The Role of Artificial Intelligence In Accelerating International Trade: Evidence From Panel Data Analysis

Udara Rangana Jayathilaka
Department Of Global Business Management
Gangseo University, Seoul , South Korea.
ORCID

Abstract

Technology has historically played a role in shaping international trade, but the current explosion in Artificial Intelligence has the potential to radically alter global commerce in the years ahead. In this research, we hypothesized that the AI capability of a nation has a major impact on international trade. This study discusses different ways in which technological advancements in the AI domain are improving global trade. We tested the hypothesis using the WDI, Government AI Readiness Index panel dataset of 150 countries for the years 2018-2021. Fixed effect, and Random effect panel models were applied. The results show that the AI capability of a nation has a major positive influence on trade. The findings also show that GDP and exchange rate have significant positive impacts, and inflation and trade restrictions have negative and significant impacts on trade. The findings of this study recommend strengthening the nation's AI capacity to increase its trade volume. AI will stimulate better economic development and open up new avenues for international trade to the extent that it fosters productivity growth. However, governments will need time to adapt and employ new AI technology, since doing so requires significant financial investments, access to skilled people, and a shift in how international companies are operated.

Keywords: Artificial Intelligence, International Trade, Panel data, Supply chain, Technology

Introduction

Trade and technological advancements are intrinsically intertwined. Technology has always played an important part in altering the way nations trade, from the development of the wheel and the railroads to the introduction of containerization, and this trend is happening at a faster rate than ever before. Innovations that take use of the internet might have a significant influence on this period of rapid technological development. Some technologies, including the IoT, AI, and Blockchain, may drastically alter the nature of commerce, including who engages in it, what is transacted, and how (Alhaddad, 2018b, 2018a; Tarafdar, Beath and Ross, 2019).

The last two hundred years have been responsible for an impressively long number of key advancements, one of the most notable of which is artificial intelligence (AI). The exponential growth in computer power, bandwidth, and digital information has paved the way for AI and other digital advances. Through their widespread use, they have altered the nature of internet commerce.

Applications in nonservice industries (e.g. manufacturing) followed after the technology had proven successful in the technology services industry. There are now lower barriers of entry for new businesses, especially in the service sector, as a result of falling capital costs. While artificial intelligence (AI) has the potential to increase average wages and enhance well-being, it also has the potential to disrupt labor markets, increase inequality, and promote growth that is not inclusive. In addition to altering the economy, public safety, and world trade, artificial intelligence is among the many evolving and supporting technologies with far-reaching ramifications for all of society (De Stefano, 2018).

Buyer habits have been drastically altered due to the rise of digital technology (Popkova and Gulzat, 2020). Smartphones, tablets, and personal computers, all of which can connect to the web, are examples of gadgets that are widely used. These gadgets provide customers instantaneous access to internet marketplaces and data. Companies' use of digital marketing strategies has improved customers' ability to obtain information about items on the market. Big data analysis and machine learning's recent advancements have been game-changers for monetizing data in the realm of digital services. The personalization of services was the first major shift brought about by this revolution in business, and it contributed to the growth of online commerce by improving the convenience of transactions and the well-being of consumers.

The economic effect that artificial intelligence is already having on a worldwide scale is enormous. There are several facets to the economic development that AI affects. First, it improves work efficiency and international exchange (Brynjolfsson, Rock and Syverson, 2018). The macroeconomic consequences of AI are one way in which this technology contributes to economic development. For example, when AI contributes to an increase in productivity growth, that rise in productivity growth also contributes to an increase in economic growth. Additionally, it expands possibilities for international commerce (Vinuesa *et al.*, 2020).

AI assists in optimizing the administration of complex manufacturing facilities. Artificial intelligence (AI) provides a centralized management solution for enterprises, allowing them to better manage complicated, dispersed production units (Acemoglu and Restrepo, 2018). AI may help a company in many ways; for instance, it can aid in inventory management, forecast customer demand, and increase the precision of its fast turnaround and delivery processes. The AI technologies also helped the proliferation of digital platforms. Artificial intelligence has made it feasible to do business on digital marketplaces (Raykhel and Ventura, 2009). As an example, eBay employs AI to automate many of its processes (Kumar and Trakru, 2020).

With the rise of globalization, technical progress, industrialization, and the exporting of services, international commerce is rapidly becoming a central factor in the monetary and economic policies of nations across the globe (Bhagwati, Panagariya and Srinivasan, 1998). The potential gains from engaging in international commerce are substantial: more income, stronger diplomatic ties, more resources, and a more robust economy as a whole. The national economies of today's world are intertwined and dependent upon one another. It is difficult to discover examples of closed economies in the modern era (van Marrewijk *et al.*, 1997). All global economies are now accessible to everybody. However, the level of openness varies considerably from nation to nation. As a result, no nation can claim to be totally self-sufficient in the present day. In this context, "self-sufficiency" refers to the degree to which a nation can meet its own needs via domestic production alone. However, the extent to which different nations are self-sufficient differs considerably (Grimwade, 2003; Feenstra, 2015).

Through trading with other nations, these countries are able to increase their consumer bases and get access to products that may not be produced in their own country. Globalization has increased the level of competition in the marketplace (Reinsdorf and Slaughter, 2009; Stern, 2009). In the

end, this fosters price competition, which benefits consumers by bringing down final costs (Jayathilaka, 2021b).

The elimination of global poverty depends on trade. Countries with liberal trade policies enjoy better rates of economic growth, innovation, productivity gains, and overall prosperity. Those with lesser incomes may also reap the benefits of open commerce since prices drop across the board. Boosting economic development and alleviating poverty on a worldwide scale, integration with the global economy via trade and global supply networks is essential.

The impact of AI on international trade

In this research, we argue that AI capability of a nation has major impact in trade. We discuss four different ways in which technological advancements in AI domain are improving global trade.

First, AI facilitates the development of more proactive global supply chains (Min, 2010; Baryannis *et al.*, 2019). Data is already vital to the success of supply chains from the very beginning to the very end. Data from online purchases, warehouse packing slips, and shipment station freight scanning may all be fed into an AI-driven logistics platform (Jayathilaka, 2020). A supply chain may reap several advantages from participating in such a scheme. They are able to foresee problems in the supply chain and make preparations accordingly. In this way, they may anticipate consumer habits and adjust inventory levels accordingly, avoiding both under- and over-ordering. Additionally, they can anticipate client cancellations and determine the most efficient and economical international shipment routes. In the end, a supply chain powered by AI is a proactive distribution network, one that is highly adaptable and can mitigate the effects of unavoidable disruptions.

Utilizing AI in warehouse management has several advantages. Improved performance of warehouse robots; accelerated pace at which shipments are received, identified, sorted, and pulled; increased productivity because the the use of artificial intelligence technologies to simplify and centralize operational activities inside the warehouse (Dash *et al.*, 2019; Pasonen, 2020; Pervaiz, 2020). Predicting consumer trends, analyzing inventory, and planning streamlined transportation procedures like loading, shipping, unloading, and delivery are all made easier and more timely by AI systems' usage of sophisticated neural networks and machine learning (Jayathilaka, 2021a). It protects valuable goods and limit the possibility of human mistake in the logistics process by using AI systems to foresee and avert potential security threats, as well as to monitor and protect against errors and harm to deliveries. Second AI is improving efficiency-boosting compliance software.

Compliance is one of the most difficult aspects of doing business internationally. Businesses need to keep investigate customers, vendors, or partners who may be breaking trade regulations. Keeping up with the ever-changing nature of these regulations may be a significant time drain for foreign firms. Compliance technology already available, of course, but it has its limitations. Because of its high rate of false detection and false classification, it often needs human inspection. Third, AI is improving Contracts. Many contracts are created by the trading industry. Although it is costly to create, evaluate, and adhere to such contracts, they are generally ignored until a dispute arises. Artificial intelligence (AI) has the potential to simplify and clarify complex legalese in trade papers, allowing firms to more effectively operate within the terms of the contract and perhaps reducing the likelihood of legal disputes (Carneiro *et al.*, 2014; Elziny *et al.*, 2016). Artificial intelligence software with a legal focus can keep track of the company's contracts and guarantee that they are being followed consistently. As a result, businesses are better able to avoid legal trouble and reap the benefits of the contract in the form of timely payments and delivery from their

customers and suppliers. With the help of AI, companies may comply with their obligations in a timely manner and without incurring unnecessary risks.

Fourth, AI is improving the accessibility of trade financing. The way banks finance enterprises involved in international commerce is one area where AI might be useful. The majority of companies that engage in international commerce need some kind of finance, although this funding may be challenging to get. Concerns regarding traders' ability to comply with trade regulations have made many financial institutions wary of lending to the trading community. To analyze loans for multinational enterprises, banks often employ compliance officers, which may drive up financing costs. However, AI can now take on this task. With the time and cost of compliance assessment reduced, several financial institutions are using artificial intelligence tools to examine compliance and expanding their financing possibilities for foreign enterprises. Companies are using AI to improve a wide range of operations, from supply chain management and legal disputes resolution to demand forecasting and customer service (Belanche, Casaló and Flavián, 2019; Jakšič and Marinč, 2019).

The financial industry makes use of AI technology to enhance and simplify the handling of money. For instance, by utilizing machine learning and extensive data sets, AI systems aid banks in making more informed loan decisions. While it is not immune to biases, employing AI in credit screening offers the potential to increase access to finance for underbanked lenders. Risk analysis is another use of AI technologies in the finance industry (Alhaddad, 2018a). Using current data, AI systems may more precisely forecast financial hazards by locating patterns, identifying dangers, shortening assessment times, and facilitating business processes and anti-money laundering activities.

Several new norms will need to be established before artificial intelligence may be used in mass-produced goods. For instance, the advent of autonomous cars would need a revised set of rules for the construction and security of motor vehicles. International talks on interoperability to eliminate obstacles to trade in goods that include AI will be sparked by the emergence of diverse domestic standards across countries, which might raise costs for foreign producers that need to reconfigure in order to export.

One barrier to the progress of AI is the need of transparency to source code as a prerequisite for investment or market entry. Many countries have emphasized the need for such access as part of the larger problem of coerced technology transfer. Since AI relies on algorithms, tying market entry to the disclosure of those algorithms acts as a barrier to international commerce that slows the spread of AI throughout the world.

The advancement of AI also brings up concerns around intellectual property (IP). For utilization, training data often has to be transferred and updated. This might include the illicit copying of hundreds of copyrighted works, based on how the data is gathered. In some countries, it is possible that such data usage will be lawful if the "transformative" or "non-expressive" fair use exemption to copyright protection is used. A flexible collection of principles-based copyright exemptions is offered by fair use. Even within the major economies, it is still unknown if fair use exclusions will apply to some of the trickier ways that data is used to train AI. Moreover, many other nations lack fair use exemptions or comparable copyright flexibility. From the standpoint of international commerce, this implies that the legal copying of data used to build AI in one country may be seen as unlawful in other nations, posing a barrier to the use of AI in these nations.

Despite the enormous utility of data in digital commerce, market concentration may also be affected by it due to data-driven economies of scale and the potency of network effects. For small and medium-sized businesses without access to sufficient quantities and diversity of data to enhance the efficiency of their goods and services, this might result in excessively high entry barriers.

Nevertheless, there is also a rising debate about whether it is necessary to change or clarify current trade obligations and laws. The foundation of trade regulations has historically been the distinction between commodities and services, as well as the borders that the items cross. However, in the digital age, these divisions are not always evident. The ability of businesses to operate flexibly from several places and to package commodities with services makes it complicated to determine the exact trade regulations that apply to a given transaction.

Literature review

AI advancement will have a wide-ranging impact on international commerce according to the international trade literature. (Meltzer, 2018) argued that the first is the macroeconomic implications of AI and the trade implications. For example, if AI increases productivity growth, this would boost economic development and open up new potential for international commerce. AI will also influence the kind and level of economic development, with ramifications for international commerce. For example, AI is anticipated to hasten the shift to service economies. This is a logical extension of issues about the effect of AI on employment, since AI is anticipated to spread automation and hasten job losses for low-skilled, blue-collar employees in industrial areas.

(Meltzer, 2018) further argued that there is a significant possibility that artificial intelligence (AI) will have a revolutionary effect on international commerce. Already, certain applications in fields like as data processing and machine translations are helping to lower the obstacles that exist in the way of commerce. At the same time, there seem to be obstacles in the advancement of artificial intelligence that may be addressed by international trade norms. One of these obstacles is the improvement of worldwide access to data that can be used to train AI systems.

(Goldfarb and Trefler, 2018) argued that AI will revolutionize some of the main categories of international commerce in products (e.g., autonomous automobiles) and international services trade within a generation (e.g., financial services). Interestingly, AI applications have already spread to some emerging countries, some of which is poised to become the global leader in AI in less than a decade. This is a breakthrough with the potential to reshape global trade patterns. AI will create game-changing goods and services that will disrupt global trade patterns. As a result, understanding how backstage regulatory and industrial regulations effect competitive advantage in AI-based goods is critical.

(Horowitz, 2018) and others including (Villani *et al.*, 2018; Dignum, 2019; Abbott, 2020) explained more beneficial uses of AI with potentially substantial positive consequences on our economy and culture are anticipated to emerge. At the same time, much of these advancements will cause disruptions in how AI augments or replaces human work, posing new challenges to the economic structure as a whole. The nature and direction of such developments are likely to be influenced by implementation design and policy choices taken in the near term, making it critical for Researchers in this field, programmers, academic researchers, and legislators to adjust the imperative to drive innovation with methods to ensure that AI's social and economic gains are widely exchanged across society.

The concept of a 4th Industrial Revolution driven by robots and AI is another method of portraying hopeful prospects for economic development (Boyd and Holton, 2018). Beyond the 1990s computer-based Third Industrial Revolution, this strategy. There has been a recent claim that the exponential growth in data storage, computing power, and wireless internet technology, as well as the increased ability to combine technological advances, means that we are rapidly approaching a transformative take-off point at which artificial intelligence and robotics will become a general system.

In their paper, (Dauth *et al*., 2017) analyze the equilibrium effect across sectors and regional labor markets in Germany, as well as the influence on the employment of individual industrial employees who have been more exposed to robots. Even if they do not find evidence that robots will eliminate all jobs, they will change the makeup of the workforce overall. One robot eliminates two manufacturing jobs. About 275,000 manufacturing jobs were lost in Germany between 1994 and 2014, which accounts for about 23 percent of the total loss in manufacturing employment in Germany.

(Makridakis, 2017) argued that the greatest obstacle that societies and businesses will face is figuring out how to make the most of the benefits that artificial intelligence technologies have to offer, such as vast possibilities for both new products and services and immense improvements in productivity, while simultaneously ignoring the risks and disadvantages associated with rising unemployment and rising wealth disparities. The research comes to the conclusion that those who make extensive use of the Internet and are willing to take risks as business owners in order to transform innovative products or services into commercial successes on a global scale will continue to enjoy significant advantages over their competitors in the future.

Methodology

We start the empirical analysis by defining dependent and the intendent variables.

$$Trade_{ij} = f(AI_{ij}, Z_{ij}) \qquad (1)$$

Where, Trade represents the trade volume of the country. According to our model, the trade volume depends on two factors: AI and Z. AI represents Artificial intelligence capability, and Z represents other control variables that may affects the trade volume in a country. They include variables such as GDP, inflation rate, and exchange rate etc. Following the previous studies discussed in the literature review section, we included 4 control variables: GDP, inflation rate, trade restrictions, and exchange rate. The final model is formulated as follows in equation 2:

$$Trade_{ij} = \left\langle \begin{matrix} \alpha + \beta_1 GDP_{ij} + + \beta_2 AI_{ij} + \beta_3 \inf_{ij} + \\ + \beta_4 TR_{ij} + + \beta_5 ER_{ij} + \varepsilon_{ij} \end{matrix} \right\rangle \qquad (2)$$

Panel data are particularly relevant when it is observed that the dependent variable is dependent on explanatory factors that cannot be directly seen but are connected with the explanatory variables that can be directly observed. Panel data estimators make it possible to get a reliable estimate of the influence of the observable explanatory factors if the variables that are left out remain the same throughout time. Panel data can be arranged in a matrix form as follows:

$$\begin{matrix} & Countries \\ Year & \begin{pmatrix} Trade_{11} & \cdots & Trade_{1n} \\ \vdots & \ddots & \vdots \\ Trade_{t1} & \cdots & Trade_{tn} \end{pmatrix} \end{matrix}$$

Because the fixed-effects model accounts for all time-invariant variations between individuals, the predicted values of the fixed-effects methods cannot be affected by omitted time-invariant attributes (Hayashi, 2011). For example, culture, religion, gender, ethnicity, and so on. If the unobserved factor does not vary over time, all variations in the dependent measure must be caused by forces other than the fixed features. One of the criticisms leveled against the fixed effect method is that it consumes a large degree of freedom, leading to weak results (Robson and Dougherty, 1993).

The random effects method is based on the assumption that the individual-specific impact or variation among entities is a random process that is mutually independent with the determinant variables. The critical difference between fixed and random effect is that the unobserved independent effect contains aspects that are associated with the model's regressors, not if these impacts are unpredictable or not (Rouzier and Kennedy, 1980). Random effects have the benefit of include time invariant characteristics such as gender, while fixed effects absorb all time invariant variables. Individual error terms are not associated with determinants in this case, allowing time invariant elements to serve as explanatory variables (Verbeek, 2008).

Results

The analysis begins with data pre-processing stage. This stage involves transforming the raw datasets into similar scale. After the data pre-processing stage, a pairwise relationship was tested with scatterplot with Kernel fit line. The figure 1 shows scatterplot with kernel fitted line (Red). It can be seen that the relation between AI and Trade volume moves in a positive direction, thus, the kernel fit line has an overall positive slope.

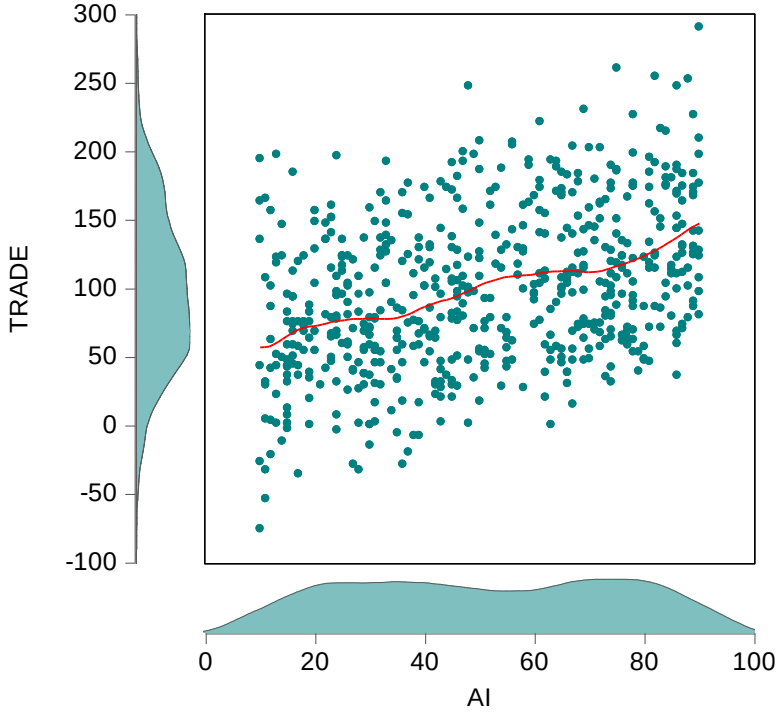

Figure 1. Trade and artificial intelligence with Kernel fit

Table 1. Results of fixed effect estimation

Dependent Variable: TRADE
Method: Panel Least Squares
Sample: 2018 2021
Periods included: 4
Cross-sections included: 150
Total panel (volumed) observations: 600
Period weights (PCSE) standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP	1.022614	0.048498	21.08569	<0.01
AI	0.992641	0.046883	21.17276	<0.01
INF	-0.988917	0.049534	-19.96453	<0.01
TR	-1.002840	0.045781	-21.90524	<0.01
ER	1.015616	0.048751	20.83282	<0.01
C	47.20383	5.380942	8.772410	<0.01

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.871619	Mean dependent var	99.32000
Adjusted R-squared	0.827190	S.D. dependent var	57.04432
S.E. of regression	23.71355	Akaike info criterion	9.387781
Sum squared resid	250237.9	Schwarz criterion	10.52365
Log likelihood	-2661.334	Hannan-Quinn criter.	9.829954
F-statistic	19.61844	Durbin-Watson stat	2.685480
Prob(F-statistic)	<0.0100		

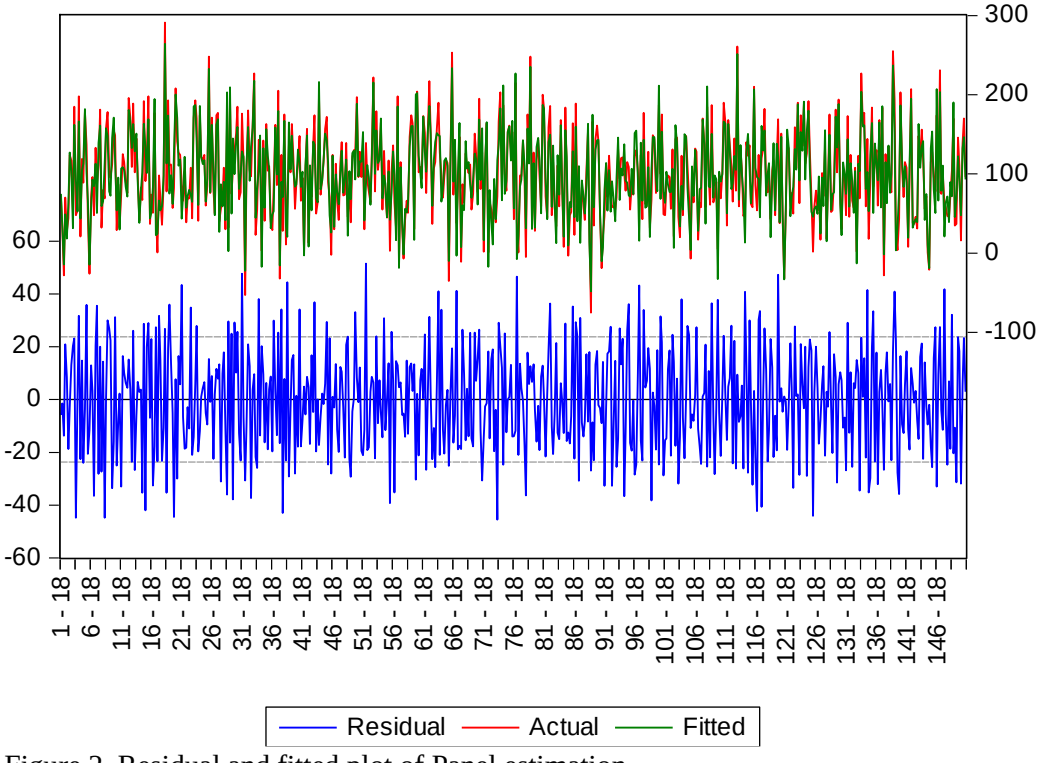

Figure 2. Residual and fitted plot of Panel estimation

Table 2. Results of Random effect estimation

Dependent Variable: TRADE
Method: Panel EGLS (Two-way random effects)
Sample: 2018 2021
Periods included: 4
Cross-sections included: 150
Total panel (volumed) observations: 600
Wansbeek and Kapteyn estimator of component variances
Period weights (PCSE) standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP	1.019776	0.041798	24.39783	<0.01
AI	0.999899	0.041179	24.28173	<0.01
INF	-0.999412	0.044122	-22.65087	<0.01
TR	-0.998709	0.040261	-24.80569	<0.01
ER	0.977310	0.042628	22.92626	<0.01
C	49.20161	4.819784	10.20826	<0.01

Effects Specification	S.D.	Rho
Cross-section random	4.034598	0.0281
Period random	1.462058	0.0037
Idiosyncratic random	23.66814	0.9682

Weighted Statistics			
R-squared	0.824443	Mean dependent var	76.43112
Adjusted R-squared	0.822966	S.D. dependent var	56.26901
S.E. of regression	23.67544	Sum squared resid	332952.8
F-statistic	557.9044	Durbin-Watson stat	2.009436
Prob(F-statistic)	<0.0100		

Table 3. Coefficient Confidence Intervals

Sample: 2018 2021
Included observations: 600

		90% CI		95% CI		99% CI	
Variable	Coefficient	Low	High	Low	High	Low	High
GDP	1.019776	0.950917	1.088634	0.937686	1.101865	0.911765	1.127787
AI	0.999899	0.932059	1.067738	0.919024	1.080773	0.893486	1.106311
INF	-0.999412	-1.072100	-0.926723	-1.086067	-0.912757	-1.113430	-0.885394
TR	-0.998709	-1.065036	-0.932382	-1.077781	-0.919637	-1.102749	-0.894669
ER	0.977310	0.907083	1.047537	0.893590	1.061031	0.867153	1.087468
C	49.20161	41.26139	57.14183	39.73572	58.66750	36.74665	61.65656

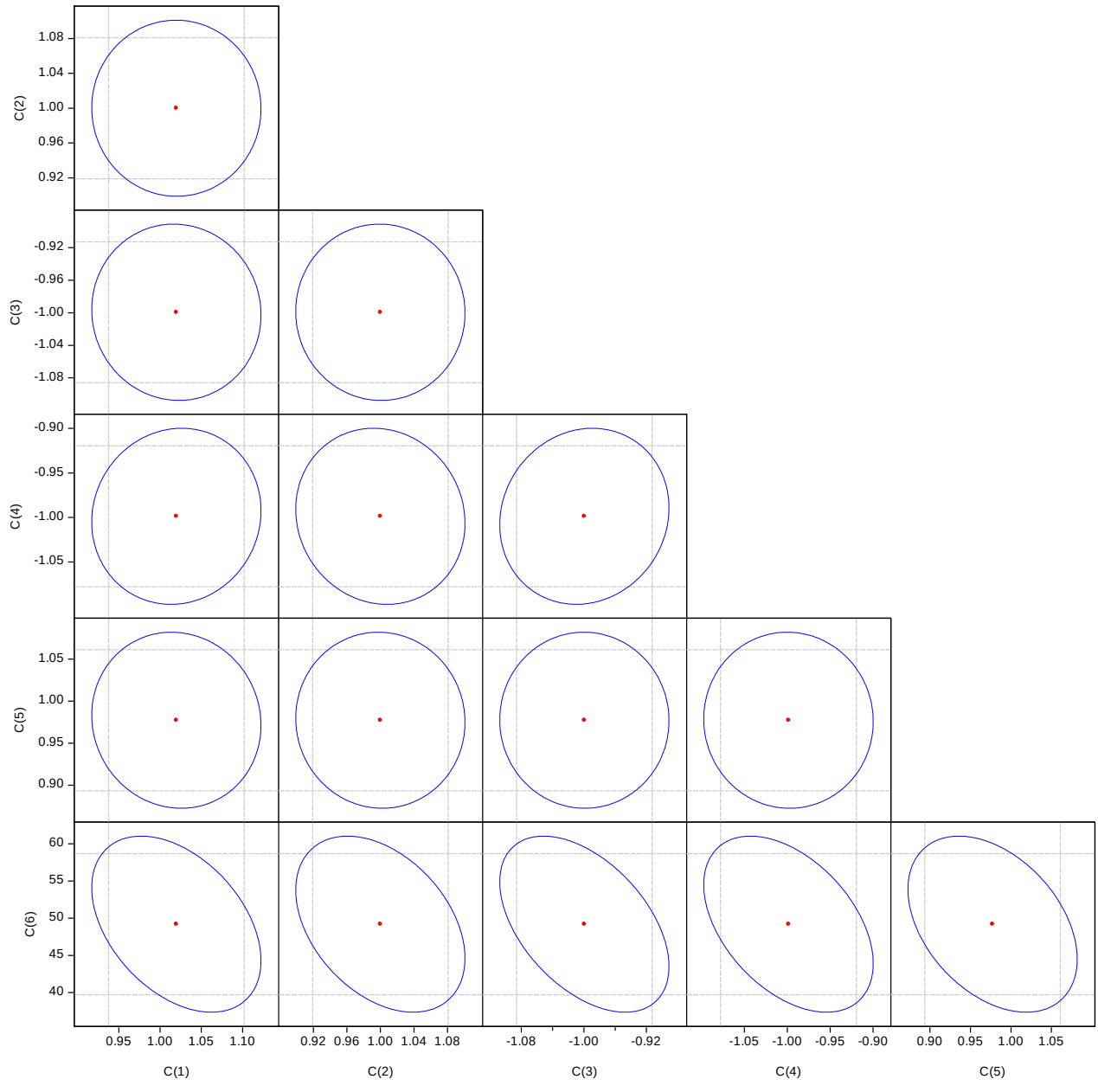

Figure 3. Confidence ellipses of coefficients

The table 3 shows confidence intervals for each independent variables at different level of statistical confidence levels, 90%, 95%, and 99%. The figure 3 displays the corresponding confidence intervals at 95%. Both the table and figure show that the low and high values of the coefficients stay at the expected intervals with expected signs.

The results of the Fixed effect model and random effect model are shown in Table 1 and 2, respectively. As previously indicated, our model has trade volume (Trade) as the dependent variable and we have added 5 independent variables in the equation. They are as follows: 1) GDP, 2) AI 3) Inflation rate (inf), 4) Trade restriction (TR), and 5) exchange rate (ER). Table 1 and Table 2 show the results fixed effects and random effect model, respectively. Both tables show that the coefficients of GDP, AI, and exchange rate is positive and significant. This implies that all the 3 variables have significant positive impacts on trade volume. On the other hand, inflation and trade restrictions index have negative and significant coefficients. This indicates that both inflation rate

and trade restrictions negatively impact trade volume of a country. The results indicate that the p-value for GDP is less than 1%. This suggests that GDP has major influence on trade volume. The variable AI has a p-value of less than 1%. This suggests that the AI capability of a nation has a major influence on trade volume. Furthermore, the p-value for the inflation rate is less than 1%. This shows that inflation rate has significant influence on trade volume.

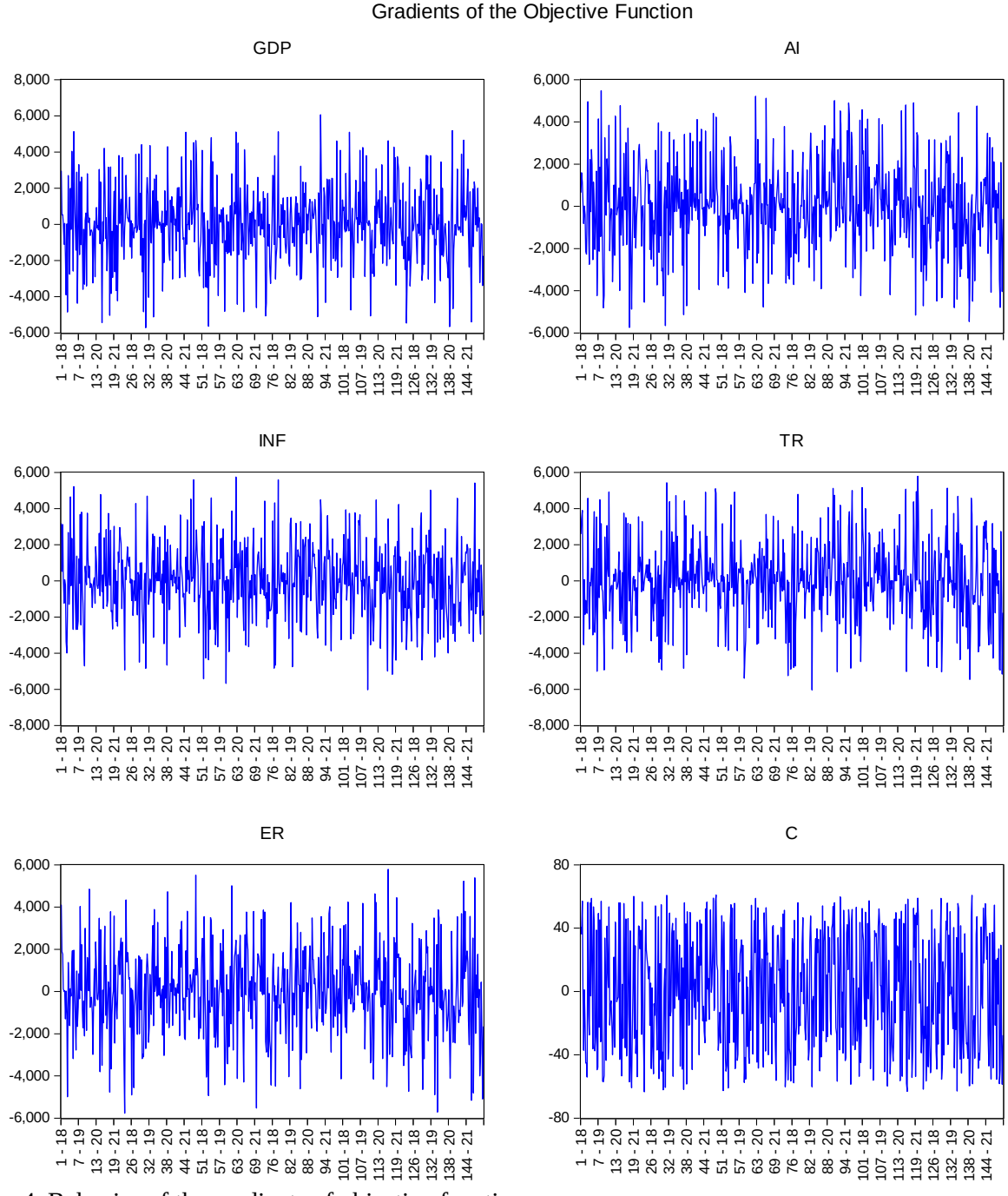

Figure 4. Behavior of the gradients of objective function

The p-value for the trade restriction variable is is less than 1%. This suggests that trade restriction has also significant influence on trade volume. Finally, the p-value for exchange rate is less than 1%. This shows that exchange rate positively and significantly causes trade volume. All of the coefficients have expected signs, supporting the hypotheses of this research.

Conclusion

Although AI's revolutionary effects have already been felt in some sectors, many international business benefits are expected to be realized in the years to come. It has had far-reaching effects on business practices and economic development even today. An even more recent wave of technologies, fueled by advancements in computers, telecommunications, and the worldwide communication networks they have spawned, are reshaping the international economy.

AI will encourage stronger economic development and provide new possibilities for international commerce to the degree that it increases productivity growth. However, it will take some time for countries to adopt and use new AI technologies, which call for substantial financial expenditures, access to trained labor, and a change in how businesses are conducted.

Numerous possibilities may arise as a result of these advancements for people, companies, and entrepreneurs all across the globe. But this procedure is not automated. Increased trade development and economic integration are not, in and of themselves, ensured by technological advancements. History demonstrates that ensuring that everyone benefits from structural changes brought on by technology is essential. We must thus learn how to use this new technology. The ability of the trade system to encourage growth, development, and the creation of jobs is essential for assisting in the endeavor to achieve the Sustainable Development Goals. The development of digital technology may potentially alter how commerce is structured. Digital technology may promote trade in services and allow for the emergence of new services in addition to facilitating trade in products.

Despite the advantages of modern technology, a lot of worries are also being raised by them. This includes concerns about market concentration, privacy invasion, security risks, the knowledge gap, and the claim that productivity has not really improved as a result of digital technology. Governments may have to consider how to address many of these issues domestically, including via the implementation of trade policy, regulation, and investments in human resources and digital infrastructure. Governments may get greater advantages from digital commerce and promote inclusiveness by collaborating internationally.

This article is intended to serve as a foundation for other articles, papers, readings, and research endeavors. In light of the assertions presented in this study, the next steps for emphasizing the effects on business and the economy should include the production of further academic works backed by statistical and market research methodologies.

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