The Impact of Digital Divide on Income Inequality—from The Perspective of Industrial Structure

Yiming Liu*

School of Economics, Fudan University, Shanghai, China

*Corresponding author: 23300680148@m.fudan.edu.cn

Abstract. The boosting digital economy not only creates new employment opportunities, but also affects the fairness of social income distribution. By analyzing and comparing the panel data of 142 countries' digital costs and income distribution indicators, this paper finds that with the income gap, digital divide has different effects on countries. The income equity of high-income countries will increase with the lower market price of digital technology, and the extensive use of digital technology will improve the production conditions, bridging the income gap within the country; Middle income countries can also benefit from the improvement of digital infrastructure, but the fragile industrial structure of low-income countries is difficult to improve productivity due to the improvement of digital conditions, and the impact on income distribution is relatively limited. It is proposed that countries with different income levels should focus on the implementation of national digitalization rather than blindly learning from the digital policies of developed countries.

Keywords: Digital divide; income inequality; industrial development.

1. Introduction

Since the concept of digital economy has emergenced, the issue of uneven wealth distribution caused by its development has become an important topic of continuous attention in academia and policy fields. On the one hand, it's effective for policy makers to use as a tool for reducing inequality and creating countless job opportunities; On the other hand, these opportunities are not equally distributed. While high-skilled workers are experiencing a leap in productivity, low - and medium-skilled workers who have difficulty accessing new technologies are being marginalized, resulting in a huge digital divide. The digital divide describes the phenomenon that information and communication technology (ICT) is not fair for everyone to access, which leads to a differentiation in individuals' ability to change their living conditions and labor return rates.

There are two forms of digital divide: algorithm awareness and data inequality [1]. The establishment of algorithm awareness is mainly affected by personal education, but the phenomenon of data inequality is deeply affected by the national industrial structure. While digital era strikes the whole world, a country that provides precision instruments,for example, may sound more competitive than countries selling raw material, as their chances for accessing data are different. The development of the digital economy leads to the biased growth of the industrial structure, which is the core reason why the digital economy can effectively solve the problem of "Curse of natural resources" [2]. The main way for digital applications to promote industrial upgrading is to combine the service industry with agriculture or manufacturing in the original industrial structure to form an internal transformation of the industry, so that the traditional industry can be transformed into a productive service industry. The upgrading of the service industry structure is not as good as the whole [3]. In other words, the original industry is the basis for the digital economy to significantly improve the production efficiency. Digital applications not only create inequality on the issue of income inequality, but also magnify the original income inequality. This paper hopes to clarify how the biased development of the digital economy affect income inequality in various countries through empirical analysis and explain the impact that industrial structure has as an endowment on digital global flows in the context of globalization.

The existing research on the digital economy mainly focuses on the impact of the digital divide in the following aspects: first, from the macro perspective, a large number of articles have confirmed

that the digital divide is a universal phenomenon, and infrastructure, institutional stability and cross-border trade will have an impact on the formation of the digital divide. There is an inverted U-shaped relationship between digital development and the income gap between urban and rural areas [4]. The differential progression of urban economic growth significantly contributes to the regional disparities in digital advancement [5]. In some areas with relatively backward infrastructure, the instability of the Internet has cultivated residents' negative psychology and use habits, and exacerbated income inequality [6]. These documents identify the impact on income which is brought by the advancement of the digital technology among different groups by distinguishing people and explaining in detail, using the secondary level of the factors affecting the digital divide. Second, at the micro level, the relevant literature focuses on the promotion of the digital economy on the fairness of income distribution within enterprises [7]. The existing literature has little research on the internal income distribution of enterprises, mainly because the data is difficult to collect and the representativeness problem is more prominent. However, these two kinds of studies rarely involve international comparison. Some literatures compare but focuses on relatively developed countries [8]. Some literatures also realize that globalization plays an important role in the formation of the digital divide. For example, Fuchs conducted an empirical test on how income distribution affects the digital economy, proposed that the digital divide is a complex problem related to technology, society and politics, and pointed out that income distribution is the most important factor among these factors [9]. In these works, China's international division of labor in the industrial chain is still rarely affected by the digital divide between countries. This paper analyzes the income inequality and digital divide of 142 countries, figuring out the impact of the digital divide on different countries. Through improving the gap of cross-border comparison through comparative analysis, a new explaination for the impact of the digital divide on international income distribution is offered [10].

2. Hypoyhesis

The emergence of the digital economy has led to the contraction of some low-skilled traditional industries, but the labor force has not been able to flow freely, resulting in the income decline of some people. Through empirical analysis, Sun zao and Hou yulin found that industrial intelligence will lead to the frequent phenomenon of "machines replacing people", leading to the polarization of employment among people with different education levels [11]. If the country's industrial structure focuses on industries where low-skilled people are easily squeezed out by new technologies, the gap between the country's income inequality and other relatively fair countries may increase. Hypothesis 1: The more the industrial structure of a country is prone to be replaced, the more the national income distribution tends to be unfair while the digital technique advances.

Among policies related to digital development of many southern countries, improving infrastructure and penetration, implementing digital finance, and strengthening the coverage of e-commerce logistics are frequently mentioned. Due to large-scale policy stimulus and demand shock, the policy support for downstream consumption may lead to the intensification of income inequality at the industry level. Hypothesis 2: The average income growth rate of individual industries with policy support is greater than that of the whole, resulting in the intensification of inequality.

The ability of various industries to access and master digital information is different. For example, e-commerce platforms are more likely to access data related to users' consumption preferences. Compared with other industries that have less contact with consumers, it is easier to formulate sales policies on consumer' group behavior and achieve excess returns. Hypothesis 3: The profitability of enterprises related to the digital economy in the market is positively correlated with the size of enterprises.

3. Model

3.1. Variable Selection and Data Source

Table 1. Variables

Meaning	variables	source
income distribution	Gini coefficient(Gini)	World Bank open data
The impact of industrial structure	Revenue share of up to 10%	
	High-tech export (TX)	
Affordable indicators ICT price	Data-only mobile broadband basket (DOMB)	International Telecommunication Union (ITU) Datahub
	Fixed-broadband Internet basket (FI)	
	Mobile cellular low usage basket (MCLU)	
	Mobile data and voice high-consumption basket (MDVHC)	
	Mobile data and voice low-consumption basket (MDVLC)	

As shown in Table 1 the indicators of the global digital development are relatively perfect, mainly including the United Nations International Telecommunication Union Information and Communications Technology (ICT) development index (IDI), the European Union digital economy and society index (DESI), and the direct measurement method proposed by the U.S. Department of Commerce to define the impact of the digital economy on the reassessment of the scope of goods. In order to describe how the digital divide affect inequality at the national level in detail, this paper selects the relevant indicators of digital information cost as the explanatory variable in the IDI indicators released by ITU. The statistical data among different countries may exhibit varying degrees of missing information due to disparities in statistical costs.From the statistical samples, the mode is basically the same, which is not included in the calculation. The Gini coefficient of different countries reflects the impact on income distribution, controls Gross Domestic Product (GDP), literacy rate and urbanization rate, controls the impact of national development level, and regresses high-income countries, middle and high-income countries, middle and low-income countries and low-income countries by grouping.

3.2. Regression

In order to study the impact of the digital divide on the income distribution of countries, the panel data from 169 countries from 2018 to 2023 were used for regression analysis. The square was used as the explanatory variable, the linear interpolation approach enhanced the Gini coefficient, and the logarithm was used to process the other variables with right deviation distribution features. Taking income type as the classification standard, high-income countries are 1, middle and high-income countries are 2, middle and low-income countries are 3, and low-income countries are 4, where I is the country, t is the time:

$$Gini_{i,t}=\beta_1 ICT_{i,t}+\beta_2 GDP_{i,t}+\beta_3 UR_{i,t}+\beta_4 LR_{i,t}+\varepsilon_{i,t} \quad (1)$$

At the same time, countries are categorized based on the percentage of high-tech exports and regressed using the interactive term between the proportion of high-tech exports and digital costs and the logarithm of national GDP in order to determine whether or not countries with different divisions

of labor in the global value chain are affected to varying degrees in the development of the digital economy. The descriptive statistics for the pertinent variables are shown in Table 2.

$$\ln(GDP_{i,t})=\beta_1 ICT_{i,t}\times TX_{i,t}+\beta W_{i,t,m}+\varepsilon_{i,t,m} \quad (2)$$

Table 2. Descriptive statistics

	mean	sd	min	max
Gini3	803.6152	844.3334	0	2905.21
ln_DOMB	1.783731	.7701691	-.5401223	3.571784
ln_FI	2.680986	.8401875	-.5310283	5.010635
ln_MCLU	1.610316	.8809138	-.9419163	3.397189
ln_MDVLC	1.969241	.7817888	-.3337344	3.689629
lrate	.0126235	.0045137	.01	.0333333
ln_GDP	24.98088	1.833978	20.01845	30.33883
urban rate	56.60278	19.76956	14.417	95.688
TX	8.652628	12.50611	0	67.04509
Interpolation of top10incomepercentage on year	15.95197	15.10055	0	42.5
Observations	152			

4. Result

4.1. Basic Regression

Based on the panel data of 142 countries around the world, when measured by access price, the digital divide has no obvious relationship with the internal income distribution of the country, but only with the development degree and urbanization rate measured by the national economic aggregate. However, in the regression grouped by income level, ICT prices and Gini coefficient show significant negative correlation, and each has its own emphasis. There is a very significant negative correlation between the low-use package of cellular mobile and the inequality of income distribution in high-income countries, and the lowest price of the high consumption package of mobile digital is positively correlated with the inequality of income distribution. Digital technology in high-income countries is generally more popular. High-tech communication tools such as cellular mobiles have a wide audience. Higher costs may represent a wider base of high-income people. The relatively low price of low-tech products can ensure the universal benefits of digital technology. The penetration rate of high-tech communication means in middle-income countries is relatively low. Fixed broadband and basic communication services can better represent the public's acceptance of digital technology applications, showing the characteristics of low sensitivity to high-tech prices but significant correlation between low-tech prices and income distribution. Low-income countries have great difficulties in the popularization of digital technology, and the economic structure is not enough to support the application of digital technology and the performance of the original productivity improvement effect, showing the conclusion that ICT prices and income distribution are not fair and significant as shown in Table 3.

Table 3. Benchmark regression results

	(1)	(2)	(3)	(4)	(5)
	Gini	Gini(high income)	Gini(higher income)	Gini(lower income)	Gini(low income)
ln_DOMB	9.552	525.436**	-406.654*	-532.920*	-100.854
	(168.603)	(213.306)	(206.987)	(285.912)	(267.153)
ln_FI	-119.895	-198.569	4459.878*	-1898.483***	770.705
	(370.899)	(212.103)	(2400.795)	(226.603)	(1026.800)
ln_MCLU	-27.306	-951.397***	65.511	-144.850	959.976**
	(284.311)	(264.310)	(270.689)	(657.101)	(248.720)
MDVHC	6.180	52.970***	-1.088	105.921***	94.450
	(7.233)	(19.136)	(5.678)	(33.263)	(129.687)
lrate	-15849.479	70578.634*	220530.644***	399374.114***	10227.762
	(101456.617)	(36316.701)	(31849.230)	(112887.054)	(409572.832)
ln_GDP	1429.911*	-353.740	-1387.741	33.435	-2717.370
	(733.335)	(944.421)	(867.147)	(901.413)	(5330.557)
urbanrate	-219.917**	-109.080	-43.799	325.570	472.482
	(99.198)	(154.779)	(48.844)	(236.714)	(840.004)
_cons	-22009.376	15373.871	28189.555	-20053.784	44136.698
	(17272.922)	(27142.840)	(21136.311)	(18299.436)	(98105.419)
N	152.000	51.000	36.000	25.000	15.000
r2	0.142	0.520	0.723	0.903	0.543
ar2					

Standard errors in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

As shown in Table 4 by analyzing the interaction between ICT prices and high-tech exports, it is found that high-tech exports significantly affect GDP growth in high-income countries and are an important driving force for growth in high-income countries. For low-income countries, there is a clear relationship between the price of digital technology and economic growth. For developed countries, high-tech prices have significantly helped the growth driven by high-tech exports. Digital technology itself may be a part of high-tech exports, and easier access to low-tech services can help alleviate the growth gap caused by the technology gap. The promotion effect on middle-income countries and low-income countries is not significant. The low proportion of high-tech exports in these countries is not conducive to the productivity improvement brought by digital technology in our province, which supports the above hypothesis.

Table 4. High-tech export's impact

	(1)	(2)	(3)	(4)	(5)
	ln_GDP	ln_GDP	ln_GDP	ln_GDP	ln_GDP
ln_DOMB	-0.107	-0.140	0.266	0.762	-0.761***
	(0.085)	(0.156)	(0.481)	(.)	(0.000)
ln_FI	0.328**	0.399	0.104	-3.723	2.395***
	(0.137)	(0.344)	(0.532)	(.)	(0.000)
ln_MCLU	0.073	-1.291***	-0.301	0.642	-0.109***
	(0.106)	(0.348)	(0.455)	(.)	(0.000)
MDVHC	-0.003	0.058***	-0.017	-0.009	-0.390***
	(0.005)	(0.016)	(0.017)	(.)	(0.000)
ln_TX	0.217***	0.151	-0.770	-0.611	-3.920***
	(0.052)	(0.335)	(0.915)	(.)	(0.000)
ln_DOMB_ln_TX	0.043	0.073	-0.127	-0.158	1.203***
	(0.034)	(0.137)	(0.198)	(.)	(0.000)
ln_FI_ln_TX	-0.078**	-0.034	0.151	0.917	-0.094***
	(0.031)	(0.138)	(0.322)	(.)	(0.000)
ln_MCLU_ln_TX	-0.043	0.200***	0.163	-0.509	0.000
	(0.048)	(0.054)	(0.310)	(.)	(.)
MDVHC_ln_TX	0.001	-0.027***	0.010	-0.001	0.000
	(0.003)	(0.008)	(0.010)	(.)	(.)
lrate	-0.175	12.039	-39.916**	754.351	0.000
	(8.751)	(21.333)	(16.333)	(.)	(.)
urbanrate	0.058***	-0.180	0.074	0.000	0.000
	(0.021)	(0.117)	(0.062)	(.)	(.)
_cons	20.943***	36.309***	21.238***	22.651	29.042***
	(1.287)	(7.723)	(4.319)	(.)	(0.001)
N	135.000	43.000	34.000	25.000	12.000
r2	0.375	0.870	0.539	1.000	1.000
ar2					

Standard errors in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

4.2. Robustness Test

As shown in Table 5 by analyzing the interaction between ICT prices and high-tech exports, it is found that high-tech exports significantly affect GDP growth in high-income countries and are an important driving force for growth in high-income countries. For low-income countries, there is a clear relationship between the price of digital technology and economic growth. For developed countries, high-tech prices have significantly helped the growth driven by high-tech exports. Digital technology itself may be a part of high-tech exports, and easier access to low-tech services can help alleviate the growth gap caused by the technology gap. The promotion effect on middle-income countries and low-income countries is not significant. The low proportion of high-tech exports in these countries is not conducive to the productivity improvement brought by digital technology in our province, which supports the above hypothesis.

Table 5. Robustness test results

	(1)	(2)	(3)	(4)	(5)
	topincome	topincome	topincome	topincome	topincome
ln_DOMB	0.177	15.305**	-6.785	-11.416*	-2.583
	(3.915)	(5.639)	(4.084)	(6.472)	(5.875)
ln_FI	0.243	-3.331	100.608*	-37.261***	19.034
	(7.775)	(5.526)	(51.322)	(5.117)	(22.431)
ln_MCLU	-1.822	-21.902***	1.483	-3.622	18.917**
	(6.439)	(6.262)	(5.385)	(14.632)	(5.369)
MDVHC	0.125	1.042**	-0.052	1.926**	2.185
	(0.151)	(0.442)	(0.113)	(0.737)	(2.824)
lrate	-108.291	1888.383**	-4222.384***	7776.438***	1476.133
	(2084.499)	(873.995)	(676.633)	(2505.616)	(8954.708)
ln_GDP	31.730*	-11.436	-17.046	6.752	-59.174
	(16.648)	(23.003)	(16.541)	(20.614)	(116.351)
urbanrate	-4.833**	-2.595	-0.552	5.889	10.465
	(2.198)	(3.840)	(1.091)	(5.294)	(18.261)
_cons	-501.632	431.273	238.894	-508.281	929.159
	(382.744)	(680.853)	(404.203)	(413.427)	(2145.337)
N	152.000	51.000	36.000	25.000	15.000
r2	0.137	0.521	0.702	0.887	0.561
ar2					

Standard errors in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

By replacing the Gini coefficient with the proportion of the top 10% of the total national income, the test results obtained are basically consistent with those obtained through the Gini coefficient, which supports the robustness of the regression results. At the same time, when using the income percentage instead of the Gini coefficient as the measurement standard for analysis, the absolute value of the correlation coefficient is larger, which may be because the indicator of high income as a percentage of social wealth is more collinear with the control variable. On the other hand, it shows that the digital divide may exacerbate the wealth differentiation between the middle and top levels of society.

5. Conclusion

This paper analyzes the income distribution, economic growth and ICT price data of 142 countries, and clarifies the impact of different technological complexity on the income inequality of countries with different income levels. For countries with higher income, the fairness of income distribution is significantly related to the lowest price of technology access in the market; For middle-income countries, the correlation between the popularity of low technology and income distribution is significantly stronger. The popularity of digital technology is conducive to promoting the export of technology and bringing greater inequality in international income distribution. The results of this paper are generally in line with the results of existing studies, supporting that the digital divide will have a negative impact on income distribution, and questioning the significant impact of income distribution and digital divide in low-income regions mentioned in some literatures, which may be since the existing literatures mainly use regional data and cannot represent the overall situation of low-income countries.

In view of the above analysis results, high-income countries should increase investment in digital services with low technology requirements, ensure that enterprises and individuals can use digital technology at a lower cost, and promote the role of digital technology in improving scientific and

technological innovation, human costs and other aspects. Middle income countries should pay more attention to the popularization of technology, ensure the availability of digital technology nationwide, and strengthen basic digital construction. Low income countries should not take the progress and application of digital technology as the primary task, but should invest more resources in improving the existing industrial structure and infrastructure to ensure future development.

In this paper, due to the tight time, the lack of data integrity, the defect of the calculation method to be tested and other factors, the results may have some deviation. In the future, it hope to continue to improve the relevant content and make a further detailed analysis of the impact of the digital economy on the income distribution of countries with different industrial structures.

References

[1] Lythreatis S, Singh S K, El-Kassar A N. The digital divide: a review and future research agenda. Technological Forecasting And Social Change, 2022, 17(5): 121-135.

[2] Bai Peiwen, Zhang Yun. Digital economy, declining demographic dividends and the rights and interests of low- and medium-skilled labor. Economic Research Journal, 2021, 56(05): 91-108.

[3] Chang X F, Yang Z H, Abdullah. Digital economy, innovation factor allocation and industrial structure transformation: a case study of the Yangtze River Delta city cluster in China. PLOS ONE, 2024, 19(4): 30-37.

[4] Peng Z, Dan T. Digital dividend or digital divide? Digital economy and urban-rural income inequality in China. Telecommunications Policy, 2023, 47(9): 102-106.

[5] Song Z, Wang C, Bergmann L. China's prefectural digital divide: Spatial analysis and multivariate determinants of ICT diffusion. International journal of information management, 2022.

[6] Gonzales A. The contemporary US digital divide: from initial access to technology maintenance. Information Communication & Society, 2016, 19(2): 234-248.

[7] Fang Mingyue, Lin Jiani, Nie Huihua. Does digital transformation promote common prosperity within firms? Evidence from Chinese A-share listed firms. Journal Of Quantitative & Technological Economics, 2022, 39(11): 50-70.

[8] Xu Xianchun, Zhang Meihui. Research on the scale measurement of China's digital economy: based on the perspective of international comparison. China Industrial Economics, 2021, 12(05): 23-41.

[9] Ndoya H, Asongu S A. Digital divide, globalization and income inequality in sub-Saharan African countries: analysing cross-country heterogeneity. Social Responsibility Journal, 2024, 20(1): 1-19.

[10] Fuchs C. The role of income inequality in a multivariate cross-national analysis of the digital divide. Social Science Computer Review, 2009, 27(1): 41-58.

[11] Sun Zao, Hou Yvlin. How does industrial intelligence reshape the employment structure of Chinese labor force. China Industrial Economics, 2019, (05): 61-79.