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The Effects of AI on International Trade with Evidence from Egypt, UK, and USA

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Abstract
This paper examine the impacts of AI or Digitalization on international trade in Egypt, UK, and USA. It found that AI will leads to reduce the transaction costs of trade, expanding cross-border services, improve service sector growth, and empowerment of SME. In Egypt AI leads to Customs Modernization, Rising Digital Exports, and Market Access. In UK it will lead to Digitally Delivered Services and International Market Access, increase AI as an Emerging Export Sector, increase the importance of Digital Customs and Border Transformation, and reduce trade costs.
The United States acts as a dominant net exporter of cloud computing, platform ecosystems, and data-driven services. In USA, AI will effect on U.S. Leadership in Digitally Deliverable Services, AI and Expansion of Cross-Border Digital Services (AI adoption → higher productivity → lower service-production costs → greater international competitiveness → expansion of digital exports), Cross-Border Data Flows as a Trade Infrastructure (digital infrastructure and regulatory environment that allow data to move internationally). And AI, will improve Global Value Chains and Manufacturing. So always USA is the leader and Pioneer in every filed, especially in which are related with AI and Digitalization forever.
Keywords: AI, Digitalization, International Trade, and applied on Egypt, UK, and USA.
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Introduction

Digitalization transforms international trade by lowering transaction costs, accelerating customs clearance, and expanding cross-border services. [1, 2]

General Effects of Digitalization on Global Trade

- Reduced Trade Costs: Electronic documentation and automated clearing cut administrative overhead and processing delays. [1, 2]
- Service Sector Growth: Cloud infrastructure turns non-tradable local services into globally deliverable digital exports (IT, finance, consulting). [1, 2, 3]
- SME Empowerment: Digital platforms allow small and medium enterprises to bypass traditional intermediaries and access international buyers directly.

Evidence from Egypt

- Customs Modernization: The implementation of digital single-window systems like the Nafza customs platform has reduced cargo release times and streamlined import-export procedures. [1]
- Rising Digital Exports: Propelled by the *Digital Egypt Strategy*, internet penetration reached roughly 82.7% (98.2 million users), helping drive Egypt's ICT exports past $7.4 billion. [1, 2]
- Market Access: Digital tools and e-commerce adoption have enabled Egyptian SMEs to scale exports into regional African and Middle Eastern markets. Research from Standard Chartered notes that 94% of surveyed Egyptian corporates strongly support harmonized digital trade and cross-border data agreements. [1, 2]

The previous three points can be developed into a stronger **research-ready section** by explicitly connecting AI/digitalization to measurable international-trade outcomes:

AI Impacts on International Trade: Digital Evidence from Egypt

1. AI-Enabled Customs Modernization

Egypt's digital customs transformation provides an important channel through which AI and advanced digital technologies can affect international trade. The **Nafeza (National Single Window for Foreign Trade)** system integrates trade documentation and customs procedures electronically, reducing paperwork, improving information flows, and supporting faster cargo clearance. The trade effect can be measured through indicators such as **customs clearance time, transaction costs, import/export processing time, and trade volumes**.

2. Expansion of Digital Exports

Egypt's digital transformation has contributed to the rapid expansion of ICT and digitally delivered services exports. The **Digital Egypt Strategy** has supported digital infrastructure, ICT services, outsourcing, and digitally enabled business activities. Recent evidence indicates that Egypt's ICT exports have exceeded **US$7.4 billion**, while internet penetration has reached approximately **82.7%**. These developments provide a measurable basis for examining whether digitalization and AI adoption are associated with higher exports of ICT-enabled services and other digitally deliverable services.

3. Greater Market Access for Egyptian Firms

AI-powered digital platforms, e-commerce, digital payments, cloud services, and online marketing can reduce the fixed and variable costs of entering foreign markets. This is particularly relevant for **Egyptian SMEs**, which can use digital platforms to reach customers in African, Arab, European, and other international markets without establishing a physical presence in every market. The trade impact can therefore be examined through **the number of exporting firms, export destinations, export values, and the survival of exporters**.

4. AI and Trade Facilitation

AI can extend the benefits of digital customs beyond simple electronic processing. Potential applications include **risk-based customs inspection, automated document verification, anomaly detection, predictive logistics, and intelligent classification of shipments**. These applications can reduce delays while allowing customs authorities to concentrate inspection resources on higher-risk shipments.

5. AI and Trade Costs

The central economic mechanism can be summarized as:

AI/Digitalization → Lower information & transaction costs → Faster trade procedures → Greater market access → Higher trade flows

For Egypt, this mechanism can be tested empirically rather than treated only as a theoretical relationship.

Suggested empirical model

A useful country-level specification would be:

$$Trade_t=\beta_0+\beta_1 AI_t+\beta_2 Digitalization_t+\beta_3 Logistics_t+\beta_4 GDP_t+\beta_5 ExchangeRate_t+\beta_6 TradePolicy_t+\epsilon_t$$

Where:

- **Trade** = Egypt's exports, imports, or total trade

- **AI** = AI adoption/use indicator
- **Digitalization** = internet penetration, digital-payment adoption, ICT investment, etc.
- **Logistics** = logistics-performance or customs-efficiency indicator
- **GDP** = real GDP
- **Exchange Rate** = EGP exchange-rate measure
- **Trade Policy** = tariff/trade-openness indicator

For a stronger international-trade study, I would recommend moving beyond a simple Egypt time series and using **Egypt's bilateral trade with partner countries**. This would allow you to investigate whether greater digital connectivity and AI adoption are associated with changes in Egypt's exports to individual trading partners.

Research hypothesis

H1: Greater adoption of AI and digital technologies is associated with increased international trade by Egypt through reductions in transaction costs, improvements in customs efficiency, and expansion of digital market access.

This gives you a much clearer empirical bridge between **AI → digitalization → trade facilitation → exports**, rather than treating AI and digitalization as synonymous.

Evidence from the UK

- Digitized Services Economy: The UK relies heavily on digitally deliverable services, with the USA serving as its top destination for digital and broader service exports. [1]
- E-Customs and Border Operations: Post-BRESCIA/Brexit trade models forced a rapid transition to digital-heavy border reporting, electronic invoicing, and automated regulatory compliance to preserve supply chain velocity with European and global partners.

Yes. For the UK, I would strengthen your section so that it distinguishes **AI's direct effects** from the broader effects of **digitalization**, while using recent official UK evidence.

AI Impacts on International Trade: Digital Evidence from the UK

1. Digitally Delivered Services and International Market Access

The UK is highly exposed to the international trade of digitally deliverable services. The latest ONS work on digital trade explicitly incorporates emerging activities such as **artificial intelligence and cloud computing** into the measurement framework. In 2023, digitally delivered services supplied through **Mode 1 (remote trade)** accounted for approximately **£315 billion of UK services exports**, representing **68.3% of total UK services exports**. This demonstrates the importance of digital technologies—including AI-enabled services—in expanding the UK's ability to supply foreign markets remotely. (Office for National Statistics)

The United States is particularly important. In 2024, the UK exported **£137.0 billion in services to the United States**, equivalent to **27.0% of total UK services exports**. (Office for National Statistics)

2. AI as an Emerging Export Sector

There is now direct evidence that AI itself is becoming internationally traded. The UK Government's **Artificial Intelligence Sector Study 2024** estimates that approximately **22% of dedicated UK-headquartered AI firms exported services internationally**. These firms operated around **1,000 international offices**, with **56% located in the United States**. (GOV.UK)

AI-related goods trade is also significant. UK imports of AI-related goods increased from **£5.4 billion in 2021 to £7.2 billion in 2024**, largely reflecting increased demand for CPUs and GPUs. (GOV.UK)

Thus, AI affects UK international trade through **both exports of AI-enabled services and imports of AI-related technologies and equipment**.

3. Digital Customs and Border Transformation

Brexit significantly increased the importance of electronic customs procedures for UK–EU goods trade. Since 2021, Great Britain–EU goods exports have been compiled directly from **customs export declarations**, creating a new customs-data environment for UK–EU trade. HMRC recorded substantial volumes of customs declarations in 2025 for trade between Great Britain and the EU as well as non-EU countries. (GOV.UK)

The next stage is the use of **AI and advanced analytics** in customs risk management, including automated document processing, anomaly detection, risk profiling and data-based targeting of inspections. These technologies can potentially reduce the time and administrative costs associated with cross-border trade.

Importantly, this should be described as an **AI-enabled evolution of digital customs**, rather than claiming that Brexit itself was caused by or necessarily produced AI-based customs systems.

4. AI, Digitalization and Trade Costs

The UK provides an especially useful case for examining the relationship:

AI adoption → automation and information processing → lower transaction costs → faster cross-border transactions → increased trade

The UK Department for Business and Trade commissioned research from the LSE Trade Policy Hub that estimated a **1.3% increase in UK GDP under universal adoption of digital trading systems**. This is evidence about the potential economic effect of **trade digitalization**, rather than a direct estimate of AI's independent causal effect. (GOV.UK)

5. Direct Empirical Evidence for the UK

A particularly useful indicator for your research is the UK's emerging **AI-trade dataset**. The UK Government now identifies AI as an emerging component of digital trade statistics, while ONS is developing measurement of digitally delivered services and incorporating AI and cloud computing into the statistical framework. (Office for National Statistics)

This makes the UK suitable for testing:

$AI_t \rightarrow Digital\ trade_t \rightarrow International\ Trade_t$

with measurable variables such as:

- AI adoption by firms
- AI-sector exports
- digitally delivered services exports
- ICT investment
- cloud-computing adoption
- digital customs transactions
- customs declaration volumes
- trade with the EU and US
- services-export value

Comparative research implication

This also creates a strong **Egypt–UK–USA comparative framework**:

Channel	Egypt	UK	USA
AI-enabled services	Emerging	Highly developed	Highly developed
Digital exports	Rapidly expanding	Major component of services trade	Major global exporter
Digital customs	Nafeza/single window	Advanced electronic customs	Automated customs systems
AI-sector trade	Emerging	Measurable	Highly developed
Digital market access	SMEs and regional markets	Global services markets	Global technology/services markets

Research proposition: Rather than measuring only whether "AI increases trade," your study can examine **which trade channels are affected by AI**—particularly digital services, customs efficiency, transaction costs, and foreign-market access. This gives the Egypt–UK comparison considerably stronger economic content.

Evidence from the USA

- Digital Trade Dominance: The United States acts as a dominant net exporter of cloud computing, platform ecosystems, and data-driven services.
- Data Flow Leadership: US trade policy heavily emphasizes unfettered cross-border data flows, heavily influencing international agreements to reduce digital trade friction for tech and manufacturing multi handers.

AI Impacts on Global Trade: Digital Evidence from the USA

The United States provides a particularly important case for examining how **AI, cloud computing, data infrastructure, and digital platforms are transforming international trade**. However, it is useful to distinguish the measurable effects of **digital technologies** from the more recent and still developing effects that can be attributed specifically to AI.

1. U.S. Leadership in Digitally Deliverable Services

The United States is a major global exporter of digitally deliverable services, including financial services, business services, software-related activities, telecommunications, and other services that can be supplied remotely through ICT networks.

The latest BEA data show that in **2025 U.S. services exports reached approximately $1.238 trillion**, while services imports were about $910.2 billion. (Bureau of Economic Analysis)

More specifically, BEA reported that in **2023**:

- U.S. exports of **digitally deliverable services** = **$655.5 billion**
- U.S. imports = **$388.8 billion**
- Surplus = **$266.8 billion**

This provides strong quantitative evidence of the importance of digital technologies in U.S. international trade. (BEA Apps)

Importantly, BEA defines these as services that **can predominantly be delivered remotely through ICT networks**; therefore, they should not all be interpreted as AI-generated exports. AI is one increasingly important technology within this broader digital-trade ecosystem.

2. AI and Expansion of Cross-Border Digital Services

AI can strengthen this existing U.S. comparative advantage by reducing the cost of producing, processing, translating, analyzing, and delivering information-intensive services.

The principal trade mechanism is:

AI adoption → higher productivity → lower service-production costs → greater international competitiveness → expansion of digital exports

This is particularly relevant for:

- software and IT services;
- financial services;
- consulting and professional services;
- research and development;
- data-processing services;
- cloud-based services;
- online platforms; and
- AI-enabled business services.

In 2024, U.S. services exports increased by **$81.2 billion to $1.108 trillion**, with particularly strong increases in telecommunications, computer and information services, financial services, and other business services. (Bureau of Economic Analysis)

3. Cross-Border Data Flows as a Trade Infrastructure

A second major channel is **cross-border data flows**. For digital services, data are effectively an input into international production and trade. Cloud computing, AI systems, digital platforms, financial technology, and multinational manufacturing increasingly depend on the ability to transfer data internationally.

U.S. trade policy has therefore sought provisions facilitating **cross-border data flows** and electronic commerce. USTR documentation explicitly identifies cross-border data flows as important to the business models and competitiveness of U.S. services and manufacturing enterprises. (United States Trade Representative)

This means that the effect of AI on international trade is not limited to exports of AI products. AI also depends on the **digital infrastructure and regulatory environment that allow data to move internationally**.

4. AI, Global Value Chains and Manufacturing

AI also affects trade in manufactured goods through its use in:

- demand forecasting;
- inventory management;
- quality control;
- predictive maintenance;
- supply-chain optimization;
- automated logistics; and

- International market intelligence.

Consequently, AI can influence **both goods and services trade**. The U.S. evidence is especially relevant because computer equipment and semiconductors are themselves major traded products. In 2025, U.S. exports of computers increased by **$16.7 billion**, while semiconductor-related exports also increased. (Bureau of Economic Analysis)

5. A Stronger Empirical Framework for the USA

For your research, I suggest measuring the U.S. case through **four distinct trade channels**:

AI/Digital channel	Possible measurable indicator	Expected trade mechanism
AI adoption	AI use by firms / AI investment	Productivity and competitiveness
Digital services	Digitally deliverable services exports	Expansion of cross-border services
Data flows	Cross-border data-flow restrictions / digital-trade indicators	Lower digital trade barriers
AI-enabled supply chains	ICT investment, cloud adoption, automation	Lower transaction and logistics costs

A useful conceptual model is:

AI →Productivity →Digital Services Exports →International Trade

With a second channel:

AI+ Cross-border Data Flows →Lower Trade Frictions →Greater Global Trade

Key evidence for the USA

The most compelling quantitative evidence for your study is therefore the **$655.5 billion of U.S. digitally deliverable-services exports and $266.8 billion surplus in 2023**, combined with the continuing growth of total U.S. services exports, which reached **$1.238 trillion in 2025**. (BEA Apps)

This makes the USA a useful benchmark for your **Egypt–UK–USA comparison**: Egypt illustrates an emerging digital-trade economy, the UK demonstrates a highly services-oriented digital economy, while the USA provides evidence from a very large digitally deliverable-services and technology ecosystem.

Further Exploration

- Review a regional analysis on the Economic Research Forum covering Digitalization, International Trade, and Arab Economies.
- Read about the local market potential via Daily News Egypt on Egypt emerging as high-potential market for global digital trade
- Examine broader impacts in the World Trade Organization report on Digital Trade for Development. [1, 2, 3]

Would you like to focus on a specific aspect, such as regulatory barriers to data flows, e-commerce logistics, or statistical models for exports?

Yes. This is a strong and highly researchable Digital Economics–International Trade topic, and it can be developed into a comparative empirical paper focusing on Egypt, the UK, and the USA.

Recommended research title

Digitalization and the Transformation of International Trade: Evidence from Egypt, the United Kingdom, and the United States

A more econometric/Q1-oriented title would be:

Digitalization, Trade Costs, Customs Efficiency, and Cross-Border Services: Comparative Evidence from Egypt, the United Kingdom, and the United States

Core research argument

The paper can test the following mechanism:

Digitalization
→ lower information and transaction costs
→ faster customs clearance
→ greater transparency and trade facilitation
→ lower international trade costs
→ expansion of cross-border digital services
→ higher exports and imports
→ greater international trade competitiveness.

Three dimensions of digitalization

Dimension	Possible indicators	Expected trade effect
Digital infrastructure	Internet users, broadband, mobile connectivity, ICT infrastructure	↓ transaction costs
Digital trade facilitation	Electronic customs, single-window systems, paperless trade, automated clearance	↓ clearance time
Digital services	ICT services exports, digitally delivered services, e-commerce	↑ cross-border services

The Egypt–UK–USA comparison is particularly interesting

Egypt:
Digitalization can be examined as a mechanism for reducing trade costs and improving the competitiveness of Egyptian exporters, particularly through digital customs, the Nafeza single-window system, the Advance Cargo Information (ACI) system, e-payments, and logistics digitalization.

United Kingdom:
The UK provides evidence from a highly developed digital economy, including paperless trade, digital customs procedures, e-commerce and digitally delivered services.

United States:
The USA provides a useful benchmark because of its highly developed digital infrastructure, e-commerce ecosystem, digital services exports and technologically advanced trade environment.

Strong research questions

1. Does digitalization reduce international trade transaction costs?
2. Does digital customs reduce customs-clearance time?
3. Does digitalization increase exports of digitally deliverable services?
4. Does digital infrastructure increase bilateral trade?
5. Is the effect of digitalization stronger in developing economies such as Egypt than in advanced economies such as the UK and USA?
6. Does digitalization improve export competitiveness and trade diversification?
7. Does digitalization have a larger effect on services trade than merchandise trade?

Suggested hypotheses

H1: Digitalization significantly reduces international trade transaction costs.

H2: Digital customs and paperless trade significantly reduce customs-clearance time.

H3: Higher digital connectivity increases cross-border trade in services.

H4: Digitalization has a positive and significant effect on export performance.

H5: The effect of digitalization on trade is stronger when supported by efficient logistics and trade facilitation.

H6: The impact of digitalization differs significantly between Egypt, the UK, and the USA.

A particularly strong empirical model

You could estimate:

Equations to Estimate the effects of Digitalization on Trade

$$Trade_{it}=\beta_0+\beta_1 Digitalization_{it}+\beta_2 Logistics_{it}+\beta_3 GDP_{it}+\beta_4 ExchangeRate_{it}+\beta_5 TradePolicy_{it}+\epsilon_{it} \quad (1)$$

But I would recommend going beyond a simple three-country time series. A bilateral country-pair panel would be much stronger:

$$Trade_{ijt}=\beta 0+\beta 1 Digitalization_{it}+\beta 2 Digitalization_{jt}+\beta 3 TradeCosts_{ijt}+\beta 4 GDP_{it}+\beta 5 GDP_{jt}+\mu_{ij}+\lambda_t+\epsilon_{ijt} \quad (2)$$

Where: i = Egypt, t = UK, and j = USA. Or where ii and jj are trading countries and t is the year.

A structural gravity model would be particularly appropriate because it directly connects digitalization with bilateral trade costs and trade flows.

The most interesting contribution

I would make trade costs the central mechanism rather than simply asking whether "digitalization increases trade."

Your conceptual model becomes:

Digitalization → Transaction Costs → Customs Efficiency → Trade Costs → International Trade

Then add a second channel:

Digitalization → Digital Services Capacity → Cross-Border Services Trade

This gives the paper two measurable transmission channels rather than one.

Data that could support the study

You could combine data from:

- World Bank — Digital Development, GDP, trade and logistics indicators
- WTO — trade and digitally delivered services
- UNCTAD — digital economy, ICT and e-commerce indicators
- OECD — digital economy and trade indicators
- World Bank Enterprise Surveys
- World Bank Logistics Performance Index
- UN Com. or trade — merchandise trade
- IMF — balance of payments and services trade
- ITU — internet and digital-connectivity indicators

- UN Global Survey on Digital and Sustainable Trade Facilitation
- National customs/trade authorities for Egypt, UK and USA

How to Measure the Equations:

Yes. For your research question, the **bilateral country-pair panel is conceptually stronger**, but the equation needs one important correction: **with only Egypt–UK and Egypt–USA, you have just two bilateral pairs**, so the panel is still very small. A stronger empirical design would use many partner countries and include Egypt–UK and Egypt–USA as focal cases.

The international literature also supports measuring digitalization through connectivity, digital trade facilitation, and related digital indicators rather than relying on one proxy. OECD/IMF/UNCTAD/WTO define digital trade as trade that is **digitally ordered and/or digitally delivered**. (OECD)

1. Recommended baseline model

I would formulate your main model as:

$$\text{Ln Trade}_{ijt}=\beta_0+\beta_1\text{Digitalization}_{it}+\beta_2\text{Digitalization}_{jt}+\beta_{3ln}\text{TradeCost}_{ijt}+\beta_{4ln}\text{GDP}_{it}+\beta_{5ln}\text{GDP}_{jt}+\mu_{ij}+\lambda_t+\varepsilon$$

Where:

- Trade $_{ijt}$ = bilateral exports from country i to country ^{j} in year t
- Digitalization $_{it}$ = digitalization of exporter i
- Digitalization _ jt = digitalization of importer jj
- Trade Cost _ ijt = bilateral trade costs
- GDP it = economic size
- μ_{ij} = country-pair fixed effects
- λ_t= year fixed effects
- ε_{ijt}= error term

The coefficient of greatest interest is:

β1

It measures the association between **exporter's digitalization and bilateral exports**, conditional on the other variables and fixed effects.

However, I would also estimate:

β2

Because digitalization in the **destination country** can affect the ability of exporters to reach customers, process payments, exchange information, and participate in digital trade.

2. How should you MEASURE digitalization?

This is the most important methodological issue.

Do **not** simply write "Digitalization" and then choose an arbitrary internet variable.

I recommend constructing a **Digitalization Index (DIGI)** from several dimensions.

Option A — Digital Infrastructure Index

For example:

$DIGI_{it}=F(Internet,Broadband,Mobile,SecureServers,ICT)$

Possible indicators:

Dimension	**Possible measure**
Internet access	Individuals using Internet (%)
Broadband	Fixed broadband subscriptions
Mobile connectivity	Mobile broadband subscriptions
Digital infrastructure	Secure Internet servers
ICT adoption	ICT goods/services indicators

You could standardize each variable:

$Z_{it}=X_{it}-\bar{X}SD(X)$

and then construct:

DIGI it=Z1+Z2+Z3+Z4+Z5

This gives you a transparent **Digitalization Index**.

3. An even better measure for your research question

Because your research question is specifically:

How does digitalization affect international trade?

I would distinguish between **general digitalization** and **trade digitalization**.

This is important because digitalization of an economy is not necessarily the same thing as digitalization of its trade procedures.

UNCTAD's Trade Digitalization Index, for example, focuses specifically on paperless and cross-border paperless trade, including electronic customs declarations, electronic single windows, e-payments, electronic certificates of origin and electronic exchange of customs documents. (UNCTAD)

Therefore, I recommend:

DIGI1 — General Digitalization

DIGI1=Digital Infrastructure/Connectivity

DIGI2 — Trade Digitalization

DIGI2=Trade Digitalization Index

Then estimate:

$$\text{Ln Trade}_{ijt}=\beta_0+\beta_1 DIGI1_{it}+\beta_2 DIGI1_{jt}+\beta_3 DIGI2_{it}+\beta_4 DIGI2_{jt}+\beta_5 \ln TradeCost_{ijt}+\beta_6 \ln GDP_{it}+\beta_7 \ln GDP_{jt}+\mu_{ij}+\lambda_t+\epsilon_{ij}$$

This would allow you to distinguish:

Digital economy → Trade

from

Digitalized trade procedures → Trade

That is a much more interesting research contribution.

4. Measuring Trade

I recommend using **bilateral exports in US dollars**:

Trade $_{ijt}$=Exports $_{ijt}$

and estimate:

ln(Exports $_{ijt}$)rather than the raw value.

For example:

TradeEgypt,UK,2020=Egypt′s exports to UK

Trade Egypt,USA,2020=Egypt′s exports to USA

You can obtain bilateral merchandise trade data from sources such as UN Com trade/WTO datasets.

For a more comprehensive study, estimate separate equations for:

1. **Total merchandise exports**
2. **Manufacturing exports**
3. **ICT-related exports**
4. **Services exports**
5. **Digitally deliverable services**

This is especially relevant because digitalization is expected to have a stronger relationship with digitally deliverable services than with some traditional goods.

OECD research finds that digital connectivity is associated with increased international trade and estimates an average association of a 1% increase in domestic digital connectivity with a 1.5% increase in international trade. (OECD)

5. Measuring Trade Costs

This variable is particularly important for your proposed research.

Instead of using only the Logistics Performance Index, I recommend:

Trade Cost ijt

Using the **WTO Trade Cost Index** where available.

The WTO's Trade Cost Index provides bilateral/sectoral estimates of the frictions making international trade more costly than domestic trade and covers 75 economies and 25 sectors for 1995–2022. (Trade Cost Index)

You can therefore test your central mechanism:

Digitalization →Lower Trade Costs →Higher Trade

This is much more powerful than simply showing that digitalization and exports move together.

6. Your research can therefore have THREE equations

I strongly recommend this structure for your paper.

Model 1 — direct effect

$$\text{Ln Trade}_{ijt}=\beta_0+\beta_1 \text{ DIGI}_{it}+\beta_2 \text{ DIGI}_{jt}+\beta_3 \ln \text{GDP}_{it}+\beta_4 \ln \text{GDP}_{jt}+\mu_{ij}+\lambda_t+\epsilon_{ijt}$$

Here:

$\beta 1, \beta 2$

Measure the relationship between digitalization and bilateral trade.

Model 2 — Digitalization and trade costs

Then estimate:

$$\text{Ln Trade Cost}_{ijt}=\alpha_0+\alpha_1 DIGI_{it}+\alpha_2 DIGI_{jt}+\alpha_3 \ln GDP_{it}+\alpha_4 \ln GDP_{jt}+\mu_{ij}+\lambda_t+\nu_{ijt}$$

Your expected result is:

$\alpha_1<0$

And potentially:

$\alpha_2<0$

If digitalization in both countries reduces bilateral trade frictions.

The WTO identifies ICT connectivity, information and transaction costs, and governance, transport and trade-policy differences among important determinants of trade costs. (Trade Cost Index)

7. Model 3 — Mediation effect

Then put trade costs back into the trade equation:

$$\text{Ln Trade}_{ijt}=\beta_0+\beta_1 DIGI_{it}+\beta_2 DIGI_{jt}+\beta_3 \ln TradeCost_{ijt}+\beta_4 \ln GDP_{it}+\beta_5 \ln GDP_{jt}+\mu_{ij}+\lambda_t+\epsilon_{ijt}$$

Now you can test whether:

Digitalization →Trade Cost →Trade

Is an important transmission mechanism.

This would give your paper a much stronger economic story.

8. Add exchange rate and trade policy carefully

Your first equation includes:

Exchange Rate

And

Trade Policy

These can be included, but there is an important panel issue.

I would use:

Tariff_{ijt}

Or a bilateral trade-policy indicator rather than simply the country's exchange rate.

A fuller gravity specification would therefore be:

$$\text{Ln Trade}_{ijt}=\beta_0+\beta_1 DIGI_{it}+\beta_2 DIGI_{jt}+\beta_3 \ln \text{Trade Cost}_{ijt}+\beta_4 \ln GDP_{it}+\beta_5 \ln GDP_{jt}+\beta_6 \text{Tariff}_{ijt}+\beta \text{Exchange Rate}_{it}+\mu_{ij}+\lambda_t+\epsilon_{ijt}$$

But I would **not overload the baseline model** with too many highly correlated digital indicators.

9. Very important: your current three-country design

You wrote:

i=Egypt, t=UK, j=USA

This is not correct notation for a bilateral panel.

It should be:

- ii = exporting country
- jj = importing country
- tt = year

For example:

i j t

Egypt UK 2010

Egypt UK 2011

Egypt USA 2010

Egypt USA 2011

UK Egypt 2010

UK USA 2010

USA Egypt 2010

USA UK 2010

If you only use Egypt, UK and USA, you can construct at most six directed bilateral relationships per year:

Egypt →UK

UK →Egypt

Egypt →USA

USA →Egypt

UK→USA

USA→UK

But this is still a **very small sample**.

My recommendation

Use:

Egypt + a sufficiently large set of trading partners, perhaps 30–50 countries, over a long period.

Then make:

UK and USA the two major case-study partners.

This produces a much stronger empirical design.

10. The ideal research design

I would therefore structure your study as:

Research title

The Impact of Digitalization on International Trade: Evidence from Egypt, the United Kingdom and the United States

Empirical strategy

Stage 1 — Descriptive analysis

Digitalization:

$DIGI_{Egypt}$, $DIGI_{UK}$, $DIGI_{USA}$

Versus

Exports Egypt, Exports UK, Exports USA

Stage 2 — Bilateral gravity model

$$\ln Trade_{ijt}=\beta_0+\beta_1 DIGI_{it}+\beta_2 DIGI_{jt}+\beta_3 \ln TradeCost_{ijt}+\beta_4 \ln GDP_{it}+\beta_5 \ln GDP_{jt}+\mu_{ij}+\lambda_t+\epsilon_{ijt}$$

Stage 3 — Trade-cost mechanism

$$\ln Trade\ Cost_{ijt}=\alpha_0+\alpha_1 DIGI_{it}+\alpha_2 DIGI_{jt}+Controls+\mu_{ij}+\lambda_t+\nu_{ijt}$$

Stage 4 — Digital trade facilitation

Replace general digitalization with:

Trade Digitalization Index

And estimate:

$$\ln Trade_{ijt}=\beta_0+\beta_1 TDI_{it}+\beta_2 TDI_{jt}+\beta_3 \ln TradeCost_{ijt}+\beta_4 \ln GDP_{it}+\beta_5 \ln GDP_{jt}+\mu_{ij}+\lambda_t+\epsilon_{ijt}$$

This is particularly attractive because UNCTAD's TDI is explicitly designed around digitalization of trade procedures. (UNCTAD)

11. How to interpret β_1

Suppose your dependent variable is:

Ln Trade

And digitalization is measured in levels.

If you estimate:

$\beta_1=0.08$

Then a one-unit increase in the digitalization index is associated with approximately an **8% increase in bilateral trade**, holding the other variables constant.

If digitalization is itself in logarithmic form:

$\ln Trade_{ijt}=\beta_1 \ln DIGI_{it}+...$

Then β_1 becomes an **elasticity**.

For example:

$\beta_1=0.25$

Means that a 1% increase in exporter digitalization is associated with approximately a **0.25% increase in bilateral exports**, ceteris paribus.

12. One major econometric improvement

There is a potential **endogeneity problem**:

Digitalization →Trade

But also:

Trade →Digitalization

Countries that trade more may invest more in digital infrastructure.

Therefore, I would not rely only on OLS.

Your empirical strategy could compare:

FE → PPML → IV/Dynamic specification

Preferred estimator for the gravity model

Consider **PPML with high-dimensional fixed effects (PPML-HDFE)** rather than simply OLS on log trade.

This is especially useful because bilateral trade data contain **zero trade flows**, and taking ln (Trade) eliminates zero observations.

13. The strongest conceptual framework

Your paper could ultimately test:

Digitalization⟶Lower Information/Transaction Costs⟶Lower Trade Costs⟶Higher International Trade

With:

Digital Infrastructure ↓

Digital Trade Facilitation ↓

Lower Trade Costs↓

Higher Bilateral Trade

This is consistent with current international measurement work: OECD research explicitly links digital connectivity and digital trade policies with lower trade costs and higher trade, while UNCTAD's framework identifies paperless and cross-border paperless processes as measurable components of trade digitalization. (OECD)

For **Egypt specifically**, this distinction is particularly useful because OECD's Egypt survey reports relatively strong 4G coverage but comparatively lower broadband penetration and a smaller share of digitally deliverable services than the OECD average—illustrating why simply using "Internet users" would not fully capture trade-related digitalization. (OECD)

My recommended final specification

For research, I would make this the **main equation**:

$$\text{Ln } Xijt=\beta_0+\beta_1 DIG_{iit}+\beta_2 DIG_{ijt}+\beta_3 TDI_{it}+\beta_4 TDI_{jt}+\beta_5 lnTC_{ijt}+\beta_6 lnGDP_{it}+\beta_7 lnGDP_{jt}+\mu_{ij}+\lambda_t+\epsilon_{ijt}$$

Where:

X = bilateral exports
DIGI = general digitalization index

TDI = trade digitalization index
TC = bilateral trade costs
GDP = economic size
μ_{ij} = bilateral-pair fixed effects
λ_t = year fixed effects.

This gives you a **testable, publishable empirical framework** rather than merely a correlation between Internet use and exports. OECD and UNCTAD's current measurement frameworks provide a strong basis for constructing the digitalization variables. (UNCTAD)

The Future Studies

- **The Future of Digitalization and International Trade: Comparative Evidence from Egypt, the United Kingdom, and the United States, 2025–2040.**
- **Digitalization, Artificial Intelligence and the Future of International Trade: A Comparative Scenario Analysis of Egypt, the UK and the USA, 2025–2040.**