pace and is influencing the economic and social development of countries worldwide. At the same time, digital divide is widening, as digital transformation is not taking place at the same pace in all countries and between groups of countries in terms of connectivity, access, and use of digital devices and equipment (UNCTAD, 2024). As a relatively new area of economics, parallel to the development and progressive growth of information technologies and services, digital economy began to be studied in the past few decades. It includes all economic activities that use digital inputs or are

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significantly enhanced by their use, including digital technologies, digital infrastructure, digital services, and data (OECD, 2020). It applies to all producers and consumers, including the government, who use these digital inputs in their economic activities.

According to available data, digital economy will reach 16.5 trillion USD and occupy 17 percent of global gross domestic product (GDP) by 2028 (O'Grady, Jacobs, & Hoffman, 2024). Moreover, digital economy grew 2.5 times faster than world GDP and almost doubled in the next 15 years from 2000 (Oxford Economics and Huawei, 2017). Most of the total global value of digital economy is recorded in just a few economies of the world: the United States of America (35 percent), China (13 percent), Japan (8 percent), the European Union (EU) together with Iceland, Liechtenstein and Norway represent an additional 25 percent and India, which records a share of 2 percent (UNCTAD, 2019).

The concept of digital transformation evolved in parallel with the rising impact of information technologies on society and the economy. It represents changes associated with the use of digital technologies in all aspects of human life (Stolterman & Fors, 2004). Digital transformation represents a process that changes habits, business models, organizational patterns, collaborations, and values with the use of digital technologies (Vial, 2019). It refers to the economic and social effects of digitization.

Technological advances contribute to the development of new business models, including new forms of trade (International Monetary Fund [IMF], Organisation for Economic Co-operation and Development [OECD], United Nations Conference on Trade and Development [UNCTAD], & World Trade Organization [WTO], 2023). There are significant differences between countries or groups of countries in indicators that show the impact of digital economy on total economy. There are also differences in the share of digital economy in GDP between countries, which lead to differences in the digital economy's share of the total economy. All these differences arise from differences in the levels of use of information and communication technologies and services. These differences in indicators of the digital economy represent the digital divide.

Exploiting comparative advantages and facing the challenges of the digital age requires reducing the digital gap in the technological development of individual countries and directing public policies. Overcoming the digital gap between individual countries is taking place through a process of digital transformation.

Digital transformation also has a significant impact on international trade. In fact, digital transformation and development of the digital economy promote imports and exports (Du, Yan & Zhuang, 2025; Wang, 2024). Here, technological innovation has a significant role (Wang, 2024) as it contributes to the development of new modes of trade as well as to the development of new products and services which are being traded. Digitalization has changed both the scope and speed of activities undertaken by companies, enabling faster and easier movement of goods, providing new ecosystems for exchange, and helping companies to better connect with each other and with consumers around the world (López González & Ferencz, 2018). It can be concluded that development and diffusion of digital technologies have made internationalization more inclusive and, consequently, contributed to the growth of trade competitiveness. Data and digital platforms have proven to be major factors of digital trade development and its governance (Chen & Gao, 2022).

The main aim of the paper is to analyze available methodologies and challenges in measuring digital trade. The purpose of the paper is to contribute to the understanding of the existing measurement difficulties, primarily classification difficulties and regulatory inconsistencies, and to explain the main elements of measurement of conceptual framework. This paper can be useful to policymakers, statistical institutions, and international organizations in their efforts to develop more reliable and harmonized approaches to measuring the scope and impact of digital trade in the contemporary global economy.

Evolution and Significance of Digital Trade

Digital trade is a part of the expanding digital economy. Although there are different views on defining and framing digital trade, a common agreement is that it encompasses digitally enabled transactions in the trade of goods and services that can be either digitally or physically delivered (González & Jouanjean, 2017).

The statistical framework for covering digital trade is based on two important criteria: (1) digitally ordered transactions and (2) digitally delivered transactions. From a statistical standpoint, digital trade is defined as "all international trade that is digitally ordered and/or digitally delivered" (IMF, OECD, UNCTAD, & WTO, 2023). More on recording and measuring digital trade is discussed in the next chapter of the paper.

Proxy measures for digital trade suggest that, in 2020, it represented 25% of global trade (just under 5 trillion USD), with digitally deliverable trade being the fastest-growing segment (López González, Sorescu, & Kaynak, 2023). Digitally ordered transactions are a subset of e-commerce. In 2020, 24 % of firms received orders online, and over 40 % of firms placed orders online. Total e-commerce value is estimated to have reached 26.7 trillion USD globally in 2019, including both domestic and international transactions (UNCTAD, 2022). Furthermore, in 2025, retail e-commerce sales are estimated to exceed 4.3 trillion USD worldwide, which is 0,8 trillion USD more than in 2019 (Statista, 2025; Yau, 2020).

New technologies and digital infrastructure have enabled the development and expansion of the exchange of services. Moreover, technological progress has enabled the development of new ways of cross-border provision of services. Trade in services, and trade in digitally delivered services as its component, have grown significantly over the past two decades (IMF, OECD, UN, and WTO, 2023). Exports of digitally delivered services accounted for 45 percent of total global services exports in 2005. They grew by 4.1 times in the period 2005-2023, while, in the same period, exports of goods grew by 2.3 times and other services by 2.2 times, which shows that global exports of digitally deliverable services grew significantly faster than exports of goods and other services (López González et al., 2023).

The principal advantage of digital trade over traditional trade lies in its ubiquity. Whereas in traditional trade flows, the physical point of sale represents the location where a purchase is completed, digital trade is defined by its accessibility anytime and anywhere. It transcends the boundaries of shopping from a physical store to purchases made from home, the workplace, personal computers, or mobile devices that have Internet access (Laudon & Traver, 2021). Digital trade enables consumers to simultaneously browse offers from multiple online retailers and to compare prices more efficiently, as well as reviews of products and services. From the consumer's standpoint, digital trade reduces transaction costs, as it eliminates the necessity of physically visiting the merchant's point of sale to complete a purchase.

Another significant advantage of digital trade is the reduction of business costs for wholesalers, since there is no requirement for a physical sales location or large product inventories. Automation in payment processing, logistics, and marketing further reduces wholesalers' operational expenses (Chaffey, 2015). Moreover, digital platforms facilitate personalized sales and enhanced customer experiences. The collection and analytical processing of consumer data enable recommendation algorithms and tailored offers for each individual customer. At the same time, personalized marketing strategies strengthen customer loyalty (Turban et al., 2018).

Conversely, the disadvantages of digital trade primarily concern security risks associated with online transactions and trust issues arising from cyberattacks or data breaches (OECD, 2019a). The absence of physical contact and the inability to directly examine products are important factors discouraging some consumers from shopping online. Additional disadvantages include concerns regarding the sharing of financial and personal information, high delivery costs, and uncertainties related to product returns (Laudon & Traver, 2013).

In the contemporary digital economy, data have emerged as a fundamental resource. However, measuring the volume or value of digital trade and its impact on broader economic indicators and flows remains a complex task. There are no universally accepted indicators or comprehensive databases dedicated to digital trade, largely due to the lack of a consistent and operational definition. As a result, digital trade is difficult to track statistically and integrate into official national import and export data (Franc & Dužević, 2020).

Weak and diverse regulation is another disadvantage of digital trade. Many countries continue to apply divergent approaches in classifying digital transactions. Inconsistencies persist, particularly in the treatment of digitally ordered but physically delivered goods, as well as in how digital platforms are defined and included within trade transaction frameworks.

Digital trade involves the exchange of large amounts of data with businesses, which use data as input in product design, research and development, and innovation, in the manufacturing process and logistics, in distribution, and engagement with customers and clients. These data require processing, storage, modeling, and analysis – all ancillary but critical services that are essential to digital value chains (Hoekman, 2022).

Guidelines for Measuring Digital Trade

Digitalization has changed the process of trade, which is increasingly being conducted digitally, but recording and measuring it is still difficult and represents a global challenge.

The nature of transactions defines a conceptual framework for measuring digital trade. In other words, the way in which the transaction is carried out determines the scope of digital trade. The conceptual framework for measuring digital trade includes two main criteria, namely the determinants of the traded product itself and of the entity that engages in digital trade and trades in digital products (IMF, OECD, UNCTAD, & WTO, 2023).

According to this framework, two types of transactions can be distinguished. The first type is digitally ordered transactions, and those are synonymous with the term "e-commerce". “E-commerce is the sales or purchase of goods or services, which is carried out over computer networks using special methods designed for the purpose of receiving or placing orders”. Although ordering is done digitally, payment and final delivery of the goods or services are not necessarily made online (OECD, 2011). App purchases and transactions made on digital platforms are also included in e-commerce. On the other hand, orders placed by telephone or email are excluded from digitally ordered trade. Offline transactions formalized by a digital signature are also excluded. When a transaction takes place *via* an offline ordering process and subsequent transactions are made *via* a digital ordering system, the subsequent orders are included in the scope of digitally ordered transactions, i.e., they enter the measurement of e-commerce (IMF, OECD, UNCTAD, & WTO, 2023).

The second type of transaction is digitally deliverable services, which are defined as “those services that can be provided over computer networks, mainly via the internet” (IMF, OECD, UNCTAD, & WTO, 2023). Here, it is important to differentiate between digitally ordered and digitally delivered. Because all types of goods and services can potentially be ordered digitally, but goods cannot be delivered digitally, and only some services can be delivered digitally.

The classification and dissemination of data on digitally deliverable services is done according to the Extended Balance of Payments Services Classification 2010 (EBOPS 2010), which provides a division of balance of payments items - trade in services. The classification thus includes the provision of more detailed information on trade in services, in accordance with the requirements of the General Agreement on Trade in Services (GATS).

The General Agreement on Trade in Services (GATS) defines four supply modes for international trade in services, which are critical for measuring digital trade. These modes provide a structured approach to classifying how digital services are transacted across borders (WTO, 1995):

1. Mode 1 – Cross-Border Supply: This mode involves services provided from one country to another without the physical movement of either the consumer or the supplier. Digital trade relies heavily on this mode, as digitally delivered services such as cloud computing, software licensing, and online education exemplify Mode 1 transactions.
2. Mode 2 – Consumption Abroad: In this mode, the consumer travels to the supplier’s country to receive a service. While this is less relevant to digital trade, digital services can enhance Mode 2 transactions in some cases. For example, tourists may use international roaming data services or book accommodation through digital platforms before traveling.

3. Mode 3 – Commercial Presence: This mode involves a foreign company establishing a presence in another country to provide services. Multinational technology firms often set up data centers, cloud service hubs, or subsidiary offices in various jurisdictions to facilitate their services in digital trade. The presence of global e-commerce and FinTech companies in foreign markets exemplifies Mode 3 in digital trade.
4. Mode 4 – Presence of Natural Persons: This mode refers to individuals temporarily traveling to another country to provide a service. While digital trade reduces the need for physical presence, skilled IT professionals and consultants may still offer in-person services using digital tools to facilitate delivery.

It is important to record and track trade in digitally deliverable services as it has grown significantly since the beginning of the 21st century. While digitally deliverable services accounted for 48 percent of global services exports in 2012, the share increased to 52 percent in 2019. Then it rose sharply to 63 percent in 2021, which is mostly the consequence of the COVID-19 pandemic (IMF, OECD, UNCTAD, & WTO, 2023).

As a result of growing digital transactions and the spread of digital economy, four major international organizations, namely the UN, the OECD, the WTO, and the IMF, published the first edition of the Handbook on Measuring Digital Trade in 2019. This Handbook gave guidelines and formalized the statistical definition of digital trade that focuses on the nature of the transaction, with digital trade defined as "all international trade that is ordered and/or delivered digitally". In the second edition of the Handbook published in 2023, some new clarifications of concepts and definitions related to digital trade and guidance on how to operationalize them were given. The measurement framework in the Handbook on Measuring Digital Trade (2023) provides a structured approach to conceptualizing digital trade and includes three key aspects:

1. Mode of Ordering: Digital trade transactions can be initiated through digital platforms, automated systems, or direct online business interactions.
2. Mode of Delivery: The delivery of goods and services can either be physical (where digital ordering is the primary mode) or entirely digital (where both ordering and delivery occur digitally).
3. Intermediation Role: Digital trade involves digital intermediation platforms that facilitate transactions between buyers and sellers without necessarily owning the products or services transacted.

This conceptual framework enables a more precise classification of digital trade by differentiating between purely digital transactions and those where digital technologies facilitate the ordering or delivery process. Additionally, it highlights the role of cross-border data flows and the increasing reliance on cloud-based service provisions in digital trade transactions. Although this Handbook has brought many benefits and clarifications to measuring digital trade, there are still some limitations and open questions. It can be concluded that more precise classifications of products and services are still needed to improve the existing guidelines. Furthermore, broader international cooperation and mandatory reporting rules are necessary, together with collaboration with the private sector. Faster data updates and the usage of big data sources (e.g., payment systems, couriers, transactional data) are additional elements that would increase the efficiency of the measurement framework.

Furthermore, various initiatives aim to expand existing statistics to better reflect trends in digital trade. Some of the approaches monitor the restrictions that countries apply in the international exchange of products, services, and data. In contrast, other approaches are based on monitoring connectivity and involvement in global markets. Below are three indices that cover some aspects of digital trade:

1. Digital Trade Restrictiveness Index (DTRI) developed by the European Centre for International Political Economy. DTRI is based on a spectrum of digital trade policies covering 64 countries worldwide.
2. Services Trade Restrictiveness Index (STRI) developed by the Organization for Economic Co-operation and

Development – OECD. STRI monitors recent regulatory trends, services policies, and enables analysis of the impact of reform options.
3. McKinsey Global Institute (MGI) connectivity index is the result of a research initiative that ranked countries by their participation in global flows, including goods, services, finance, people, and data and communication.

Regulatory Challenges and Measurement Inconsistencies

Although the debate on the need for improved regulation and clearer conceptualization of digital trade has intensified, various challenges and inconsistencies remain in this field. In continuation, some of the main challenges in measuring and recording digital trade are considered:

a) different classification of digital goods and services
b) regulation of international data flows
c) data accessibility
d) small transactions made by small and medium-sized enterprises (SMEs).

Many studies have emphasized the need for a new regulatory framework on trade that would adequately encompass digital trade (IMF, OECD, UNCTAD, & WTO, 2023; Jones, Kira, & Tavengerwei, 2024). Mourogane (2021) emphasizes that digital transformation is "still largely invisible" in official trade statistics, and many aspects of digital trade are hidden or poorly recorded. The main challenges of digital trade measurement include: the data do not differentiate between digitally ordered and digitally delivered; difficulties in identifying transactions that are digitally enabled; lack of standardized sources; unclear boundaries of what is considered digital trade.

Jones, Kira, and Tavengerwei (2024) analyze recent trade agreements with a focus on norm-entrepreneurship, i.e., who impose new norms and standards in digital trade. They conclude that agreements led by Singapore extend regulatory obligations into new areas, but often through "soft" norms. This can add complexity to the measurement of digital trade. If countries have different agreements or norms, the measurements cannot be uniform. The authors suggest that proper regulation and international standards would help digital trade grow more securely and that measurements would be harmonized more easily.

A further challenge arises from data accessibility. Key data sources are often controlled by private companies that operate digital platforms functioning as marketplaces. These platforms, along with payment service providers and logistics companies, typically do not disclose transaction-level data due to concerns over business confidentiality and the potential exposure of commercially sensitive information (OECD, 2019b; Fassnacht, Benz, Heinz, Leimstoll, and Satzger, 2023). This limited access to micro-level data significantly hinders the work of researchers and policymakers, and obstructs the development of accurate, evidence-based indicators for digital trade.

The regulatory and legal framework also plays a crucial role in data availability. Those determine the conditions under which data may be collected, processed, and shared. According to the International Association of Privacy Professionals, 144 countries worldwide have enacted privacy and data protection laws, covering 82% of the global population (Apacible-Bernardo & Bushey, 2025). Prominent examples include the General Data Protection Regulation (GDPR) in the European Union, the California Consumer Privacy Act (CCPA/CPRA) in the United States, the Personal Information Protection Law (PIPL) in China, the Act on the Protection of Personal Information (APPI) in Japan, the Lei Geral de Proteção de Dados (LGPD) in Brazil, and the Personal Information Protection Act (PIPA) in South Korea (Gadoni Canaan, 2023; Lim & Oh, 2025). These legal instruments limit the scope of personal data collection and processing, while imposing obligations related to data transparency, purpose limitation, data minimization, and the application of anonymization techniques.

Data on cross-border flows can be used to measure digital trade. They include the direct exchange of digital goods, as well as the digitally enabled exchange of physical goods, services, financial resources, and even labor. However, this method of measurement also has its drawbacks (Franc & Dužević, 2020). First, there is a possibility of overestimating data flows due to Internet hubs that route data across multiple borders to connect the point of destination and the point of origin. Second, exchanges involving video transmission require significantly more transmission power

than simpler forms of communication, potentially distorting the assessment of the most economically valuable data flows. The amount or path of data itself does not reveal what is being transferred; it is not clear whether it is a product, service, advertisement, communication, content, or something else. Countries with more data centers will automatically have more incoming and outgoing data, but this does not mean that they necessarily "trade" more digitally. Finally, as said, there is no globally harmonized methodology for measuring and categorizing cross-border data flows.

Chen & Gao (2022) identify key challenges in standardizing and classifying goods and services (digitally deliverable vs digitally ordered), as well as in ensuring data availability and accurately measuring platforms and interactions through them. Authors find that governments often set such policies that restrict international data flows and intervene in the distribution of gains from digital trade. If not regulated properly, there will be a rise in digital protectionism and imposing restrictions on digital trade (BSA, 2014).

Regarding the issues of measuring digital trade and its effects, Kersan Škabić (2021) investigated the indicators of digital development in the EU that are prerequisites for the development of digital trade. She concludes that, to exploit ICT in trade activities effectively, the EU must overcome regulatory framework differences among member states, promote investments in necessary infrastructure and skills, and facilitate companies' market presence through digital platforms. The research results show that the EU member states are very heterogeneous in terms of ICT development, primarily in the old and new member states. As an unexpected result of the research, the author states that some of the EU member states impose stringent restrictions on conducting digital trade.

An empirical study by Lee et al. (2022) researched the impact of platforms and social networks on SME internationalization. The results indicated many benefits but also noted methodological difficulties in measuring these effects and the use of platforms in official statistics. Digital platforms can lower entry barriers to markets, making participation more inclusive (OECD, 2021). Hence, SMEs often use external services (outsourcing) for more complex digital functions, so transactions can be "hidden" in aggregates or in service provider data, which makes disintegration and measurement difficult (OECD, 2021).

Finally, Anukoonwattaka et al. (2024) investigated the effect of digital trade and related policies on sustainable development. Their findings show there is a significant and positive relationship between the achievement of sustainable development goals (SDG) targets and the growth of digital trade, particularly concerning environmental and social areas. However, the results related to economic development, governance, and global partnerships are unclear.

Extant statistical indicators of international trade predominantly disaggregate flows on the basis of sectors and product categories (e.g., HS codes, ISIC codes), while they seldom account for the modalities of ordering or delivery associated with particular transactions. Such an approach indicates that current statistical frameworks have yet to adequately capture the dynamics and flows inherent to digital trade. The above-mentioned challenges illustrate how methodological, institutional, and legal constraints continue to limit the comparability and reliability of digital trade measurement worldwide.

Conclusion

The discussion on digital trade is becoming more intense as digital trade flows represent an increasing share of total global trade. The expansion of digital trade contributes to increased competitiveness and expansion into new markets, especially for small and medium-sized enterprises. It stimulates innovation, but at the same time poses challenges in terms of regulation, data protection, and measuring its real volume. The results of the analysis have shown that measuring and recording digital trade is still difficult, inconsistent, and differs among countries. This hides accurate data and statistics. While some guidelines are given at the international level, these are still too flexible and not binding for all. Possible solutions for more accurate and more comprehensive measurement of digital trade include standardizing definitions and methodologies at the international level to ensure comparability of data across countries. Furthermore, different data sources need to be combined, including business statistics,

administrative sources, and information from digital platforms, which additionally requires solutions for the security of data transmission and the protection of data privacy. The focus should also be on monitoring actual economic transactions and value creation, not just data flows. International cooperation and regulatory harmonization would enable more precise and comprehensive measurement of digital trade. This implies that governments have the responsibility to adapt and change their regulatory and tax frameworks and policies to adjust to the changes brought about by digitalization and digital trade. Each country should develop solutions in line with its specific characteristics, priorities, and national objectives. Tailored technical assistance and funding should be provided, especially to developing economies to support the development of national strategies for digital trade measurement and digital infrastructure. Finally, public–private data sharing agreements between governments and major digital platforms could encourage data availability and data security, which would contribute to improved accuracy of data and statistics.

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