Theoretical and Practical Research in Economic Fields

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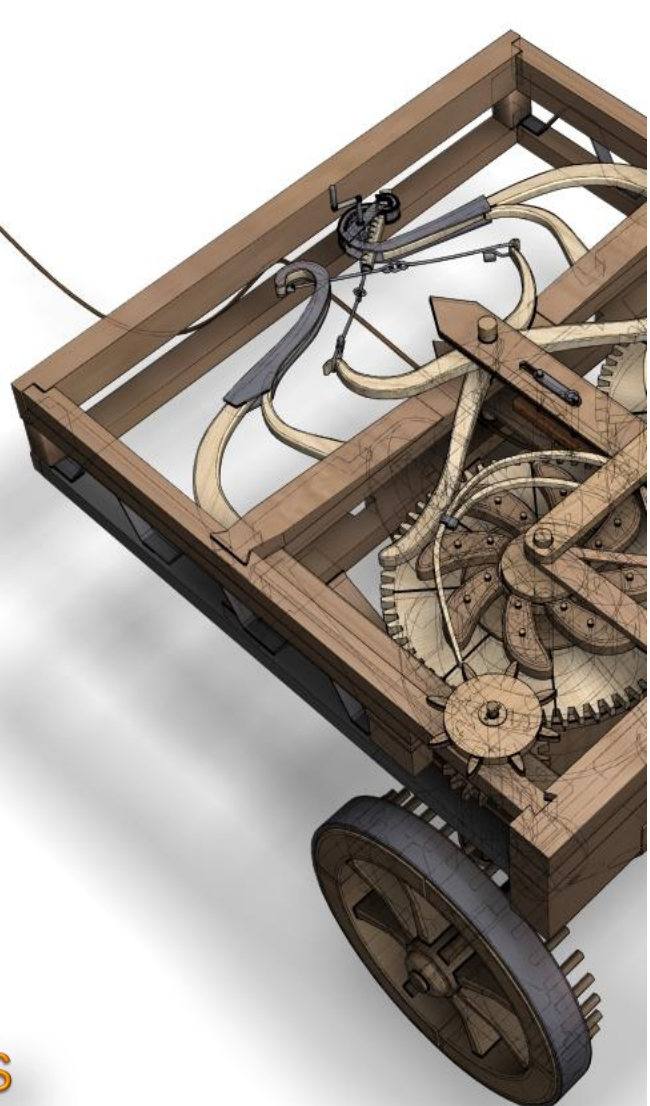## Winter Issue
Theoretical and Practical Research in Economic Fields

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At the same time, the journal encourages the interdisciplinary approach within economic sciences, this being a challenge for all researchers.

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Is the Digital Economy Partnership Agreement Effective in Export of Digitally Deliverable Services? The Case of Türkiye

Mustafa Engin TÜRKARSLAN
Department of International Trade
Institute of Graduate Programs
Ankara Hacı Bayram Veli University, Türkiye
turkarslan.mustafaengin@ogr.hbv.edu.tr
Department of International Trade and Finance
Faculty of Economics, Administrative and Social Sciences
Ankara Medipol University, Türkiye
mustafa.turkarslan@ankaramedipol.edu.tr
ORCID: 0000-0002-7614-3310; Researcher ID: JHT-2097-2023

Abstract: This study examines the potential of the Digital Economy Partnership Agreement (DEPA) in addressing the challenges faced by Turkish businesses in e-commerce and e-export activities. It begins with a comprehensive analysis of the concepts of e-commerce and e-export, focusing on the digitalization of international trade. The study then evaluates the provisions of DEPA, particularly those relevant to the specific barriers encountered by Turkish e-commerce and e-export businesses. The findings suggest that DEPA includes various mechanisms that could help mitigate these challenges and enhance Türkiye's integration into the digital economy. The research employs a panel data analysis using the Fixed Effects Model with Driscoll-Kraay (FE-DK) standard errors to assess the impact of DEPA on the export of digitally deliverable services alongside other key independent variables. Data from DEPA founding countries New Zealand, Singapore, Chile, and Türkiye, which is not a party to the agreement, are analyzed. The empirical results highlight the significance of a secure internet infrastructure and structured international agreements, such as DEPA, in fostering the growth of digital services exports. Moreover, participation appears to positively influence export performance, although the statistical significance varies depending on model specification.

Keywords: e-commerce; digitalization in international trade; strategy of Türkiye's e-export; panel data analysis.

JEL Classification: F13; F14; C23; L81; O57.

Introduction

E-commerce is a significant and growing sector, with an increasing level of trade and a substantial contribution to exports. Many countries are reaching agreements on e-commerce through free trade agreements, economic agreements, or dedicated digital economy regulations. Today, most international economic agreements include provisions related to e-commerce and, consequently, e-exports.

Countries seeking to expand their e-exports often engage in cooperative agreements to achieve common goals. These goals include establishing electronic platforms to facilitate transactions, end-to-end digital trade, online commercial activities protection, and creating a standardized framework for conducting business (Ministry of Trade and Industry Singapore 2025).

Various actors participate in e-exports, including small and medium-sized enterprises (SMEs) selling on e-commerce platforms, entrepreneurs with independent online businesses, and large-scale enterprises. This activity involves complex interactions between sectors like IT, logistics, law, foreign trade, finance, and more, necessitating collaborative efforts for successful outcomes (OECD 2020).

Digitally deliverable services refer to services that can be delivered remotely over information and communication technology (ICT) networks. These include sectors such as telecommunications, computer and

information services, financial and insurance services, and certain categories of professional and educational services. In the context of international trade, digitally deliverable services represent a rapidly growing component of cross-border service flows, as recognized by World Trade Organization (WTO) statistics (WTO 2023).

This study aims to assess the potential of the DEPA to address the challenges faced by Türkiye's e-commerce and e-export sectors. The study provides a general overview of e-commerce and e-export and subsequently identifies the terms of the DEPA agreement that are relevant to the specific challenges faced by Turkish businesses engaged in digital trade. A panel data model is employed to examine digitally deliverable services exports (DSE) as the dependent variable. This variable encompasses the e-exports of insurance and pension, financial, intellectual property, telecommunication and information, research and development, professional and management, technical, trade-related, audiovisual, recreational, health, educational, cultural, and heritage services. DEPA - which includes regulations covering most of these sectors - is incorporated into the model as a key explanatory variable alongside trade to gross domestic product ratio (TGDP) and secure internet servers (SIS). Through this quantitative framework, the study contributes to the empirical understanding of DEPA's trade effects, offering a novel approach within a literature that is predominantly conceptual and policy focused.

1. Literature Review

The digital economy has emerged as a key driver of global economic growth, influencing trade policies, governance structures, and labor markets (Ciuriak 2022). While definitions of the digital economy vary, they generally focus on producing goods using digital technologies and their impact on socio-economic processes (Zaistev 2019). The concept of a digital economy first explored Bowman (1996), has gained renewed relevance due to recent global events such as the COVID-19 pandemic, which accelerated digital adoption. This transformation, driven by technological disruption, has created opportunities and challenges across various sectors (Śledziewska and Włoch 2021). Given this rapid evolution, further qualitative and quantitative research is recommended to gain deeper insights into the digital economy (Limna, Kraiwanit, and Siripipatthanakul 2023).

The expansion of the digital economy is particularly pronounced in developing countries, where it is estimated to account for approximately 5% of global GDP and 3% of global employment (Bukht and Heeks 2017). However, digital transformation has presented significant challenges for international trade and governance. The Organisation for Economic Co-operation and Development (OECD) proposed tax reforms for the digital economy that have raised concerns regarding national sovereignty, market competitiveness, and the risk of monopolization (Gurdgiev 2019). To address these challenges, a flexible international governance regime incorporating multistakeholder organizations and "soft rules" has been suggested to promote policy convergence (Cowhey and Aronson 2018). Furthermore, trade agreements must evolve to accommodate new digital trade modes, tackling issues such as net neutrality, data localization, and privacy (Ciuriak and Ptashkina 2018).

Digital technologies have fundamentally reshaped economic activities by reducing costs associated with search, replication, transportation, tracking, and verification (Goldfarb and Tucker 2017). This transformation has also spurred the rise of digital entrepreneurship, an emerging and increasingly interdisciplinary field gaining academic and practical legitimacy (Zaheer, Breyer, and Dumay 2019).

The acceleration of digitalization has made e-commerce significant in the global economy. The growing flow of goods and services between countries via online platforms has transformed business models and influenced legal and economic regulations. Many international institutions have established global standards and policies guiding e-commerce throughout the period.

Established in 1995 to replace the General Agreement on Tariffs and Trade (GATT), the WTO is an international organization that works to resolve trade disputes between member countries and to liberalize trade (WTO 2025). In 1998, the WTO launched a work program aimed at establishing standards in the areas of goods, services, and intellectual property related to e-commerce. This program covers various issues, including the exemption of goods and services delivered electronically from customs duties and the conditions for fair competition (WTO 1998).

In the 2000s, a trend toward liberalization in e-commerce emerged alongside the General Agreement on Trade in Services (GATS). However, this era also gave rise to anti-liberal viewpoints grounded in concerns that companies, taking advantage of relaxed regulations, could shift online activities to jurisdictions with cheaper labor, lower taxes, or more lenient environmental laws (Shniad 2000). If a WTO member identifies potential violations of the GATS, GATT, or TRIPS agreements in another member's e-commerce-related practices, it may raise the issue under Article 1 of the Dispute Settlement Understanding (WTO 1994).

Another organization that regulates e-commerce is the United Nations Commission on International Trade Law (UNCITRAL), which operates under the United Nations (UN). The commission's mandate includes worldwide legal reforms to modernize and harmonize international trade rules. In this context, it develops model laws and guiding principles in the field of electronic commerce. To establish a legal framework for electronic commerce and harmonize national laws, UNCITRAL published the Model Law on Electronic Commerce in 1996 and the Model Law on Electronic Signatures in 2001. Additionally, it created the CLOUT system to disseminate various commercial case rulings (UN 2013).

The Model Law on Electronic Commerce provides a framework to support the use of modern communication techniques, such as electronic data interchange, electronic signatures, data messages, and digital contracts, while recognizing their legal validity. Additionally, the law is based on the principle of "functional equivalence." This approach acknowledges that electronic documents can replace paper documents and considers them legally equivalent as long as they fulfill the same functions (UN 1999).

The Model Law on Electronic Signatures was developed to ensure the legal validity of electronic signatures in international trade and to enhance their reliability. Based on functional equivalence, the law establishes that electronic signatures have the same legal effect as handwritten signatures. It also includes provisions for the recognition of foreign certificates and electronic signatures used in cross-border trade (UN 2002). The law helps reduce legal uncertainty in e-commerce transactions, fostering a secure digital trade infrastructure.

The United Nations launched the "eTrade for all" initiative to promote equal opportunities in e-commerce. This initiative aims to enhance the ability of developing and least-developed countries to utilize and benefit from e-commerce (UN Conference on Trade and Development 2016). As part of the UN's Sustainable Development Goals, the initiative also focuses on advancing gender equality by empowering women in the digital economy. Additionally, to foster partnerships for shared objectives, it seeks to strengthen global cooperation, reduce inequalities between countries, and support economic growth. The initiative plays a role in organizing meetings, publishing reports, and identifying individuals capable of providing technical assistance to countries in need of support in e-commerce activities (UN 2024).

In the context of digital piracy and e-commerce, the World Intellectual Property Organization (WIPO) Copyright Treaty, prepared by the WIPO, is a significant international regulation. This treaty includes provisions to protect works in the digital environment, particularly ensuring copyright protection for computer programs and databases (WIPO 1996). Additionally, in Türkiye, Regulation of Publications on the Internet and Combating Crimes Committed Through Such Publications is in force as part of efforts to combat digital piracy. This law aims to regulate online publications and address crimes committed via these publications (Official Gazette of the Republic of Türkiye 2007). Regulations like these provide essential legal frameworks for combating digital piracy and ensuring the safe continuation of e-commerce.

The Handbook on Measuring Digital Trade, created by various international organizations, emphasizes that e-commerce is a significant subcomponent of digital trade. Digital trade is defined based on the criteria of digitally ordered trade and digitally delivered trade. In this context, e-commerce is described as the international sale or purchase of goods or services through digital ordering, and the handbook provides statistical guidelines for measuring international e-commerce (International Monetary Fund *et al.* 2023). The handbook also proposes using various data sources (*e.g.*, surveys, payment data, customs records) to overcome challenges in measuring digital trade. It aims to help policymakers utilize these data sources more effectively for informed decision-making.

In conclusion, the legal regulations and policies introduced by international organizations aim to strengthen the impact of e-commerce on the global economy while ensuring that trade takes place on a safer, more accessible, and sustainable foundation. Governments are developing new digital economy agreements to complement existing trade frameworks to address the challenges and opportunities presented by digital transformation. These agreements aim to facilitate digital trade, promote innovation, and establish governance mechanisms for emerging technologies. The DEPA exemplifies this broader trend, focusing on enhancing regulatory coherence and interoperability across jurisdictions (Ciuriak 2022). Such agreements play a crucial role in ensuring that digital trade rules align with contemporary technological advancements, particularly in artificial intelligence, quantum computing, and cybersecurity (Peters 2023).

Despite these efforts, existing international trade frameworks, particularly the WTO rules, have struggled to keep pace with rapid technological advancements and the emergence of digital trade barriers (Burri 2016). The Information Technology Agreement (ITA), established in 1996, has not evolved alongside the digital economy, raising concerns about its obsolescence (Lee-Makiyama 2011). Various policy approaches have been proposed

to address these gaps, including extending the ITA, developing a Trade in Services Agreement (TISA), or creating a dedicated Digital Economy Trade Agreement (Burri 2016). These initiatives aim to develop future-oriented multilateral rules for digital trade that accommodate the complexities of the modern digital landscape while promoting inclusive economic growth and development (Burri 2016; Peters 2023).

2. E-Export

To understand the definition of e-export, we first need to define e-commerce. Various sources offer different definitions of e-commerce. Some of these are as follows. Goode (2020) defined e-commerce as the electronic production, distribution, marketing, sale, or delivery of goods and services. This definition emphasizes the broad scope of e-commerce, encompassing the entire value chain of goods and services.

Commission of the European Communities (1997) provided a more detailed definition: E-commerce is based on the electronic processing and transmission of data, including text, sound, and video. It encompasses a wide variety of activities, including e-commerce in goods and services, online delivery of digital content, electronic funds transfers, electronic stock trading, electronic bills of lading, commercial auctions, collaborative design and engineering, online sourcing, public procurement, direct consumer marketing, and after-sales service. It covers both products and services; it includes traditional activities (*e.g.*, healthcare, education) and new activities (*e.g.*, virtual shopping malls). This definition highlights the diverse applications of e-commerce across various sectors and activities.

OECD (2011) offered a more concise definition: E-commerce is the sale or purchase of goods or services conducted over computer networks by methods specifically designed to receive or place orders. This definition focuses on the core transaction of buying and selling goods and services online.

In Figure 1 M2M and A2A are emerging types of e-commerce with novel applications. For example, in a pantry where a smart home system is used, artificial intelligence software might digitally order the legumes running out in your home from the websites you have previously selected, price and quantity, and supply the necessary products. A2A encompasses e-commerce transactions between government agencies or within different departments of the same government, facilitating efficient inter-agency communication and collaboration for improved public service delivery.

Figure 1. E-Commerce Types
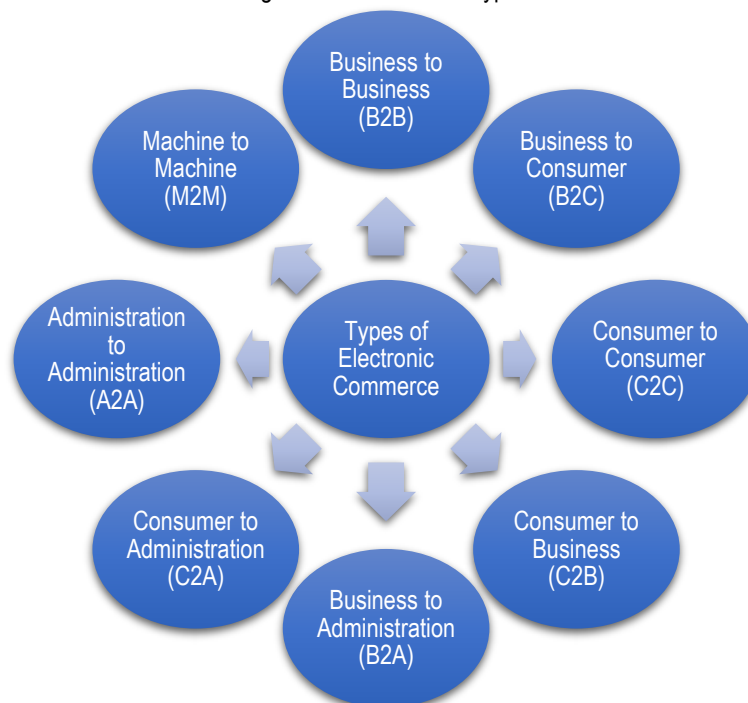
Source: Author

Jain, Malviya, and Arya (2021) explained e-commerce types as follows: B2B encompasses all electronic transfers of products or services between businesses. Manufacturers and traditional wholesale companies often utilize this approach for efficient supply chain management and procurement. B2C represents the online equivalent of traditional retail sales, where consumers can access more information about products and services,

enabling informed purchasing decisions. C2C covers all electronic transactions of goods or services between consumers, typically facilitated by a third-party platform that provides an online marketplace. C2B is prevalent in companies leveraging crowdsourcing, where individuals offer products or services to businesses seeking specific solutions, such as platforms for royalty-free images, media, and design elements. B2A involves all online transactions between businesses and government agencies, encompassing various applications like tax returns, healthcare services, legal documentation, and public records management. C2A includes all electronic interactions between individuals and government entities, often facilitated through e-government platforms for services like online tax payments, license renewals, and access to public information.

E-commerce offers significant economic advantages. It fosters a competitive market environment, driving prices towards optimal equilibrium and providing consumers with access to a broader selection of goods and services at competitive prices. Additionally, consumers benefit from increased transparency and access to information, enabling more informed purchasing decisions.

According to the Ministry of Trade: Republic of Türkiye (2022), e-export can be defined as cross-border e-commerce. It involves delivering goods ordered online from a foreign country, adhering to micro-export regulations, and encompasses cross-border B2C, B2B, and C2C transactions.

The distinctions between e-commerce and e-export are similar to the ones faced by businesses expanding into international markets. These include establishing websites that support foreign currency transactions, adapting websites to cater to target markets' languages, and navigating logistical complexities such as shipping regulations and international shipping fees.

In Figure 2 e-commerce spending in Türkiye is predominantly domestic, as shown in the comparison between 2024 and 2025. However, cross-border e-commerce transactions, where one party is a foreign country, increased by 5,67% in 2025 compared to the previous year. It's crucial to consider exchange rate fluctuations when interpreting this increase. The total volume of transactions by foreign customers on Turkish websites increased by 3,32% while spending by Turkish consumers on foreign e-commerce platforms rose by 2,35%. The overall share of cross-border e-commerce remained relatively large. The rates of both e-exports and e-imports have increased.

Figure 2. Distribution of E-Commerce Spending in the 1st and 2nd Quarters of 2024 and 2025
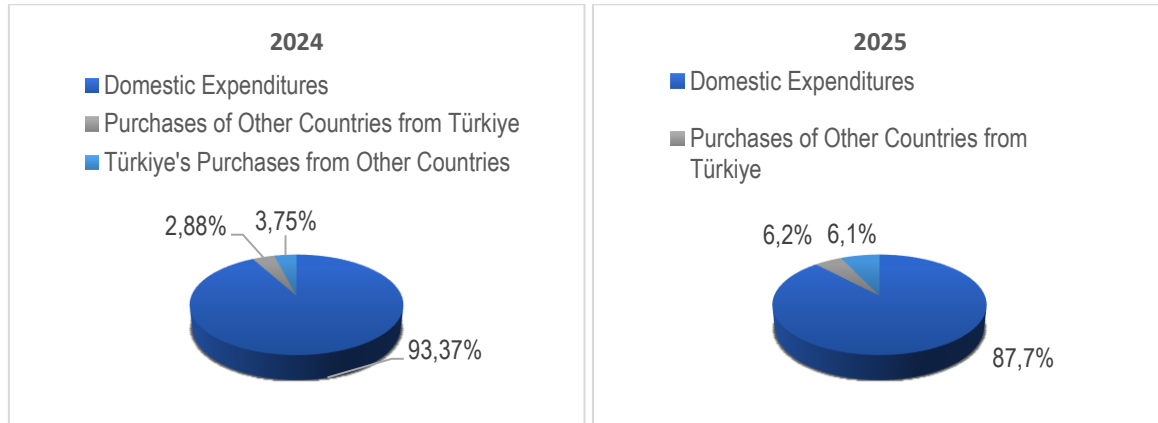
Source: Translated by the author from (Ministry of Trade: Republic of Türkiye 2024; 2025).

2.1. Can DEPA Address Sectoral Problems in Türkiye's E-Export?

DEPA is the world's first digital trade agreement. It consists of sixteen chapters and introduces new regulations on e-commerce and e-exports, considering previous agreements signed by the countries. It was signed by the three founding members on November 6, 2020, and entered into force on January 7, 2021 (Pacific Economic Cooperation Council 2021). Table 1 provides an overview of the countries participating in DEPA and their respective membership statuses.

Other countries may also join this agreement. In general, DEPA is a unique and forward-looking project that comprehensively covers various issues that affect the digital economy. It provides a solid foundation for the harmonization and interoperability of domestic frameworks and international cooperation, taking complexities sufficiently into account (Burri 2021). The parties to the agreement establish a joint committee representing the governments. The committee makes decisions based on consensus (Ministry of Trade and Industry Singapore 2024).

China, Canada, Costa Rica, Peru, United Arab Emirates (UAE), and El Salvador aim to join DEPA for several reasons. It seeks to promote e-commerce domestically and enable trade diversification for the countries' businesses, including SMEs. Additionally, Canada recognizes that past free trade agreements lack the sophistication to address the challenges faced by businesses operating in the digital economy.

Table 1. DEPA Party Countries and Their Status

Country	Status
New Zealand	Founding Member
Chile	Founding Member
Singapore	Founding Member
South Korea	Member
Canada	Applicant
Chinese	Applicant
Costa Rica	Applicant
Peru	Applicant
United Arab Emirates	Applicant
El Salvador	Applicant
Ukraine	Applicant

Source: Author's table based on Ministry of Trade and Industry Singapore (2025).

By joining early, Canada can contribute to the future development of DEPA and ensure its interests are reflected in the agreement's evolution (Government of Canada 2022). A study discussing Canada's participation in the DEPA concluded that it could help reduce Canada's future domestic policy barriers to adopting new laws and regulations for digital trade policy (Fay and Ciuriak 2022). The DEPA welcomed its first new member, Korea, in May 2024 (Ministry of Trade and Industry Singapore 2024).

Figure 3 presents a comprehensive overview of the thematic areas covered by the DEPA, encompassing digital trade, data-related issues, digital security, emerging technologies such as AI and fintech, and digital inclusion. These components reflect DEPA's holistic approach to regulating the digital economy.

Figure 3. Some Areas Covered in the Agreement

Source: (Asia Pacific Foundation of Canada 2021).

The agreement encompasses several key domains relevant to digital trade, including: The promotion of paperless trading, streamlined customs procedures, e-payments, and the adoption of e-invoicing to reduce costs. DEPA further emphasizes data protection through legal frameworks for personal data and principles such as

transparency, accountability, and data quality. It reaffirms commitments on cross-border data flows and server localization, while also safeguarding public policy interests. Cybersecurity, spam regulation, digital identity interoperability, and open government data initiatives contribute to a trusted digital environment (Ministry of Trade and Industry Singapore 2024).

In addition, DEPA addresses emerging issues like FinTech, artificial intelligence, and digital public services. It establishes cooperation frameworks for small and medium-sized enterprises (SMEs), encourages innovation, and ensures transparency in digital regulations. The agreement also provides a fair and efficient dispute resolution mechanism designed to minimize the need for formal arbitration, reinforcing DEPA's role as a flexible and future-ready model for digital trade cooperation.

In recent years, important publications have been made by ministries and institutions operating in the export sector. In this section it will be determined what the identified problems are in Türkiye's e-exports and whether DEPA will be a solution. Table 2 summarizes key consumer problems identified in Türkiye's e-commerce landscape.

Table 2. Turkish Retail E-Commerce Consumer Problems

The Rate of People Who Have Problems (%)	2011	2012	2015	2016	2017
	7,4	9,4	23,2	24,9	21,5
Types of Problems (%)					
Technical malfunction encountered on the website during the order or pay phase	9,4	16,7	20,3	24,2	20,1
It is difficult to find information about warranty conditions and other legal rights	3,7	3,5	12,6	12,9	13,6
The delivery is slower than specified	31,0	39,9	47,0	44,9	46,5
The price of the product or service is higher than specified (*e.g.*, unexpected transaction costs or high delivery fees)	5,8	5,2	11,4	7,4	9,8
Delivery of incorrect, damaged product or service	42,7	47,7	45,4	42,1	49,1
Fraud (*e.g.*, Failure to deliver a product or service, credit card misuse of their information, etc.)	15,4	5,5	10,8	10,6	15,0
Difficulties in complaints and compensation or inability to get satisfactory answers after complaints	4,2	4,6	18,1	19,7	19,5
Not selling goods and services from websites originating abroad to the country	-	-	9,7	5,3	7,3
Other	7,3	3,1	1,6	2,7	1,8

Source: TurkStat as cited in Deliçay (2021).

Regarding the problems encountered during the payment phase, DEPA has goals to ensure the compatibility of the payment infrastructure between countries by establishing a new system. In the section on electronic payments regulated by Ministry of Trade and Industry Singapore (2024):

- Connecting payment infrastructures by accepted international standards and promoting innovation and competition in a way that benefits the payments ecosystem.
- Encouraging the use of Application Programming Interfaces (APIs) to enable the development of electronic payment systems.
- Parties endeavoring to ensure trust and reliability factors, such as cross-border verification of digital identities.

The problem of slow deliveries shows an increasing trend year by year, and this issue has been addressed by DEPA. In express shipments, steps will be taken to facilitate delivery of e-export by shortening customs procedures.

To ensure a broader environment of trust in matters such as misleading or fraudulent product and service pricing, a series of articles have been outlined (Ministry of Trade and Industry Singapore 2024). In Article 6.3, which regulates online consumer protection: Consumer protection laws and compensations will come into effect to prevent deceptive, misleading, and fraudulent conduct regarding the material characteristics, price, quantity, and origin of goods and services and to prevent situations such as pages opened for product advertising without the intention to supply or non-delivery of the product despite collecting a fee from the consumer it has been said.

The agreement also includes provisions regarding protecting personal data, which is critical to consumers. These provisions include the harmonization of different laws to protect personal data, clearly defining the purpose of data collection, and minimizing unsolicited commercial electronic messages (Ministry of Trade and Industry Singapore 2024). Other sections and articles explain what will happen in contentious cases (determining the court of jurisdiction, dispute resolution, conciliation, arbitration, etc.).

While a survey was conducted for consumers in Table 2, the Turkish Exporters Assembly touched upon the problems faced by businesses operating in the sector in Figure 4. As seen in the survey research in which 112 companies participated and the Turkish Exporters Assembly report, some similar problems are striking. It means that the difficulties encountered by consumers and businesses overlap.

Figure 4. Problems Encountered in the Sector

Could you please specify the 3 issues that you consider most important for the development of the sector?

	2018	2017	2016
Fluctuations in exchange rates	63%		
Skilled workforce shortage	56%	65%	59%
Problems encountered in applications related to R&D incentives	41%	39%	47%
Price-oriented public procurement policies	27%	46%	38%
Lack of venture capital	27%	30%	31%
High and complex tax structure in the sector	26%	34%	29%
Lack of outsourcing demand	14%	12%	18%
Inadequate university-industry collaboration	13%	19%	26%
Inadequacy of regulation regarding intellectual property rights	11%	16%	17%
Problems experienced regarding foreign trade legislation practices	8%	14%	14%
Other	6%	8%	7%
Lack of Technopolis / Incubation centers	4%		

Source: Translated by the author from (TÜBİSAD and Deloitte 2019).

DEPA is an agreement that includes provisions related to public procurement, tax regulations, intellectual property rights regulations, and shortening the duration of customs procedures. It stipulates the creation of a publicly available database indicating intellectual property rights and observes the international agreements signed by the member countries (Ministry of Trade and Industry Singapore 2024).

In a publication by the European Union Intellectual Property Office investigating intellectual property rights infringements in e-commerce, the institution selected four countries (Sweden, Spain, the United Kingdom, and Germany) and identified some suspicious e-commerce sites in these countries in terms of intellectual property rights. When the 27,870 suspected sites were examined, it was determined that 25.9% of the hosting companies were Turkish, 19.3% were Dutch, and 18.3% were US-based companies (European Union Intellectual Property Office 2017). Regarding government procurement, as regulated in the Ministry of Trade and Industry Singapore (2024):

- The Parties acknowledge that the digital economy has an impact on public procurement and affirm the importance of open, fair, and transparent public procurement markets.
- To this end, the parties undertaking cooperative activities to understand how further digitization of procurement processes and goods and services affects existing and future international public procurement commitments.

Furthermore, the coordination of competition laws among member countries is also among the regulations in public procurement. Regarding customs duties, there is a goal to shorten the duration of customs procedures for express shipments, and the parties will not apply customs duties to electronic transmissions (Ministry of Trade and Industry Singapore 2024).

Chapter 15 of the agreement sets out situations in which prudential exceptions may be appropriate (such as monetary and exchange rate policy exceptions, tax exceptions, and measures to safeguard the balance of payments).

According to UTİKAD (2019), some of the problems encountered in the logistics processes of e-commerce and e-export are a lack of knowledge of SMEs in logistics processes, product returns, increasing cargo costs, loss and damage occurring for various reasons when delivering goods to the end user, obstacles arising from legislation, systems or bureaucracy, delays in the processing of shipments subject to the Electronic Commerce Customs Declaration, preventing them from leaving the country the next day, and the lack of publication of statistics regarding this declaration, inconsistencies between the procedures applied and the legislation, and inter-institutional communication by mail. This study also, which specifically addresses many problems related to

the Electronic Commerce Customs Declaration, states that e-invoices cannot be used in transactions subject to this declaration, micro-exporters pay stamp duty for their shipments, and it is unsuitable for inward and outward processing procedures.

For these reasons, the lengthening of delivery times and the decrease in international competitiveness negatively affect the e-export sector. In the e-export sector, which stands out in the global market, competition among countries has increased. Deficiencies and errors in a highly competitive market may direct customers to alternative exporters and discourage them from purchasing. Addressing these problems may lead to a decrease in costs and an expansion in the e-export sector.

According to Önal (2022), SMEs are unsuccessful in e-export due to delivery time, logistics costs, return processes, legislation, lack of foreign language skills, and collection and payment methods.

DEPA's new delivery models for logistics, the use of electric and autonomous vehicles, the implementation of electronic delivery lockers, the sharing of logistics applications among the parties, and last-mile logistics solutions are supportive of the countries party to the agreement (Ministry of Trade and Industry Singapore 2024).

International trade transactions involve many actors and continue to be carried out mainly using paper. In 2014, Danish shipping company Maersk observed a refrigerated container full of roses and avocados traveling from Kenya to the Netherlands to document the process, which consisted of physical processes and paperwork affecting each shipment. They found that around 30 actors and over 100 people were involved throughout the journey, and the number of interactions exceeded 200. It took approximately 34 days for the shipment to reach retailers from the farm, including 10 days spent waiting for documents to be processed. During this time, one of the critical documents was lost and later found after much effort (Park 2018).

As AI-powered programs and cryptography applications advance, the complexities and challenges associated with foreign trade processes will decrease. With the acceptance of cryptocurrencies by countries and companies increasingly accepting payments in cryptocurrencies, their use is growing day by day. This will further increase with the implementation of Central Bank Digital Currencies (CBDCs) that central banks are developing.

The operating mechanism of cryptocurrencies is based on distributed ledger technology. This technology, also known as blockchain technology, can be used to audit the security of the cryptocurrency system and transfer documents used in international trade. It is also stated that distributed ledger technology reduces document requirements in sectors such as e-commerce, real estate, healthcare, digital content, and copyright (Ünal and Uluyol 2020).

According to the report published by Türkiye Exporters Assembly (2019), the weaknesses and threats in the e-export sector are the inability to access e-export figures, the lack of vertical and horizontal analysis of e-export, the unavailability of internationally accepted payment systems such as PayPal in our country, long processing times in exporter unions, the constantly changing market, the fact that the rate of fully digitized SMEs is 4% of the total number of SMEs, the inability of institutions and ministries to see bank records, and the lack of distinction between e-export and conventional export.

Various processes using paper documents increase coordination and administrative costs and are prone to errors, loss, and fraud. The complexities and costs associated with international trade in goods have led companies and governments to explore how blockchain can be used to reduce paperwork and improve processes involved in exporting goods, from trade finance to customs procedures and transportation (Ganne 2018).

The paperless trade and electronic invoice articles regulated by DEPA aim to prevent some errors of SMEs and those caused by the system. Regarding paperless trade and regarding electronic invoices Ministry of Trade and Industry Singapore (2024):

- The Parties will endeavor to provide trade administration documents in a manner that incorporates Optical Character Recognition (OCR) capabilities.
- The necessary documents and requirements regarding imports, exports, and transit will be obtained from a single-window system.
- Internationally accepted standards will carry out data exchanges in this system.
- It is important to adopt a common international standard so that businesses can work and coordinate with each other across borders.
- Parties will make efforts to promote the existence of basic infrastructure that will support e-invoices, raise awareness about invoices, and develop the capacity of the system.

DEPA is an agreement that includes provisions supporting SMEs and transparency with the opportunities it provides, such as artificial intelligence and analysis, harmonization of payment methods, and shortening transaction times. It is an agreement that also covers topics such as the importance of using artificial intelligence

in the digital economy, the importance of a fair and transparent state in the market, and the promotion of cooperation between financial technology companies (Ministry of Trade and Industry Singapore 2024).

DEPA supports SMEs in e-export with its article that provides for investments and collaborations in the digital economy for SMEs and aims to promote SME exports. It includes issues such as regulating investments and collaborations for SMEs in the digital economy and promoting SME exports (Ministry of Trade and Industry Singapore 2024).

3. Empirical Analysis

3.1. Data Description

The study analyzes the volumes of DSE for four countries: Chile, New Zealand, and Singapore, which hold founding member status under the DEPA, and Türkiye, which is not a member of DEPA. The independent variables include the number of SIS, the DEPA dummy variable, and the TGDP. The analysis uses data from the years 2010 to 2023. Table 3 provides a detailed overview of all variables used in the study, including their sources and units of measurement.

Table 3. Definition of Variables

Variable	Definition	Database	Unit
TGDP	Total Trade as a Percentage of GDP	World Bank (2024b)	%
DEPA	Digital Economy Partnership Agreement	Ministry of Trade and Industry Singapore (2024)	Dummy (0, 1)
SIS	Secure Internet Servers	World Bank (2024a)	Quantity
DSE	International Trade in digitally deliverable services exports	UNCTADstat (2024)	Millions (USD)

Source: Author

All panel data analyses, and the model's reliability and validity tests were conducted in Stata 17. Since data on Türkiye's digitally deliverable services exports were unavailable for 2010–2012, missing values were imputed using a machine learning approach - Scikit-learn's linear regression-based model (Pedregosa *et al.* 2011). The data for all variables spans the years 2010 to 2023. Utilizing a balanced panel dataset enhances the validity and reliability of the analysis by mitigating bias associated with missing data (Baltagi 2021).

Figure 5. Model Performance Comparison
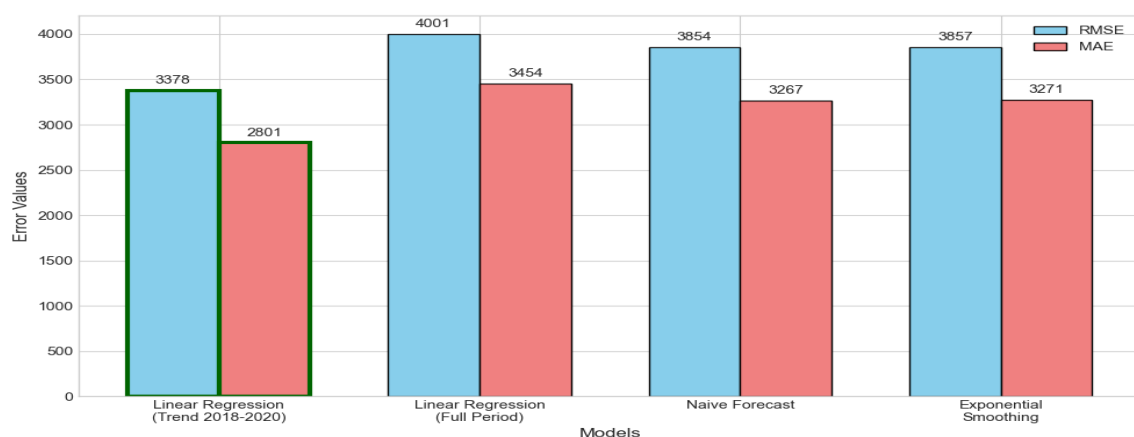
Source: Author

Different methods were compared for the estimation of missing DSE values. For this purpose, the years 2013–2020 were used as the training set, and model performances were evaluated based on the test data from 2021–2023. While DSE values in the training period followed a relatively stable pattern (ranging between 5820 and 7348), the test period exhibited a rapid increase (8478, 9584, and 13259), providing a suitable ground to assess the models' extrapolation capabilities.

As shown in Figure 5, the analysis demonstrates that the linear regression model trained on the recent portion of the training data (2018–2020) yields the lowest error values, with an RMSE of 3378.11 and an MAE of 2800.83 on the test set. In contrast, the full-period linear regression model using all available data (2013–2023)

results in higher error levels (RMSE: 4001.35, MAE: 3454.35), as do the naive forecast method (RMSE: 3853.80, MAE: 3267.33) and the exponential smoothing approach (RMSE: 3857.12, MAE: 3271.24). Therefore, the trend-based linear regression model was selected as the most appropriate method for imputing the missing values from 2010 to 2012.

3.2. Methodology and Research Results

The Im-Pesaran-Shin (IPS) panel unit root test has been widely used in econometric analysis. It allows for individual effects, time trends, and common time effects, assuming all series are non-stationary under the null hypothesis (Bornhorst and Baum 2001). The IPS test relaxes the restrictive assumptions of the Levin-Lin test, making it more applicable in practice (Maddala and Wu 1999).

The Hadri unit root test is a statistical method for examining stationarity in panel data. Unlike traditional unit root tests, it has a null hypothesis of stationarity. The test can accommodate models with fixed effects or deterministic trends and allows for heteroskedasticity across units (Hadri 2000).

In Table 4, the ΔTGDP variable, the negative mean, indicates an overall decline, while the wide range of observations reflects the diversity of the dataset. Additionally, it is known that for the DEPA variable, 82.69% of the sample takes the value 0, while 17.31% takes the value 1. This descriptive analysis serves as a critical preliminary investigation into the distribution of the variables and the diversity present within the dataset, which will be instrumental in subsequent regression models and econometric analyses. Moreover, the extensive dispersion among variables may necessitate further investigation into potential issues such as heteroscedasticity in the model estimations.

Table 4. Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max	IQR
DSE	56	28662.64	48632.39	1520	186790	22346
TGDP	56	128.8064	123.4223	43.98217	379.0986	137.52
SIS	56	219509.5	322884.6	790	1353061	246520.5
DEPA	52	0.1730769	0.3820047	0	1	1
ΔDSE	52	3112.038	5859.58	-966	27916	4926.5
ΔTGDP	52	-1.054643	8.740941	-30.99592	13.8093	9.98265
ΔSIS	52	48481.63	70435.57	-22306	235107	63950.25

Source: Author

Table 5 presents the results of the IPS and Hadri panel unit root tests, which are widely employed in panel data analysis to assess the stationarity of the time series examined in this study. The IPS test's null hypothesis posits that each individual series contains a unit root, while the Hadri test assumes stationarity as its null hypothesis. For each variable, the IPS t-bar statistic and its corresponding p-value are reported alongside the Hadri z statistic and its p-value.

Table 5. IPS and Hadri Unit Root Test Results

Variable	IPS t-bar	IPS p-value	Hadri z	Hadri p-value
ΔDSE	-3.4213	0.0122	-0.7907	0.7854
ΔTGDP	-2.9869	0.0040	0.3117	0.3776
ΔSIS	-2.6158	0.0137	0.8860	0.1878

Source: Author
Note: IPS Critical Values 1%: -3.210, 5%: -2.870, 10%: -2.700

For ΔDSE, the IPS test yields a t-bar of -3.4213 with a p-value of 0.0122, which is below the conventional significance levels when compared to the provided critical values (1%: -3.210, 5%: -2.870, 10%: -2.700).

Similarly, for ΔTGDP and ΔSIS, the IPS t-bar statistics of -2.9869 (p = 0.0040) and -2.6158 (p = 0.0137), respectively, lead to the rejection of the null hypothesis of a unit root. Moreover, the Hadri test results - with p-values of 0.7854 for ΔDSE, 0.3776 for ΔTGDP, and 0.1878 for ΔSIS - do not indicate any significant deviation from stationarity.

These findings confirm that after taking the first differences, the series becomes stationary. Consequently, the transformed data does not suffer from unit root issues, making them suitable for subsequent econometric analyses using panel data models, such as FE or RE estimations.

In equation (1), the term u_i accounts for country-specific fixed effects (time-invariant heterogeneity), while ε_{it} represents the error term. Driscoll and Kraay's approach extend nonparametric covariance matrix estimation to produce consistent standard errors as the time dimension increases. This model employs Driscoll-Kraay standard errors to address issues of serial correlation, heteroskedasticity, and cross-sectional dependence, ensuring reliable and robust results (Driscoll and Kraay 1998). The Driscoll-Kraay approach offers a valuable solution for panel data analysis with cross-sectional dependence, addressing limitations of more common covariance matrix estimators (Hoechle 2007).

$$\Delta DSE_{it} = \beta_0 + \beta_1 \cdot \Delta TGDP_{it} + \beta_2 \cdot \Delta SIS_{it} + \beta_3 \cdot DEPA_{it} + u_i + \varepsilon_{it} \tag{1}$$

Table 6 indicates that panel effects are statistically significant according to the Breusch–Pagan LM test, supporting the application of a panel data estimation method. Furthermore, the Hausman test rejects the random effects model in favor of the fixed effects model.

Table 6. Selection of Panel Data Estimation Technique

Test	Hypothesis	Statistic	p-value	Result
Breusch-Pagan Lagrange multiplier (LM) Test	H_0: No panel effect.	$X^2(01) = 6.63$	0.01	Panel effects present.
Hausman Test	H_0: Difference in coefficients not systematic.	$\chi^2(2) = 32.09$	0.0000	RE model not suitable. FE model preferred.

Source: Author

The FE Model captures the impact of independent variables on digital services exports while controlling unobservable country-specific characteristics. This model ensures that the estimated coefficients reflect the true within-country variation over time by accounting for time-invariant heterogeneity. As shown in Table 7, the results show that the share of total trade in GDP has a statistically significant positive effect on digital services exports, with a coefficient of 106.71 (p = 0.025), indicating that a 1% increase in this variable leads to an average increase of 106.71 units in digital services exports. SIS also exhibits a significant positive effect (p = 0.002), highlighting the importance of robust digital infrastructure in supporting digital exports. Although the DEPA variable is on the borderline of statistical significance (p = 0.052), its large coefficient (2092.43) suggests a substantial potential impact on digital services exports. The model's goodness-of-fit, reflected by an R-squared value of 0.3864, implies that about 39% of the variation in digital services exports is explained by the model, and the F-statistic confirms its overall significance (F (3, 45) = 9.44, p = 0.0001).

In contrast, the RE Model assumes that country-specific effects are random and uncorrelated with the explanatory variables. This model yields somewhat different results than the FE model, particularly regarding the variable total trade in GDP, which appears with a negative and statistically insignificant coefficient (-30.71, p = 0.678). However, the SIS variable remains significant and positive, with a higher coefficient (0.0509, p $<$ 0.001), reinforcing its importance in enhancing digital exports. Meanwhile, the DEPA variable fails to reach statistical significance in this model (p = 0.146), though it still suggests a potential positive association. The overall model fit, with an R-squared of 0.4224, appears slightly better than that of the FE model, and the Wald chi-squared statistic (χ^2 (3) = 35.10, p < 0.0000) indicates that the joint effect of the independent variables is statistically significant.

Table 7. FE and RE Analysis Result

Test	Variable	Coefficient	Std. Err.	t/z Value	P Value	R² and F Value
FE	ΔTGDP	106.71**	45.87	2.33	0.025	R² = 0.3864 F (3, 45) = 9.44 p = 0.0001
	ΔSIS	0.0221***	0.0067	3.28	0.002	
	DEPA	2092.43*	1050.34	1.99	0.052	
	C	1790.23***	515.88	3.47	0.001	
RE	ΔTGDP	-30.71	73.92	-0.42	0.678	R² = 0.4224 Wald χ² (3) = 35.10 Prob> χ² = 0.0000
	ΔSIS	0.0509***	0.0092	5.50	0.000	
	DEPA	2469.64	1697.05	1.46	0.146	
	C	183.96	818.97	0.22	0.822	

Source: Author
Note: *p<.10, **p<.05, ***p<.01; unstandardized coefficients.

Table 8 shows that the FE model exhibits both serial correlation and heteroskedasticity, as indicated by the Wooldridge and Modified Wald tests. However, the null hypothesis of cross-sectional independence is not rejected according to Pesaran's test. The FE-DK offers a more robust alternative by addressing serial correlation, heteroskedasticity, and cross-sectional dependence. This approach increases the reliability of standard errors, leading to more robust statistical inference (Driscoll and Kraay 1998).

Table 8. Tests for Serial Correlation, Heteroskedasticity, and Cross-sectional Dependence in FE Model

Test	Hypothesis	Statistic	p-value	Result
Wooldridge Test for Serial Correlation	H_0: No first-order serial correlation	$F(1, 3) = 14.604$	0.0315	Serial correlation detected.
Modified Wald Test for Group-wise Heteroskedasticity	H_0: $\sigma_i^2 = \sigma^2$ for all i	$\chi^2(4) = 229.12$	0.0000	Heteroskedasticity detected.
Pesaran's Test for Cross-sectional Dependence	H_0: Residuals are cross-sectionally independent	Pesaran's Test Statistic = 0.816	0.4145	Cross-sectional independence is not rejected.

Source: Author

The results from the FE-DK model, as presented in Table 9, align closely with those from the standard FE model. The total trade in GDP variable remains positive but slightly loses statistical significance (p = 0.076), indicating a marginal effect on digital services exports. The SIS variable continues to show a significant and positive impact (p = 0.041), affirming the critical role of secure internet infrastructure in boosting digital exports. Similarly, the DEPA variable is statistically significant at the 10% level (p = 0.057), with a coefficient of 2092.43, emphasizing its potential influence on digital services exports. The model's F-statistics (F(3, 12) = 15.31, p = 0.0002) further supports the overall significance of the regression, while the R-squared value (0.3864) remains consistent with the standard FE model.

Table 9. FE-DK Analysis Result

Model	Variable	Coefficient	Std. Err.	t/z Value	p-value	R² and F Value
FE-DK	ΔTGDP	106.71*	54.93	1.94	0.076	R² = 0.3864
	ΔSIS	0.0221**	0.0097	2.28	0.041	F (3, 12) = 15.31
	DEPA	2092.43*	994.00	2.11	0.057	Prob> F = 0.0002
	C	1790.23***	500.20	3.58	0.004	

Source: Author
Note: *p<.10, **p<.05, ***p<.01; unstandardized coefficients

4. Discussions and Further Research

The present study demonstrates that DEPA can positively influence the export performance of digitally deliverable services. While the econometric evidence indicates a general positive association, the degree of statistical significance varies across model specifications.

In the broader literature, studies on DEPA have predominantly taken the form of legal or policy evaluations, focusing on textual provisions or country-level compatibility analyses. By contrast, this paper offers one of the first empirical assessments through panel data econometrics, positioning Türkiye as a non-member benchmark. This approach provides new insights into how digital trade agreements might extend benefits beyond their formal membership, thereby broadening the empirical base of digital trade governance research.

At the same time, the analysis faces certain limitations. The complexity of digital ecosystems and sectoral differences within digitally deliverable services are not fully captured, and the relatively recent nature of DEPA restricts the ability to observe long-term dynamics. Nevertheless, the findings point to promising directions for future research. In particular, DEPA's provisions on logistics could be integrated into an expanded model, with variables designed to capture the evolving role of logistics infrastructure in enabling digital trade. Future studies could benefit from incorporating additional variables and broader datasets to further refine these conclusions.

Overall, this study advances the discussion by empirically linking DEPA to digital service exports and highlighting Türkiye's potential integration into the global digital economy. By doing so, it underscores the importance of institutionalized cooperation in an increasingly digitalized trade environment.

Conclusions

Türkiye is still negotiating the Economic Partnership Agreement (EPA) with Japan, for which negotiations began in 2014. Furthermore, since 2022, Türkiye has negotiated with Azerbaijan, Kazakhstan, Kyrgyzstan, and Uzbekistan for the DEPA between the Organization of Turkic States (OTS) members. These ongoing negotiations demonstrate Türkiye's current aim to enhance growth in its e-commerce and, consequently, e-export sectors through mutual international agreements (Organization of Turkic States 2024). The member countries of OTS signed the landmark DEPA in November 2024 with the same name as DEPA. This agreement aims to deepen cooperation among OTS members in key areas such as e-commerce development, regulatory harmonization, customs regulations, and FinTech. In addition, the implementation of this agreement may contribute to strengthening capabilities in the areas of consumer rights protection and cybersecurity in digital trade among member states (Bayramova 2024).

In this context, Türkiye could become a party to an innovative agreement like DEPA, open to the membership application and participation of every country, such as China and Canada, and is the first of its kind in the sector. This may lead to an expansion of Türkiye's e-commerce and e-export sectors through the acquisition of new trading partners and alignment with an agreement regulated by international standards.

As indicated in this study, DEPA is an agreement with the potential to address various problems. Despite holding the positions of the world's largest exporters and importers, even large markets like China and Canada have applied to DEPA. They are continuing negotiations, citing the need to expand their electronic exports and imports, according to statements on the official websites of these countries. When we compare Türkiye's problems in the sector with DEPA's solutions, we observe overlapping problems and solutions.

Comparing the three models highlights important insights. The FE model and the FE-DK model consistently show that SIS and the DEPA significantly and positively impact digital services exports. While significant in the FE model, the total trade in GDP variable appears weaker in the FE-DK model and insignificant in the RE model, suggesting potential sensitivity to model specification. The RE model's results are less reliable due to the inconsistency in total trade in GDP and DEPA, reflecting the possibility that the RE assumption does not hold. Given these findings, the FE-DK model emerges as the most reliable approach for policy recommendations, providing robust standard errors that account for multiple data issues. In light of the results, policymakers should prioritize expanding secure internet infrastructure and enhancing digital economy partnerships to foster digital services exports.

The DEPA dummy variable exhibits a positive and economically meaningful coefficient in the FE and FE-DK model specifications. Although its statistical significance remains marginal (with p-values of 0.052 and 0.057), the consistency in sign and magnitude suggests a potential association worth further investigation - particularly given the limited time coverage and the early-stage implementation of the agreement.

In conclusion, the findings suggest that Türkiye's participation in DEPA could be instrumental in securing its digital trade landscape, particularly through provisions that support cross-border digital transactions, data governance, and online consumer protection. The study highlights the need for further investments in secure internet infrastructure to maximize the potential benefits of DEPA. Policymakers should encourage to strengthen their digital trade policies and regulatory frameworks to align with international digital economy standards, ensuring Turkish businesses remain competitive in the evolving global digital marketplace.

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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.

Declaration of use of generative AI and AI-assisted technologies

The author declares that he has not used generative AI and AI-assisted technologies during the preparation of this work.
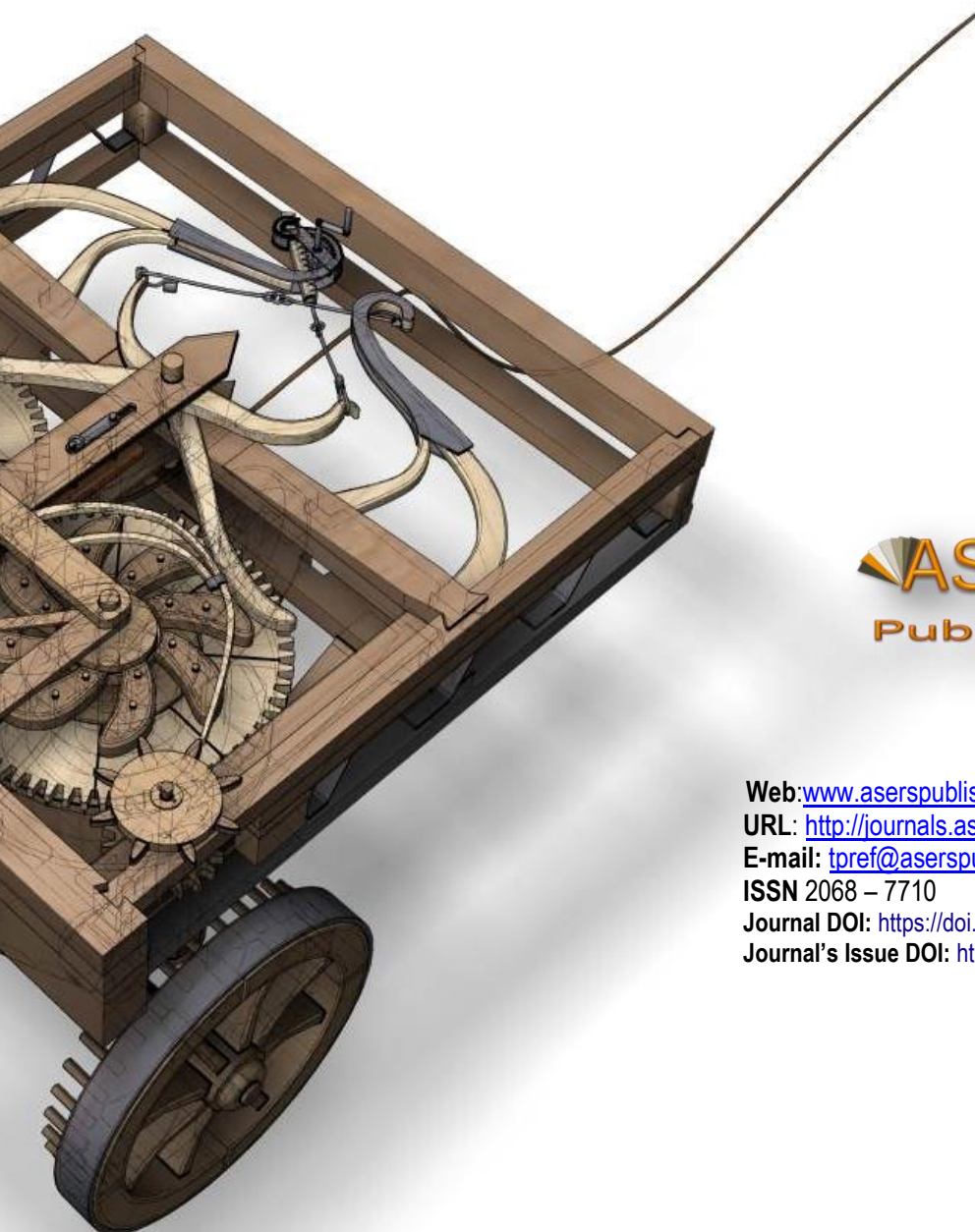
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