Technology Driven Inequality

An approch on Western Balkan Countries

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Abstract: The scope of this paper is to analyse the extent to which technological innovations have affected the inequality. Based on Kuznets model, while technology opens new areas for exploration and makes human capital more efficient, it will allow more people to take advantages of the resulting opportunities. The paper identifies the tools and variables used to measure inequality and further observes this phenomenon in the optic of technological development and artificial intelligence in Western Balkan Countries. The question addressed on behalf of this paper is how technological development is reshaping Western Balkan economies. The results indicate that inequality arising due to advanced technological adaption displays certain characteristics such as: speed, gender, age and access to technological industry.

Keywords: technological development, artificial intelligence, inequality, economic development

JEL Classification Codes: O15, O32, O38

1 Introduction

The world economy has gone through many changes over time and history. Industrialization, globalization, and now digital revolution. These revolutions have reshaped the world economy. In the framework of digitalization and artificial intelligence, humans and economic systems are facing new challenges and opportunities.

Artificial Intelligence (AI) can have a significant impact on equality distribution. On the one hand, AI can help to improve equality by providing access to resources,

opportunities, and services to individuals who might otherwise not have access to them. For example, AI-powered education platforms can help to provide personalized learning experiences to students, regardless of their socioeconomic status. Similarly, AI-powered healthcare technologies can help to improve health outcomes for marginalized populations.

On the other hand, there is also the risk that AI could exacerbate existing inequalities, particularly if the data used to train AI algorithms is biased or reflects existing societal inequalities. For example, if an AI algorithm is trained on data that reflects historical patterns of discrimination, such as biased hiring practices, the algorithm may learn to replicate those patterns. This could lead to further discrimination and inequality, particularly for marginalized groups.

It is therefore essential to ensure that AI technologies are designed and deployed in a way that promotes equality and does not reinforce or exacerbate existing inequalities. This can be achieved by using diverse and representative data to train AI algorithms, promoting transparency and accountability in AI development and deployment, and engaging with diverse stakeholders, including marginalized communities, throughout the AI development process.

1.1 Income inequality among Western Balkan Countries

Many definitions and studies are made regarding inequality, but this article takes into consideration the income inequality among western Balkan countries. The Western Balkans region, which includes countries such as Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia, and Serbia, has historically experienced significant levels of economic and social inequality.

One of the main drivers of inequality in the region is the legacy of the wars and conflicts of the 1990s, which had a significant impact on the region's economic development and social fabric. The transition to market economies in the aftermath of the wars has also been uneven, with some countries faring better than others in terms of economic growth and development.

In addition to these historical factors, there are also ongoing issues that contribute to inequality in the Western Balkans. These include corruption, weak institutions, a lack of investment in infrastructure and human capital, and high levels of unemployment, particularly among young people. Furthermore, marginalized groups such as Roma communities, women, and people with disabilities face additional barriers to social and economic inclusion. Discrimination and prejudice against these groups are still prevalent in many parts of the region.

Overall, while there have been some improvements in reducing inequality in the Western Balkans in recent years, there is still much work to be done to ensure that all people in the region have access to the opportunities and resources they need to lead fulfilling and productive lives.

Technological Development

The rapid development of technology and artificial intelligence is challenging the world economy and society in overall. There has been a huge debate whether AI is improving or worsening today's economy. Considering a simplified swot analysis, it is accepted that AI leads to (i) an increase workplace productivity and is adopted by many industries, and (ii) created a better lifestyle. In terms of weaknesses: (i) AI remains unhuman and will not be able to replace the real human as a employee, (ii) Governments are lacking behind and face difficulties in adopting or following up with AI developments.

In terms of opportunities, AI can generate (i) smart solutions for disabled human and (ii) less strain on employees. Nevertheless, it is widely accepted that AI is becoming a threatening for economic systems, as the workforce as a factor must be reconsidered.

2 Literature Review

Income plays a decisive role in determining the welfare. Shehu, Shahzad, Rubbaniy, Perveen (2017) in their study about US firms paid an important attention to income gap among gender in different industries [12]. Wage and bonus inequality are used to evaluate gender inequality and income distribution inequality.

Machin (2011) dates the start of wage inequality in the US and UK at the end of the 1970s confirming that this phenomenon is becoming more and more widespread [8].

According to Qureshi, Z. (2019), inequality has two dimensions: it has increased within most of the countries, and on the other side has decreased between countries. This is because fast growing emerging economies are narrowing the gap with advanced economies [10]. Regarding Comin and Mastieri (2018), technological advancements and their way of interacting with market conditions affects the productivity and income distribution of a country, considering here that tew technologies are being adapted mainly from a small number of big companies [4].

The rapid and massive development of artificial intelligence can substantially eliminate employment. During the three industrial revolutions, the workforce largely shifted to compensate for technological changes: (i) in the first one, subsistence farming gave way largely to manufactory or other labour-intensive work; (ii) In the second, workers transitioned to assembly lines and machine-assisted tasks and (iii) in the third Industrial Revolution, workers transitioned to more service-oriented positions to capitalize on the benefits of automation and data.

Acemoglu and Restrepo (2019) in their study about US, stated that labour markets more exposed to artificial intelligence leading to lower human employability and

wage growth [1]. This consequence was heavier to those who do not have a college degree and lower-class workers, deepening income inequality among society.

Considering lower educated people more threatened by technological development, Goldin and Katz (2008) argue the role of technological development, education, and inequality in society's development [5]. They state that educational slowdown and recent technological development have increased inequality in US.

Jaumotte, Lall, and Papageorgiou (2013) in their study of 51 countries over a 23 year timespan, find out that technology is a significant force driving inequality [6]. Furthermore, they find that inequality is more severe in uppermiddle icome countries.

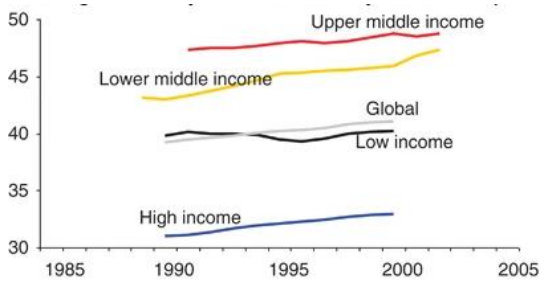

Figure 1.

Average of country Gini coefficient by income group

Source: Jaumotte, Florence., Lall, Subir., and Papageorgiou, Chris. (2013)

Considering the fact that technological advancement is more rapid in highly developed countries and more accessible to higher income societies, it must be accepted that high technological development deepen inequality. This findings about technological development and society income distribution, are in line with Liu, Zhou, and Wu (2015) [7].

Comin and Mestieri (2018) in their study about technology and income diversion after evaluating the impact of 25 major technologies into income among 139 countries over the last 200 years, confirm that income gap between Western and non-Western countries increases when growth derives only from technological advancements [4].

An important role in income distribution is played by globalisation as well. As supported from Shehu and Musta (2017) globalisation is a driving factor of society's wellbeing [14]. Jaumotte et.al (2013) finds that apart fom technology which plays a determinant role in inequality (measured here by Gini index) and important factor is globalisation as well (refer to the graph below) [6].

On the other hand, there is evidence proofing that technology possession and adaption can increase access to technology and reduce poverty. For instance, Ruhyana and Essa (2020), analysed data on ICT variables including ownership of cell phones, computer usage, and internet access [12]. Their findings suggest that ICT usage correlates with a decreased likelihood of poverty, even when adjusting for factors like age, gender, education, household size, access to credit, and employment status.

Same results are indicated in the study of Bussolo and O'Connor (2002), who stated that technology has contributed to poverty reduction [2]. Rizqulloh and Firmansyah (2021) in their study onducted in 34 provinces in Indonesia, found evidence that information and communication technology significantly affect poverty alleviation [11].

Thompson and Atkins (2010) highlight that effective technology implementation can act as a social equalizer, creating opportunities for marginalized individuals [15]. Expertise is crucial for technology to reduce poverty and transform global mobility into a source of valuable information for impoverished regions.

Marker, McNamara and Wallace (2002) reveal that information, communication and knowledge are critical elements of poverty reduction [9].

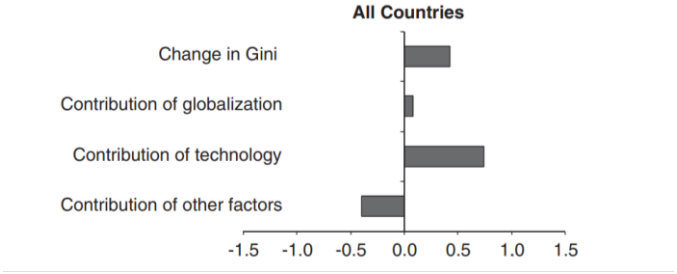

Figure 2.

Decomposition of the change in income inequality

Source: Jaumotte, Florence., Lall, Subir., and Papageorgiou, Chris. (2013)

Technological development has the potential to provide greater access to information, improve productivity, and create new economic opportunities. However, the distribution of these benefits is not always equal, and technological development can sometimes exacerbate existing inequalities or create new ones. Some of the ways in which technological development can contribute to inequality are:

Unequal access to technology

Technological development may be unevenly distributed, with certain groups having greater access to technology than others. For example, people living in rural or low-income areas may have less access to high-speed internet or the latest

technology, which could limit their ability to fully participate in the digital economy.

Skill-based inequality

As technological development advances, certain skills become more in demand, leading to a growing divide between those who possess those skills and those who do not. This can create a gap in wages and employment opportunities between highly skilled workers and those without specialized skills.

Automation

Technological development can lead to the automation of jobs that were previously performed by humans, potentially displacing workers who are not equipped with the necessary skills to transition into new jobs. This can exacerbate existing inequalities in the workforce, particularly for low-skilled or low-wage workers.

Bias in algorithms

Artificial intelligence and machine learning algorithms are only as unbiased as the data they are trained on. If the data contains biases, such as racial or gender stereotypes, these biases may be reflected in the algorithm's output, potentially perpetuating inequalities and discrimination.

Privacy concerns

With the growth of technology, there are increasing concerns around the use and misuse of personal data. Those with access to this data may be able to use it to their advantage, creating further disparities in power and wealth.

Overall, while technological development has the potential to benefit society as a whole, it is important to be aware of how it may contribute to inequality and work to mitigate these effects. Considering this inequality a toxic phenomenon, government and policy makers of each country have to consider a strategy of reducing inequality under the circumstances where technological advancements poses new challenges.

3 Data and Methodology

This section analysis the data collection, data design and methodology used to evaluate findings and draw conclusions.

3.1 Variables

Inequality

Inequality, on behalf of this article is measured through Gini index. The Gini index, also known as the Gini coefficient, is a statistical measure of income inequality or wealth distribution within a population. It is a number between 0 and 1, where 0 represents perfect equality (i.e., everyone has the same income or wealth) and 1 represents perfect inequality (i.e., one person has all the income or wealth, while everyone else has none). The Gini index is commonly used by economists and policymakers to measure and analyse income inequality and to evaluate the effectiveness of policies aimed at reducing inequality

Poverty

Technological development can provide solutions to poverty, it is also important to address the underlying causes of poverty such as inequality, lack of access to education and resources, and inadequate infrastructure. A holistic approach that considers both poverty and technological development is essential to create a more equitable and sustainable world. Poverty headcount ratio at $2.15 a day is the percentage of the population living on less than $2.15 a day at 2017 purchasing power adjusted prices

Technological Development

High-technology exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery.

Research and Development

Gross domestic expenditures on research and development (R&D), expressed as a percent of GDP. They include both capital and current expenditures in the four main sectors: Business enterprise, Government, Higher education, and Private non-profit. R&D covers basic research, applied research, and experimental development.

Sample

The initial sample was 116 observations. After dropping the missing data, the net sample was 57 observations. Some of the Western Balkan Countries do not comply in terms of statistical data.

After having the net sample, the variables were checked for normal distribution and pretested in terms of assumptions. Variables [R&D] and [High Tech] were

transformed into natural logarithm to comply with normal distribution requirements. After generating summary statistics and correlation matrix, variables were empirically analysed through a multiple regression analysis.

4 Findings

Descriptive statistics table indicates values regarding mean, median, standard deviation, kurtosis, skewness, range of minimum and maximum values. Technological advancements show to have a strong correlation with all the variables, excluding Gini Index.

Using multivariate regression, it is obvious that under ceteris paribus conditions, an increase in high technology with one unit, will lower the Gini Index with 0,8 uints. Almost the same finding appears with countries investing in R&D. An increase in Research and development as part of GDP planning leads to a decrease in Gini Index with 2.5 units (p value 0.013).

Similar figures are depicted when considering Poverty (using National poverty headcount indicator). Data show that increase in high technology by 1 unit, will reduce poverty by 2.8 units (p value 0.000). The technology advancements reduce the percentage of the population living below the national poverty line., giving them the opportunity to adjust with market requirements. Technology provides more opportunities to people, reduces costs, improves productivity and efficiently and hence reduces the ratio of people living below national poverty rate.

Research and development as percentage of GDP leads to a reduction of poverty. The findings on behalf of this article show that countries that spend more on Research and Development are more likely to reduce the poverty, reduce the number of people living below the national poverty line. Increase in Research and Development and technological advancements can provide access to all population, equipping them with information. Access to information and trainings on how to leverage technology can improve productivity and reduce poverty.

For instance, technology can significantly reduce poverty by enhancing access to education, creating job opportunities, and improving financial inclusion. Innovations in mobile banking and digital payment systems provide crucial financial services to underserved communities. Research and development (R&D) drive advancements in agricultural technology, boosting productivity and income for farmers. Telemedicine and health information systems improve healthcare access, ensuring better health outcomes. Additionally, technology supports small businesses through e-commerce platforms and digital marketing, expanding their market reach. R&D also contributes to infrastructure improvements, such as clean water and electricity, further enhancing living conditions and economic prospects for impoverished populations.

Table 1

Table 1 reports the descriptive statistics of the variables of this study. The sample includes 57 observations from 5 western balkan Countries. The correlation matrix gives a clear picture of the strength of potential relationships between variables.

Variables		Descriptive Statistics						Correlation Matrix							
		Obs	Mean	Median	Std	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
(1)	*Ln_HighTech*	57	20,291	20,635	0,947	17,584	21,491	1,000							
(2)	*R&D / million*	57	1843	1831	803	432	4010	0,784	1,000						
(3)	*Ln_R&Dmillion*	57	7,406	7,513	0,516	6,068	8,297	0,875	0,948	1,000					
(4)	*R&D %GDP*	57	0,736	0,770	0,274	0,197	1,496	0,710	0,879	0,869	1,000				
(5)	*Ln_R&D GDP*	57	-0,389	-0,262	0,438	-1,626	0,403	0,780	0,847	0,914	0,961	1,000			
(6)	*Gini*	57	35,512	35,000	3,344	28,900	42,800	-0,234	-0,111	-0,170	-0,321	-0,328	1,000		
(7)	*Poverty*	57	2,654	1,500	2,577	0,100	10,400	-0,835	-0,579	-0,687	-0,585	-0,672	0,600	1,000	

Table 2

This table documents the results of our multivariate regression Models (Panel A) and (Panel B), where Inequality (Gini Index) and Poverty (Poverty index) are the dependent variables explained by the explanatory and control variables. Panel A shows the results for each of the explanatory variables individually as simple regression analysis and multiple, while Panel B exhibits the same regressions (simple and multivariate) for Poverty. P-values are in parenthesis. *, **, *** indicate significance at 10%, 5% and 1% levels respectively

	Panel A: GINI Index				**Panel B: Poverty**			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Ln_HighTech	-0,826*			-1,623*	-2,271***			-2,811***
	(0,080)			(0,067)	(0,000)			(0,000)
#Ln_R&Dmillion		-1,105		8,074***		-3,432***		2,911**
		(0,205)		(0,002)		(0,000)		(0,014)
Ln_R&D GDP			-2,503**	-8,461***			-3,957***	-2,351**
			(0,013)	(0,000)			(0,000)	(0,028)

policymakers. Firstly, investment in digital infrastructure is crucial to ensure equitable access to high-speed internet and digital technologies across all regions, potentially involving subsidies for broadband access in underserved areas or incentives for telecom companies to expand coverage. Alongside this, implementing digital literacy programs can improve digital skills among all demographics, particularly focusing on marginalized communities and older adults who may be less familiar with technology. Policymakers should also establish and enforce regulations to prevent monopolistic practices in technology markets, ensuring fair competition and consumer protection, while addressing issues related to data privacy and security.

Support for small businesses and entrepreneurs is vital, providing resources, training, and funding opportunities to help them leverage technology effectively and compete with larger firms. Inclusive innovation policies should be encouraged through scholarships, mentorship programs, and policies that promote diversity in hiring and retention practices within tech fields. To address algorithmic bias, guidelines and standards must be developed to minimize bias in AI and machine learning applications, ensuring they do not perpetuate existing inequalities. Adapting social safety nets to the digital age is also essential, considering issues such as job displacement due to automation and the gig economy, possibly exploring universal basic income or similar concepts to support those adversely affected by technological change.

Collaboration with technology companies can help design and implement initiatives that promote equity and inclusivity, such as community engagement programs and initiatives to provide affordable tech products and services. On a global scale, fostering international cooperation to address digital divides is necessary, recognizing that inequalities in access and skills are not confined within national borders. Continuous monitoring and evaluation of the impact of policies on technology-driven inequalities through data collection and analysis is essential, allowing for the adjustment of strategies to achieve more equitable outcomes. By adopting a comprehensive approach that combines these strategies, policymakers can work towards mitigating technology-driven inequalities and fostering a more inclusive digital society.

5 Concluding remarks

Digitalisation has brought about many benefits, but it has also widened the gap between the rich and the poor. The government can take several steps to reduce inequality in the framework of digitalisation, some of which are:

Encouraging digital literacy is a vital step in bridging the gap between those who have access to technology and those who don't. Imagine a community where everyone, regardless of age or background, can confidently use a computer or

navigate the internet. By providing training and education programs, the government can help make this a reality, ensuring that more people have the skills they need to thrive in the digital world. These initiatives can transform lives, opening new opportunities for learning, employment, and personal growth.

Investing in infrastructure is another crucial strategy. Picture rural areas and remote communities finally getting high-speed internet and reliable mobile networks. This isn't just about connecting people to the web; it's about connecting them to a wealth of information, resources, and opportunities that were previously out of reach. By focusing on building and expanding digital infrastructure, the government can help everyone participate in the digital economy and enjoy its benefits, no matter where they live.

Promoting digital inclusion means making sure digital services and technologies are accessible and affordable for everyone. Think of a family with a limited income who can now afford a laptop and internet service for their children's education. The government can help by reducing the cost of digital devices and services, ensuring that no one is left behind in the digital age. This inclusivity ensures that everyone, regardless of their financial situation, can benefit from the advancements in technology.

Creating regulations to protect workers, especially those in the gig economy, is essential for fair treatment and adequate benefits. Imagine a gig worker who can now rely on sick leave, retirement savings, and workers' compensation, just like traditional employees. The government can establish regulations to provide these protections, ensuring that gig workers are treated fairly and have the security they need to work with peace of mind.

Encouraging entrepreneurship by providing funding, resources, and support to start-ups and small businesses developing digital solutions to social and economic challenges is another key strategy. Envision a young entrepreneur with a brilliant idea for a tech solution that could change lives, receiving the support needed to turn that idea into reality. By fostering innovation and supporting new ventures, the government can stimulate economic growth and create opportunities for individuals to make meaningful contributions to the digital economy.

Addressing algorithmic bias is vital to prevent existing inequalities from being perpetuated by technology. Consider an algorithm that makes fair and unbiased decisions because it was developed with transparency and accountability. The government can create regulations to ensure this fairness and promote diversity and inclusion in the development of digital technologies. This way, everyone benefits from advancements in technology, and no group is unfairly disadvantaged.

Overall, R&D can sometimes widen the gap between the rich and the poor, technological advancements hold the potential to bridge these disparities. The ongoing tech revolution requires careful attention from policymakers to ensure its benefits reach everyone and its challenges are managed effectively. With thoughtful

and inclusive policies, technology can be harnessed as a powerful tool for equality and opportunity, offering a brighter future for all.

Limitations and Further Research Gaps

One of the major hurdles researchers face today is the scarcity of comprehensive and reliable data for Western Balkan countries. These nations often struggle with data collection and reporting, leading to significant information gaps. Imagine trying to understand the economic or social dynamics of a region with only half the puzzle pieces—it's challenging to form a complete picture. This lack of detailed data makes it difficult to analyse and understand the region's economic, social, and technological landscapes accurately. To make informed decisions, policymakers and researchers desperately need better data collection methods and stronger statistical frameworks. Only with high-quality, detailed data can they craft policies that truly address the region's needs and challenges.

Another pressing issue is the confusion and complexity surrounding the transition processes in many Western Balkan countries. Picture a nation trying to shift from a centrally planned economy to a market-oriented system—it's a bit like trying to change the tires on a moving car. These countries are undergoing significant structural changes and policy reforms, but the journey is often bumpy and uncertain. This period of transition is marked by inconsistent information, frequent policy changes, and a lack of coherent strategies, creating confusion both within the countries and among those trying to understand and assist them from the outside. The ever-changing landscape makes it difficult to track progress and accurately assess the impact of various policies and reforms.

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