**Chapter**

# Digitalization, Comparative Advantages, and Digital Divide

*Guang-Jong Fann, Su-Ying Hsu and Chu-Ping Lo*


## Abstract

This study presents a simple model to elucidate the pivotal role of digital intensity in shaping a nation's competitiveness on the global stage. We introduce digitalization into Krugman's dynamic comparative advantage model, in which we suppose that technology development depends on an index of cumulative experiences and these experiences have to be conducted through digitalization. We argue that digitalization has the potential to trigger a positive feedback loop, particularly in countries characterized by elevated digital intensity. This phenomenon leads to heightened productivity, often translating to a competitive edge in tradable sectors and amplified income levels relative to other nations. Nevertheless, the widening divergence in digital intensity between developing (the South) and developed (the North) countries, referred to as the digital divide, poses a challenge by amplifying income inequality across these regions. This proposed model emphasizes the crucial role of the disparity in access to digital infrastructure in perpetuating the digital divide between developing and developed countries. The dynamic comparative advantage framework in this model further suggests that digitalization can lead to a virtuous circle in countries with a high level of digital intensity. However, for countries with low levels of digital intensity, the opposite may occur. This phenomenon thus exacerbates income inequality between developing and developed countries.


**Keywords:** digitalization, international trade, digital intensity, comparative advantage, digital divide

## 1. Introduction

Recent technological breakthroughs, aided by digitization, have in many fields enabled the substantial replacement of many workplaces that are normally operated by humans. Most of these technological capabilities are based on big data, so digitization not only helps improve efficiency (e.g., [1]) but also helps reduce trade barriers [2]. Thus, the more digital intensity a country is, the more efficient, productive, and traded it is (e.g., [3–6]). Many empirical studies have shown that digitalization significantly improves trade. For example, Choi [7] found that Internet usage led to a significant increase in services trade by looking into data from 151 countries from 1990 to 2006. Vemuri and Siddiqi [8] showed that digital infrastructure helped promote trade in 64 countries from 1985 to 2005. Freund and Weinhold [9] presented that a 10% increase in the Internet abroad is associated with about a 6% increase in the level of U.S. imports and a 4% increase in the level of U.S. exports in 1995–1999.

To echo the above empirical literature, the main purpose of this paper is to theoretically address how digitalization plays a role in the changes in trade patterns and relative incomes between countries. In this model, the degree of digitalization of a country is reflected by the digital intensity of the country. We argue that the more developed a country's digital infrastructure is, the higher digital intensity it is, which helps firms in the country to increase productivity, thus giving them a comparative advantage in more tradable sectors and earning higher incomes than countries with lower levels of digital intensity.

The subsequent sections of this paper are structured as follows: Section 2 offers an extended literature review concerning digitalization and its impact on global competitiveness. In Section 3, the model framework is established. Moving to Section 4, we present the equilibrium with digitalization, elucidating its effects on trade patterns and relative incomes. Section 5 provides a comprehensive discussion of the findings and their implications. Finally, Section 6 encapsulates the conclusions.

## 2. Digitalization and global competition

As is well known, investments in high-speed internet, mobile networks, and other technologies that enable greater access to digital resources help countries to improve their competitiveness in tradable sectors and increase their income potential (e.g., [10, 11]). Therefore, in order to bridge the digital divide in order to promote greater economic equality between countries, policymakers should focus on implementing policies that promote digital literacy, access to technology, and investment in digital infrastructure. For example, Brynjolfsson et al. find that the introduction of an online machine translation system significantly increases international trade by 10.9%. Meltzer [12] shows that eBay's machine translation service helps increase exports to Spanish-speaking Latin America by 13.1% in trade volume. In addition, Lendle et al. [13] found that eBay's online platform helps reduce average trade costs by up to 65%, which is akin to companies becoming more efficient due to accessing digital resources and results in higher efficiency.

Furthermore, policies that promote education and training in digital skills can help ensure that workers are equipped to take advantage of digital technologies and contribute to economic growth (e.g., [14]). This is particularly important for developing countries, where a lack of skilled labor can be a significant barrier to economic development (e.g., [15]). All these digital infrastructure investments that help reduce the digital divide are resource-consuming (e.g., [16–18]).

In addition, the enhancement of production efficiency through digitalization can manifest in various ways, including shorter production cycles, reduced inventory, lower defect rates, decreased energy consumption, and more (e.g., [9, 19–23]). Conversely, this trend also suggests a decreased demand for "traditional" or non-digital-related workers. For instance, Gulshan et al. [24] illustrate that Google's deep-learning artificial intelligence (AI) can analyze digitized retinal images and provide diagnoses as accurately as human physicians. This could potentially lead to reduced demand for physicians who are not adept at utilizing digital technologies, highlighting the importance of implementing policies that promote digital literacy, access to technology, and investment in digital infrastructure.

## 3. The model

In a simple world of North and South, both labor and good markets are clear in each country. A constant share of income is assumed to be spent on non-traded goods. Each traded good receives a constant and equal share of expenditure. Suppose further that each country has an exogenously given labor force at any point in time: $L(t)$ for the North and $L^*(t)$ the South. Both these labor forces are assumed to grow exponentially at the same rate.

We also assume that a country has two sectors: one is the manufacturing sector in perfect competition, while the other is the digitalization sector in monopolistic competition. Manufacturing labor is devoted to production. Labor devoted to digitalization, such as data collection, cleaning, management, mining, maintenance, decoding, and tuning the associated AI algorithms, helps improve productivity. Suppose the North allocates $r$ a share of its labor to the digitalization sector and the remaining $(1 - r)$ to the manufacturing sector. Suppose that labor is freely moveable across sectors.

The production function for a continuum of goods $j \in [0, 1]$ in the North is as

$$y_j(t) = A_j l_{jm}(t), \tag{1}$$

where $l_{jm}(t)$ is a measure for manufacturing workers and $A_j$ is the productivity in sector $j$ in the North. Here, we suppose that, within a country, only one firm exists in a sector given that only this firm has a comparative advantage in that sector.

In real practice, it generally takes several stages of processing to produce a final good, generating various data associated with quality such as quality control and quality assurance. The market clears when demand equals supply. Feedback from consumers is well-known to play an essential role in improving product quality and production efficiency. This consumer data consists of multiple levels, including identity data, engagement data, behavioral data, and attitude data. Thus, we denote $d_j$ the aggregate raw data generated from all stages of the processing for good $j$ as

$$d_j = \left( \sum_{k=1}^{K} d_j(k)^{\frac{\sigma}{\sigma-1}} \right)^{\frac{\sigma-1}{\sigma}} \tag{2}$$

where $\sigma > 1$ is a parameter of elasticity of substitution among data and $K > 1$ denotes the number of data varieties (e.g., [25]).

In the digitalization sector, there are variable costs and fixed investment costs involved. Variable costs include data collection, cleaning, governance, mining, and maintenance, among others, while fixed investment costs include encoding and decoding to adapt the AI algorithms. For simplicity, it is assumed that all firms have the same cost function, with AI-adapted investment as the fixed cost $f, \forall \mu$. It is also assumed that a country's level of digital infrastructure contributes to its digital intensity. Digital intensity can be defined as the level of competition and engagement within digital channels, and a high level of digital intensity indicates that there is fierce competition and high levels of engagement within the digital environment of a country. This environment can enable firms in the country to have a higher rate of digitization. We refer to $a$ as North's digital intensity, while the digital intensity of the South is $a^*$. Thus, to process $k$ a variety of data in the sector $j$ in the North, a firm uses a volume of data equal to $f + d_j(k)/a$. Its profit maximization leads to the optimal cost for processing a variety of data as

$$c_d = \frac{\sigma}{\sigma - 1}\frac{w}{a}, \forall k, j, \tag{3}$$

where $w$ denotes wage of the North. With (3), the free entry condition leads to the optimal quantity of data for a variety $k$ of sectors $j$ as

$$d_j(k) = (\sigma - 1)af, \forall k, j. \tag{4}$$

In (4), all firms produce the same quantity of data at the same cost. With (2) and (4), we obtain the labor market equilibrium in the digitalization sector as

$$K = rL/\sigma f. \tag{5}$$

Plugging (4) and (5) into (2), we obtain the aggregate data in the sector $j$ as

$$d_j = (\sigma - 1)\left(\frac{rL}{\sigma f}\right)^{\frac{\sigma-1}{\sigma}} af, \forall j \tag{6}$$

which increases with a country's size ($L$) and its digital intensity ($a$) as well.

In a way similar to Krugman's [2] dynamic comparative advantage model, we suppose that technology development depends on an index of cumulative experiences, while these experiences have to be conducted through digitalization. That is, only digital assets that are generated through digital labor matter in the accumulative experiences:

$$A_j(t) = D_j(t)^{\varepsilon}, 1 > \varepsilon > 0. \tag{7}$$

Here, the benefits of digitalization in terms of improved production efficiency and product quality can be reflected in shorter production cycles, lower inventory, reduced defect rates, and decreased energy consumption, among other things (e.g., [9, 19, 21–23]).

We also allow cross-border flows to exist to some degree, such that digitalization from not only domestic but also foreign production enters into the index of experiences:

$$D_j(t) = \int_{-\infty}^{t} d_j(z) + \delta d_j{}^*(z)dz, \text{and } D_j{}^*(t) = \int_{-\infty}^{t} \delta d_j(z) + d_j{}^*(z)dz, \tag{8}$$

for the North and the South, respectively. Here, $0 \le \delta \le 1$ denotes a measure of barriers hindering cross-border data flows, where the greater the barriers, the smaller the $\delta$. Furthermore, as implied in (6)–(8), digitalization acts as a productivity shifter, with higher levels of digital intensity stimulating higher levels of productivity (e.g., [26]). On the other hand, for (6)–(8), suppose that the North will first maximize its objective function to find the optimal allocation of its resources between the digitization and manufacturing sectors before trade:

$$\max_r \pi = \int_{j=0}^{1} A_j l_{jm} - w l_{jm} - w(f + (\sigma - 1)af/a)dj \tag{9}$$

$$= \left[(\sigma - 1)\left(\frac{rL}{\sigma f}\right)^{\frac{\sigma-1}{\sigma}} af\right]^{\varepsilon}(1 - r)L - wL. \tag{10}$$

The first order condition of the above maximization with respect to $r(t)$ leads to an optimal resource allocation in the North as well as in the South as:

$$r = r^* = \frac{\varepsilon(\sigma - 1)/\sigma}{1 + \varepsilon(\sigma - 1)/\sigma}, \forall t \tag{11}$$

## 4. Equilibrium

From Eq. (7), the relative productivity of a firm in the North to a firm in the South in sector $j$ is:

$$\frac{A_j(t)}{A_j^*(t)} = \left(\frac{D_j(t)}{D_j^*(t)}\right)^{\varepsilon}, 1 > \varepsilon > 0. \tag{12}$$

Taking a derivative of (8) with respect to time, we obtain

$$\dot{D}_j(t) = d_j(t) + \delta d_j^*(t) \text{ and } \dot{D}_j^*(t) = d_j^*(t) + \delta d_j(t). \tag{13}$$

We therefore can write the changes in the experience indices as

$$\frac{\dot{D}_j(t)}{D_j(t)} - \frac{\dot{D}_j^*(t)}{D_j^*(t)} = \frac{d_j(t) + \delta d_j^*(t)}{D_j(t)} - \frac{d_j(t) + \delta d_j^*(t)}{D_j^*(t)}. \tag{14}$$

A steady state in the long run leads to an equilibrium $\frac{\dot{D}_j(t)}{D_j(t)} - \frac{\dot{D}_j^*(t)}{D_j^*(t)}$ as all factors come to converge; otherwise, income disparity will go to infinity. The left-hand side of Eq. (14) converges to zero in the steady state, so that we rewrite Eq. (14), with the help of Eqs. (1) and (2), as[1]

$$\frac{D_j(t)}{D_j^*(t)} = \left(\frac{d_j(t)}{d_j^*(t)}\right)\left(\frac{1 - \delta\big(D_j(t)/D_j^*(t)\big)}{1 - \delta\big(D_j^*(t)/D_j(t)\big)}\right). \tag{15}$$

Plugging Eqs. (6) and (7) into Eq. (14), we obtain

$$\frac{A_j(t)}{A_j^*(t)} = \left(\frac{rL}{r^*L^*}\right)^{\left(\frac{\sigma-1}{\sigma}\right)\varepsilon}\left(\frac{a}{a}\right)^{\varepsilon}\left(\frac{1 - \delta\big(A_j(t)/A_j^*(t)\big)^{1/\varepsilon}}{1 - \delta\big(A_j^*(t)/A_j(t)\big)^{-1/\varepsilon}}\right)^{\varepsilon} \tag{16}$$

There exists a marginal sector arises in which two firms might co-exist, say $m$, in equilibrium as $\frac{w(t)}{w^*(t)} = \frac{A_m(t)}{A_m^*(t)}$. Combining it with Eqs. (11) and (16), we obtain

[1] From (6), we have $\frac{d_j(t)+\delta d_j^*(t)}{D_j(t)} = D_j(t)^{-1}d_j(t) + \delta\left(\frac{D_j^*(t)}{D_j(t)}\right)D_j^*(t)^{-1}d_j^*(t)$ and $\frac{d_j^*(t)+\delta d_j(t)}{D_j^*(t)} = D_j^*(t)^{-1}d_j^*(t) + \delta\left(\frac{D_j(t)}{D_j^*(t)}\right)D_j(t)^{-1}d_j(t)$, respectively. Putting them together, in the steady state, we obtain $\left(\frac{D_j(t)}{D_j^*(t)}\right)^{-1} = \left(\frac{d_j^*(t)}{d_j(t)}\right)\left(\frac{1-\delta\big(D_j^*(t)/D_j(t)\big)}{1-\delta\big(D_j(t)/D_j^*(t)\big)}\right)$.

$$\omega(t) = \left(\frac{L}{L^*}\right)^{\left(\frac{\sigma-1}{\sigma}\right)\varepsilon} \left(\frac{a}{a^*}\right)^{\varepsilon} \left(\frac{1-\delta(A_m(t)/A_m{}^*(t))^{1/\varepsilon}}{1-\delta(A_m{}^*(t)/A_m(t))^{-1/\varepsilon}}\right)^{\varepsilon}, \tag{17}$$

where $\omega = w(t)/w^*(t)$ denotes the relative wage of the North to the South. In Eq. (17), the relative wage of the North relative to the South increases with not only their relative sizes $(L/L^*)$ but also their relative digital intensity $(a/a^*)$. This is a version of the Ricardian model, such that we rank tradable sectors by their relative productivities $A_j(t)/A_j^*(t)$ in order of decreasing comparative advantage of the North over the South. Then, we can illustrate Eq. (17) as a downward sloping $AA$ curve with an upper bond $\delta^{-1/\varepsilon}$ and a lower bond $\delta^{\varepsilon}$ as shown in **Figure 1**.[2]

On the other hand, the balance of payments equilibrium, as described by the standard framework of Dornbusch et al. [27] is as

$$\frac{w(t)}{w^*(t)} = \frac{\overline{\sigma}}{1-\overline{\sigma}} \frac{L^*(t)}{L(t)}, \tag{18}$$

where we define $\overline{\sigma}(t)$ as the share of tradable sectors where the North has a comparative advantage in total tradable sectors relative to the South at time $t$. We can illustrate the equilibrium in (18) as an upward sloping $BB$ curve in **Figure 1**. The $AA$

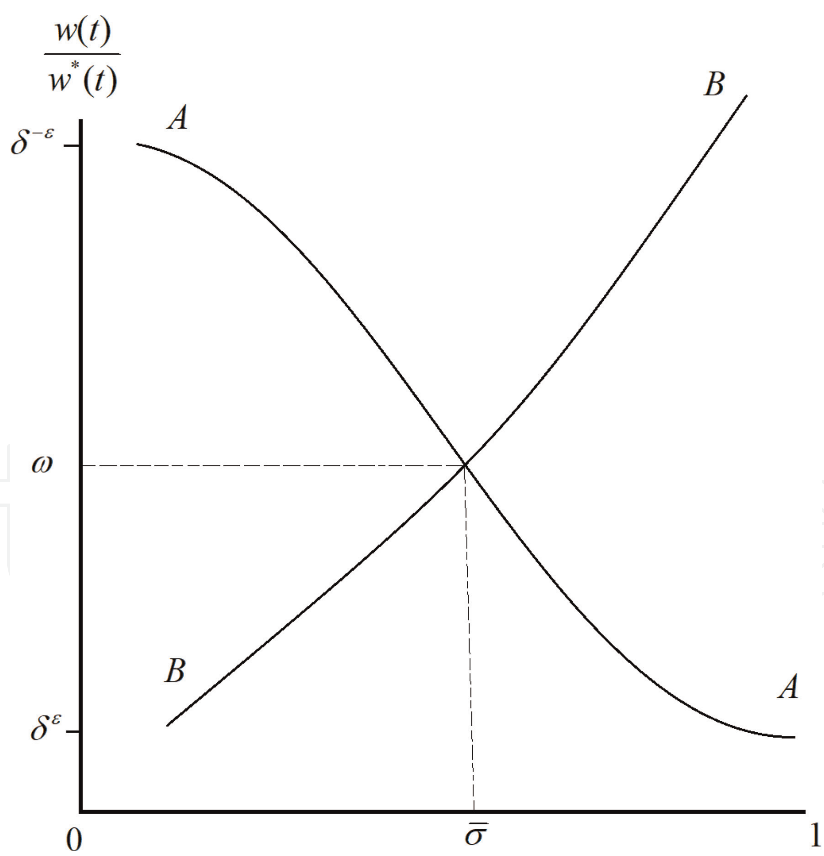


**Figure 1.**
*Equilibrium.*

[2] Implied in (17), we have constraints of $1-\delta(A_m(t)/A_m{}^*(t))^{1/\varepsilon}=0$ and $1-\delta(A_m{}^*(t)/A_m(t))^{-1/\varepsilon}=0$, leading to an upper bond as $A_m(t)/A_m{}^*(t)=(1/\delta)^{\varepsilon}$ and a lower bond as $A_m{}^*(t)/A_m(t)=\delta^{\varepsilon}$, respectively.

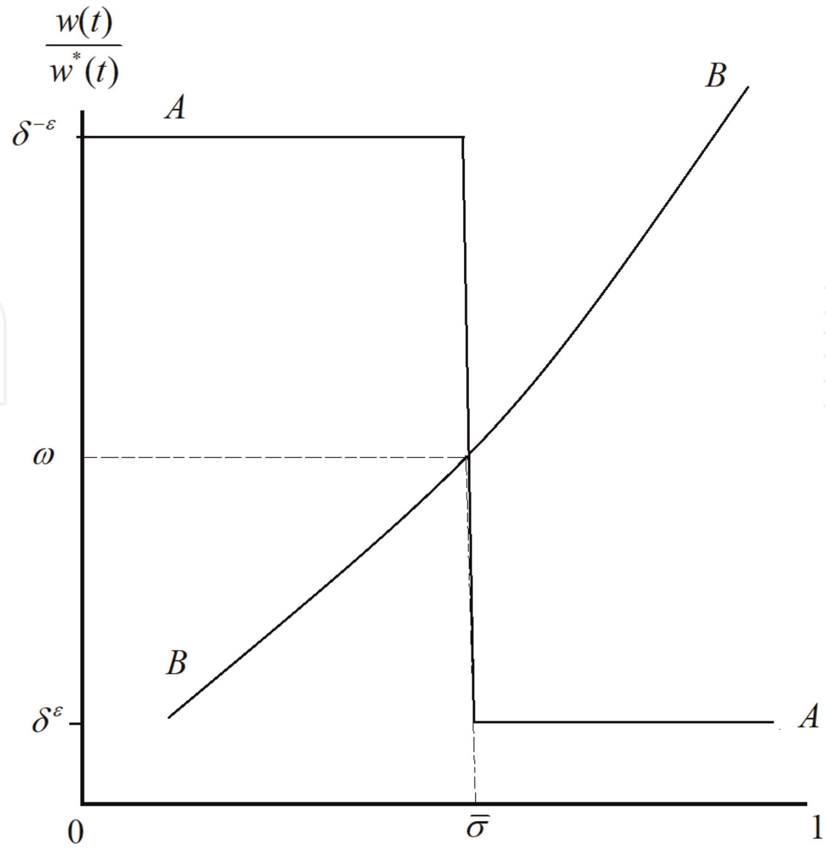


**Figure 2.**
*Long-run equilibrium.*

and *BB* curves come across an equilibrium $(\overline{\sigma}, \overline{\omega})$ at a point of time as shown in **Figure 1**. In equilibrium, the sectors along $[0, \overline{\sigma}]$ are located in the North while the sectors along $[\overline{\sigma}, 1]$ in the South.

In the long-term dynamics of specialization, digitalization, being similar to Krugman's model, the firms in the North will accumulate their productivity faster than the Southern firms in the sectors along $[0, \overline{\sigma}]$ while slower in the sectors along $[\overline{\sigma}, 1]$, such that the *AA* curve will come to have a "step" shape as shown in **Figure 2**.

If the disparity in digital intensity between the North and South narrows as $a/a^*$ decreases, the *AA* curve will be pushed downward as shown by the dashed line curve as in **Figure 3**. The two curves intersect at a new equilibrium point $(\overline{\sigma}^*, \omega^*)$, which indicates that a country with a higher level of digital intensity tends to have more tradable sectors and achieve a higher relative wage than a country with a lower level of digital intensity as $\overline{\sigma}^* < \overline{\sigma}$ and $\omega^* < \omega$. The above illustration suggests that countries with higher digital intensity tend to have a comparative advantage in more tradable sectors, implying that digitalization can significantly improve trade (e.g., [7–9]). However, it also implies that an increase in the digital divide, specifically a growing disparity in digital intensity, between the North and South could exacerbate income inequality between them (e.g., [28]).

## 5. Discussion and implications

In this section, we outline some broader significance of our theoretical model, which help address the practical implications of the model's findings and provides

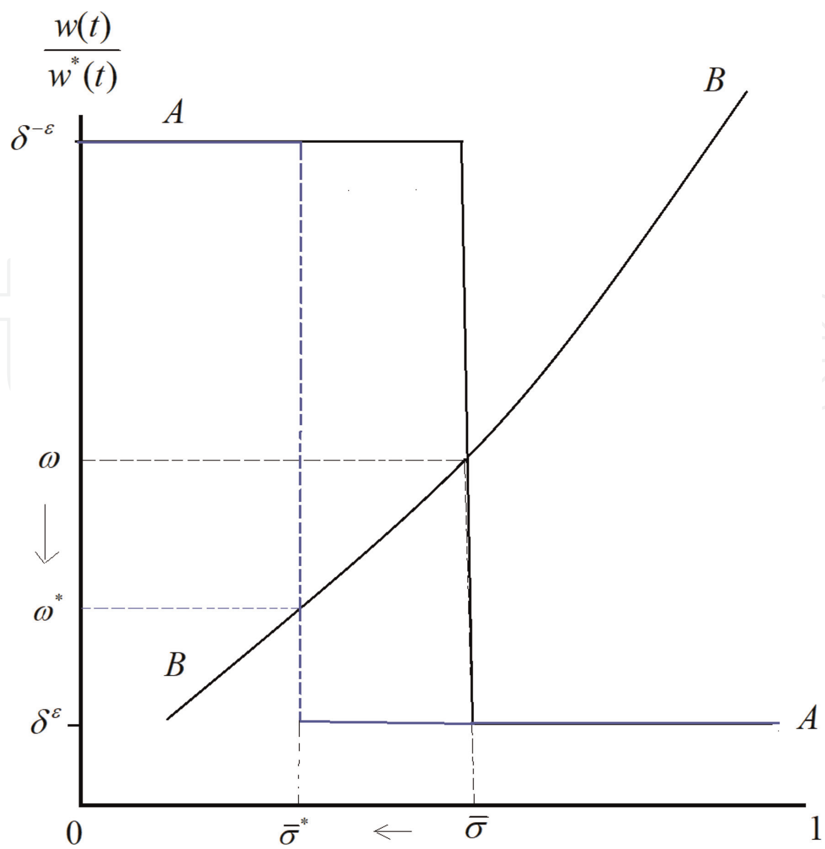


**Figure 3.**
*Digital intensity and trade pattern.*

some recommendations for addressing the challenges posed by the digital divide. First, this paper emphasizes that digital intensity is a key determinant of a country's competitiveness in the global market. It asserts that countries with higher levels of digital intensity are likely to have higher productivity, which in turn grants them a competitive advantage in tradable sectors. The model suggests that digitalization can initiate a virtuous cycle of enhanced productivity, leading to increased income and global market presence. Second, the paper highlights that digitalization has the potential to reshape trade patterns and income distribution between countries. The model demonstrates how a country's digital infrastructure contributes to its digital intensity, influencing its comparative advantage in tradable sectors. However, it also points out that the growing digital divide between technologically advanced countries (i.e., developed countries) and less-developed countries (i.e. developing countries) could exacerbate income inequality among them.

The main thrust of the paper's discussion is to offer policy implications for addressing the challenges posed by the digital divide. It suggests that policymakers should focus on strategies to bridge this divide, particularly in developing countries. The proposed strategies include: implementing policies that promote digital literacy and skills development among the population. This ensures that individuals are equipped to leverage digital technologies for economic and social advancement. Invest in digital infrastructure, such as high-speed internet and mobile networks, to ensure widespread access to digital resources. Improved connectivity can contribute to increased competitiveness and economic growth.

Although this model simplifies certain aspects, such as treating digital infrastructures as exogenous endowments rather than investments, it indicates that there might be additional factors and dynamics at play in the real world. If we further relax this assumption, it could lead to more nuanced policy implications. Nevertheless, despite that, this current model advocates for proactive policy measures to bridge the digital divide, enhance digital literacy, and promote digital infrastructure development. These actions are crucial to ensure that countries can effectively harness the benefits of digitalization for both economic growth and greater equality.

## 6. Concluding remarks

This paper has demonstrated that the digital divide between developing (the South) and developed (the North) countries is mainly due to differences in access to digital infrastructure. Developing countries often lack the necessary resources to invest in digital infrastructure, resulting in a growing digital divide between developed and developing countries. This divide has far-reaching implications for income inequality between countries, as countries with higher digital intensity have a competitive advantage in trade, allowing them to generate higher income. In contrast, developing countries with lower digital intensity are left behind and unable to compete in the global market, resulting in increasing income inequality between developed and developing countries.

The dynamic comparative advantage framework in this model further suggests that digitalization can lead to a virtuous circle in countries with a high level of digital intensity. Digitization can increase productivity, leading to more production and trade, which in turn can make the country more capable of advancing digitalization further. However, for countries with low levels of digital intensity, the opposite may occur. A low degree of digital intensity can trigger a vicious circle, leading to a decline in productivity relative to other countries, resulting in a loss of comparative advantages in more industrial sectors. This phenomenon can exacerbate income inequality between countries, highlighting the importance of promoting digital infrastructure and technology in developing countries to reduce the digital divide and increase their competitiveness in the global market.

In summary, the digital intensity of a country plays a crucial role in its rate of digitization and competitiveness in the global market. Therefore, it is essential, particularly for developing countries, to prioritize digital infrastructure when allocating their resources to reduce the digital divide and promote global economic growth and development. By investing in digital infrastructure and technology, developing countries can increase their digital intensity to enhance their competitiveness and then generate higher income, thus promoting a more equitable distribution of wealth globally. However, in this paper, we treated digital infrastructures as endowments, rather than endogenous investments. Relaxing this limitation could lead to more nuanced policy implications. We leave it for future research.

## JEL classifications

J21, J24, O33, O47

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## References

[1] Matt C, Hess T, Benlian A. Digital transformation strategies. Business and Information Systems Engineering. 2015; **57**:339-343

[2] Krugman P. The narrow moving band, the Dutch disease, and the competitive consequences of mrs. Thatcher: Notes on trade in the presence of dynamic scale economies. Journal of Development Economics. 1987;**27**(1–2): 41-55

[3] Ross P, Maynard K. Towards a 4th industrial revolution. Intelligent Buildings International. 2021;**13**(3): 159-161

[4] Einav L, Kuchler T, Levin J, Sundaresan N. Assessing sale strategies in online markets using matched listings. American Economic Journal: Microeconomics. 2015;**7**(2):215-247

[5] Mattes A, Meinen P, Pavel F. Goods Follow Bytes: The Impact of ICT on EU Trade. DIW Berlin Discussion Paper no. 1182. German Institute for Economic Research; 2012

[6] Reis J, Amorim M, Melão N, Matos P. Digital transformation: A literature review and guidelines for future research. In: Rocha Á, Adeli H, Reis LP, Costanzo S, editors. Trends and Advances in Information Systems and Technologies. Vol. 745. World CIST'18 2018. Advances in Intelligent Systems and Computing. Cham: Springer; 2018

[7] Choi C. The effect of the internet on service trade. Economics Letters. 2010; **109**(2):102-104

[8] Vemuri VK, Siddiqi S. Impact of commercialization of the internet on international trade: A panel study using the extended gravity model. International Trade Journal. 2009;**23**(4): 458-484

[9] Freund C, Weinhold D. The internet and international trade in services. American Economic Review. 2002;**92** (2):236-240

[10] OECD. Bridging the Digital Divide: OECD Evidence and Policy Guidance. Paris: OECD Publishing; 2016

[11] UNCTAD. Digital Economy Report 2019: Value Creation and Capture: Implications for Developing Countries. Geneva: United Nations; 2019

[12] Meltzer JP. The Impact of Artificial Intelligence on International Trade. Brookings Report: A Blueprint for the Future of AI: 2018–2019. Brookings Institution Press; 2018

[13] Lendle A, Olarreaga M, Schropp S, Vézina P-L. There goes gravity: eBay and the death of distance. The Economic Journal. 2016;**126**(591):406-441

[14] Galperin H, Fernanda Viecens M. Connected for development? Theory and evidence about the impact of internet technologies on poverty alleviation. Development Policy Review. 2017;**35**(3): 315-336. Blackwell Publishing Ltd

[15] World Economic Forum. The Global Digital Divide: How Can we Close the Gap? Geneva: World Economic Forum; 2021

[16] Baron L, Dasgupta S, Zhang H. Financing firms in India. Journal of Financial Economics. 2017;**123**(1): 182-210

[17] De Haan J, Sturm JE. Finance and income inequality: A review and new

evidence. European Journal of Political Economy. 2017;**50**:171-195

[18] Zhavoronok A, Popelo O, Shchur R, Ostrovska N, Kordzaia N. The role of digital technologies in the transformation of regional models of households' financial behavior in the conditions of the national innovative economy development. Ingénierie des Systèmes d'Information. 2022;**27**(4):613-620

[19] Clarke GRG, Wallsten SJ. Has the internet increased trade? Developed and developing country evidence. Economic Inquiry. 2006;**44**(3):465-484

[20] Egger PH, Lassmann A. The language effect in international trade: A meta-analysis. Economics Letters. 2012;**116**(2):221-224

[21] Liu L, Nath HK. Information and communications technology and trade in emerging market economies. Emerging Markets Finance & Trade. 2013;**49**(6):67-87

[22] Alberto O, Tan Shawn W. Disaggregating the Impact of the Internet on International Trade. Policy Research Working Paper: No. 7785. Washington, DC: World Bank; 2016

[23] Xing Z. The impacts of information and communications technology (ICT) and E-commerce on bilateral trade flows. International Economics and Economic Policy. 2018;**15**:565-586

[24] Gulshan V, Peng L, Coram M, Stumpe MC, Derek W, Narayanaswamy A, et al. Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs. Journal of the American Medical Association. 2016;**316**(22):2402-2410

[25] Lo C-P. 2023. Digital Divide, Economics of Scale, and International Trade. Working paper.

[26] Brynjolfsson E, Hitt LM, Kim HH. Strength in Numbers: How does Data-Driven Decision-Making Affect firm Performance? SSRN eLibrary: 1819486. 2011

[27] Dornbusch R, Fischer S, Samuelson PA. Comparative advantage, trade, and payments in a Ricardian model with a continuum of goods. American Economic Review. 1997;**67**(5):823-839

[28] Billon M, Lera-Lopez F, Marco R. Differences in digitalization levels: A multivariate analysis studying the global digital divide. Review of World Economics. 2010;**146**(1):39-73