



New Labour Market Divide: AI, Human Capital, and Income Inequality

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Abstract. The current study examines the relationship between technological innovation, the changing nature of the labour market, and human capital through an integration of theory and empirics related to indicators of human capital as determined by schooling. An increased demand for more educated workers resulting from technological innovation has been observed in the current analysis. Well-educated nations can take advantage of technological innovation while poorly-educated nations will experience greater inequality and labour market chaos. On the whole, the conclusion that technological innovation not only entails occupational obsolescence but also job restructuring and changes in employment has been drawn in this case. Such findings have been considered against the backdrop of the race between education and technology in which the importance of technological innovation is largely determined by the existence of human capital. In such a case, schooling becomes a key indicator of the efficiency of educational institutions.

Keywords: Technological change, Human capital, Education inequality, Skill-biased technological change, Labour market polarisation

1. Introduction

The fast emergence of digital technologies and AI has greatly transformed the characteristics of work in modern economies. One of the most influential theories that have been put forward to explain changes in skill requirements in the era of rapid technological development is skill-biased technological change (SBTC). The concept explains how technological advancements increase the demand for skilled labour while reducing the demand for unskilled or routine labour (Acemoglu, 2002; Autor, 2015). In the contemporary AI-driven economy, technological advancements complement labour with higher educational and cognitive abilities, while routine labour, traditionally performed by middle-skill labour is substituted. Recent evidence further shows that the deployment of robots and automation technologies has significantly displaced workers in affected labour markets (Acemoglu & Restrepo, 2020).

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The most obvious outcome of this changing nature and skill requirements of work has been the automation of middle-skill jobs. Jobs that involve routine and codifiable tasks, such as clerical work, administrative support, and manufacturing, are more likely to be automated (Autor et al., 2003). The development of robotics, algorithms, and machine learning has enabled computers to perform tasks more efficiently and cost-effectively, thereby reducing job opportunities in routine middle-skill jobs.

At the same time, technological advancements have fuelled the creation of high-skill jobs, especially those that require greater analytical, technical, and problem-solving skills. Data scientists, engineers, and technology experts play an important role in planning, managing, and implementing emerging technologies. With the rise of high-skill jobs, there is also an increase in low-skill jobs in the services sector, including caregiving, hospitality, and personal services. These jobs are less likely to be automated due to their high dependence on interpersonal interactions and nonroutine manual tasks. These changes in job patterns contribute to labour market polarisation. Labour market polarisation is defined as an increase in jobs at both high- and low-skill levels, with a decline in jobs at the middle skill level. These changes in job patterns have significant implications for wage inequality in the labour market. With the rise of technology, high-skilled workers benefit more than low-skilled workers. Workers who lose their jobs due to routine task automation have limited opportunities to find similar jobs.

In the age of artificial intelligence, the study of the interface between technological change, human capital, and labour market outcomes has become even more important. Studying how new technologies are changing skills and labour market structures has become vital in informing policy on education, reskilling, and development in a rapidly changing labour market.

2. Literature Review

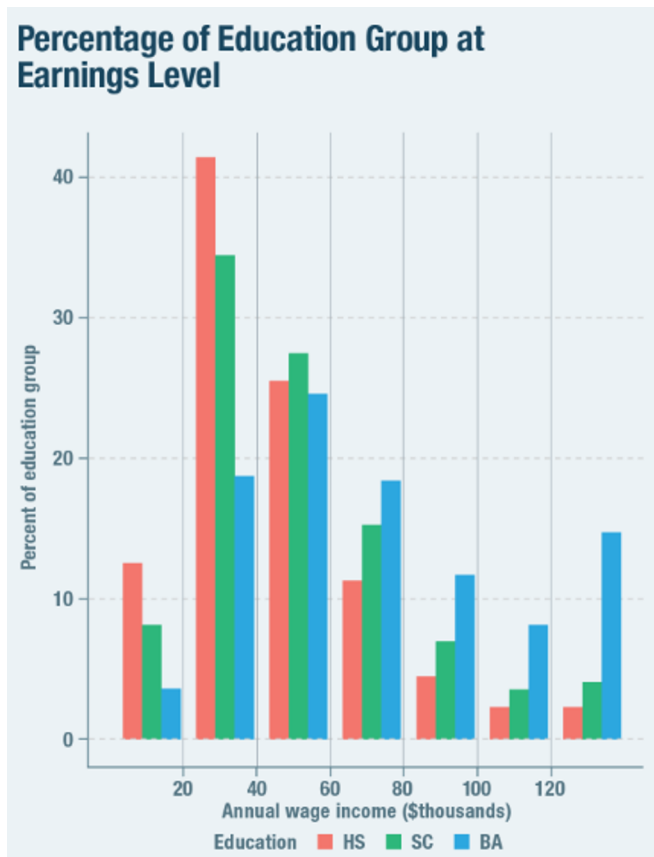
The interaction of education, human capital development, and technological advancement has been analyzed extensively in the economics literature. According to human capital theory, human capital investments through education and training boost people's productive abilities and lead to economic growth (Schultz, 1961; Becker,

1964). Education is important in enabling people to develop the necessary knowledge and technical capabilities, allowing them to participate in the modern labor market. With the increased use of technology in the economy, the need for educated workers grows.

Several studies have focused on the impact of skill-biased technological change (SBTC) on labour market dynamics. SBTC implies that technological development raises the efficiency and income of skilled labour while diminishing the demand for routine labour (Acemoglu, 2002; Autor, 2015). Owing to digital technology and automation, tasks demanding routine cognitive and physical abilities will continue to be automated. This implies that there has been a reduction in the number of people working in middle-skill occupations and increased in the number of people working in high-skill occupations and some low-skill occupations (Autor & Dorn, 2013).

In this context, the pattern of educational attainment is significant for understanding the labour force. Some studies highlight the importance of secondary education in bridging the gap between basic and higher levels of educational attainment. This level of education provides individuals with intermediate cognitive and technical abilities required to pursue further educational courses (Hanushek & Woessmann, 2012). Differences in enrolment and dropout rates across countries and income groups can influence the distribution of the population's human capital.

Empirical research also suggests that limited access to secondary education may constrain the supply of skilled labour and reinforce inequality. Fig. 1 shows that the annual wage for college graduates is much higher than that for high school graduates. Countries with high dropout rates at the middle levels of schooling often experience workforce segmentation, in which a large share of individuals possess only basic education, while a smaller group attains higher education and advanced skills (Goldin & Katz, 2008).

Fig. 1. Education group and earnings level.

This divergence can amplify wage inequality because technological change rewards workers with higher levels of education and specialised skills. The patterns and trends in school enrolment and dropout rates are also significant in this regard. Trends in global education show that although primary education is expanding through universal education programs, secondary completion rates are much lower. The turning point in the formation of human capital is the transition around age 7, as the shift from primary to secondary education is significant in this regard. The dropout rates are very high during this period; these rates have an impact on the development of human capital since students fail to gain skills necessary for the current labour market. The dropouts in schools can also be attributed to the low rate of returns from secondary school education. This educational structure, characterised by a large segment in basic education and a smaller segment in higher education, might lead to structural inequality in income and employment opportunities. This, in turn, might prove critical in a

technological environment, especially when labour markets increasingly reward skills and flexibility.

In conclusion, the literature suggests that technological change and educational attainment play a vital role in determining inequality and polarisation in labour markets. Higher completion rates in secondary education are vital in developing human capital formation and ensuring participation in a skill-intensive labour market, especially in an age marked by technological advancements such as artificial intelligence.

3. Data and Methodology

Data on years of schooling are taken from the latest Barro and Lee (1970–2020) dataset (Barro & Lee, 2013). Years of schooling can be defined as the weighted average of the years of education received by students who completed the particular level of education and those who did not. Data limitations restrict us to considering 134 countries, covering major countries from all continents. There are 10 periods from 1970 to 2020, with a five-year gap between consecutive periods.

Besides the data on number of schooling years (Barro–Lee data), enrolment, completion and dropout ratios in primary, secondary and tertiary education (Figs. 2–7) are taken from UNESCO Institute for Statistics (2025) data set, as well as the authors' calculations. The enrolment ratio is the gross enrolment ratio, i.e. the total number of those who enrol at a certain educational level without age limitation; the completion ratio is the fraction of the corresponding age cohort completing that level; and the dropout ratio is the difference between 1 and the completion ratio. Countries are categorized according to their being high income, upper- middle income, lower - middle income and low income using the World Bank's income classification criteria, thereby making it possible to examine enrolment and dropout trends by level of economic development as opposed to looking at them as an overall global average. This study uses a purely descriptive approach where education system characteristics, enrolment and completion trends and dropout patterns are used to provide evidence for the

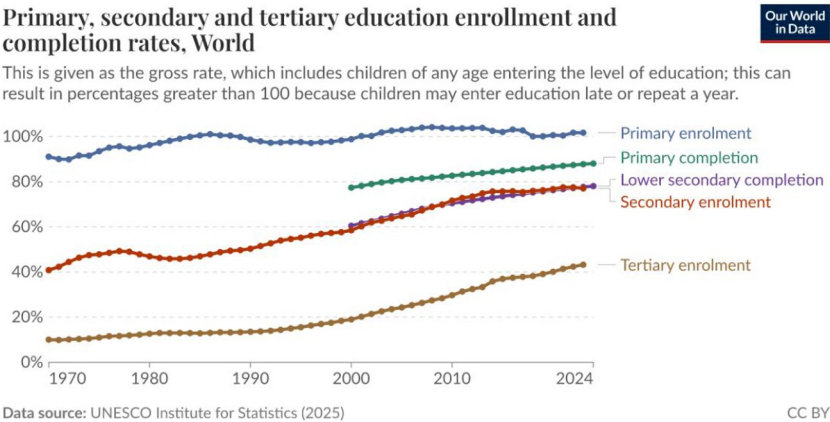
connection between skill biased technological change and labour market polarization and inequality and not to test the SBTC model. Data limitations such as insufficient Barro-Lee/UNESCO data for small states and certain low income countries limit the study to only 134 countries.

4. Result and Discussion

The growth of human capital over the last five decades has been a result of both the number of individuals who enroll and graduate at each level of schooling and the actual time they spent at school. The data that correspond to the first criterion can be seen in Figure 2. Gross enrollment in primary education has been between 100% and 120% since the 1970s. Primary completion, lower secondary completion, and secondary enrollment rates are increasing simultaneously and by 2024 reached about 80%. Tertiary enrollment rates have been constantly growing but are still below 45%. Secondary attendance has increased almost two times between 1970 and 2024, starting from 40% up to about 80% of the population, whereas university enrolments have increased more than four times since 1970 to 2024, rising from below 10% to over 40%, but still not reaching half the percentage of secondary enrollment. The table below complements this picture by tracking the average years of schooling actually completed

at each level across five sub-periods (1970–2020, $n = 112$) (Table 1). The number of years of primary education increased marginally from 3.45 to 4.99, whereas that of secondary schooling increased at a much higher rate from 1.35 to 3.66—increasing more than two and a half times compared to the starting level and years of tertiary education which has increased threefold from 0.15 to 0.49. If read in conjunction, Fig. 2 and Table 1 reveal that the increase in school enrolment and completion does not mean proportional acquisition of years of schooling, particularly at secondary and tertiary levels, because even as accessibility is increasing, the stock of human capital beyond primary education is still meagre.

Fig. 2. Primary, secondary and tertiary education enrolment rates.



Source: UNESCO Institute for Statistics (2025).

Table 1. Average years of primary, secondary, and tertiary schooling by sub-period, 1970-2020.

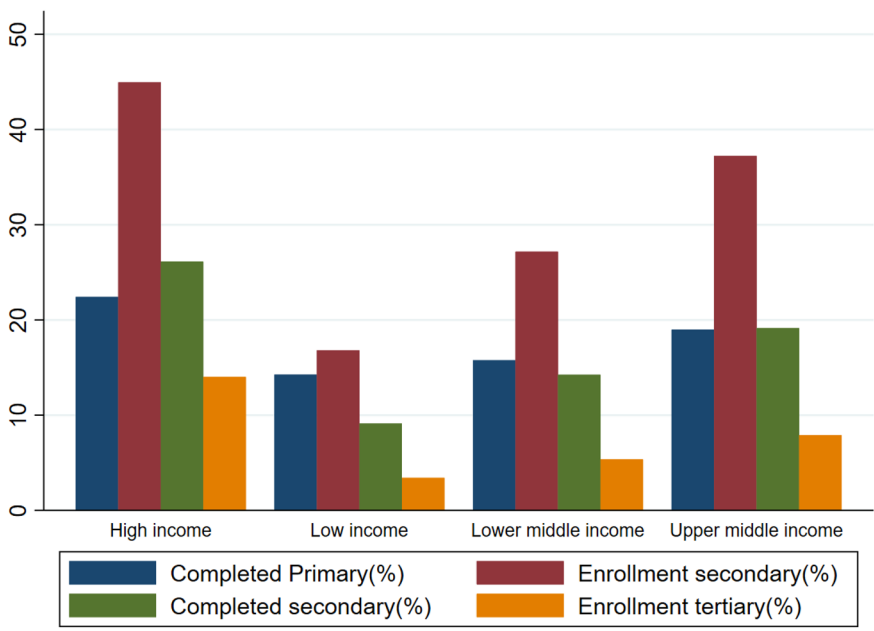
Variables	Observatio n	1970- 1979	1980- 1989	1990- 1999	2000- 2009	2010- 2020
Average years of primary schooling	112	3.45	3.97	4.41	4.76	4.99
Average years of secondary schooling	112	1.35	1.88	2.41	2.93	3.66
Average years of tertiary schooling	112	0.15	0.21	0.3	0.41	0.49

Source: Author's calculation using Barro & Lee dataset.

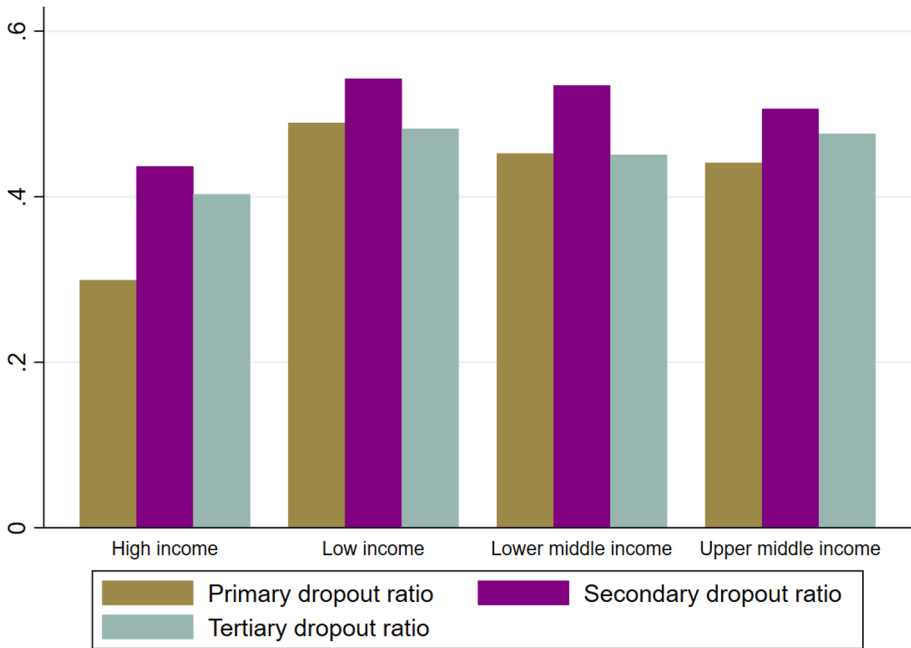
The average school enrolment (repeaters and regular students) and completion rates in secondary schooling for the period 1970-2010 show significant variation across

country groups. For example, the average enrolment in high-income countries is around 45%, while the completion rate is only around 25%; for middle-income countries, the attainment and completion rates are around 38% and 19%, respectively (Fig. 3). The dropout rate in secondary education across countries and income groups is around 0.5 (Fig. 4), which is too high, as most countries have compulsory schooling between the ages of 6 and 14. Other developed countries, such as Germany, have compulsory schooling up to age 16. In spite of the prevalence of compulsory schooling in the majority of countries, dropout rates are not falling, which has various labour market implications; more people are not able to catch up with the skilled labour force, which requires a university degree and a better skill set. As a result, a rise in inequality in wages and income is witnessed in the current labour market across countries.

Fig. 3. Enrolment and completion rate, 1970-2020.

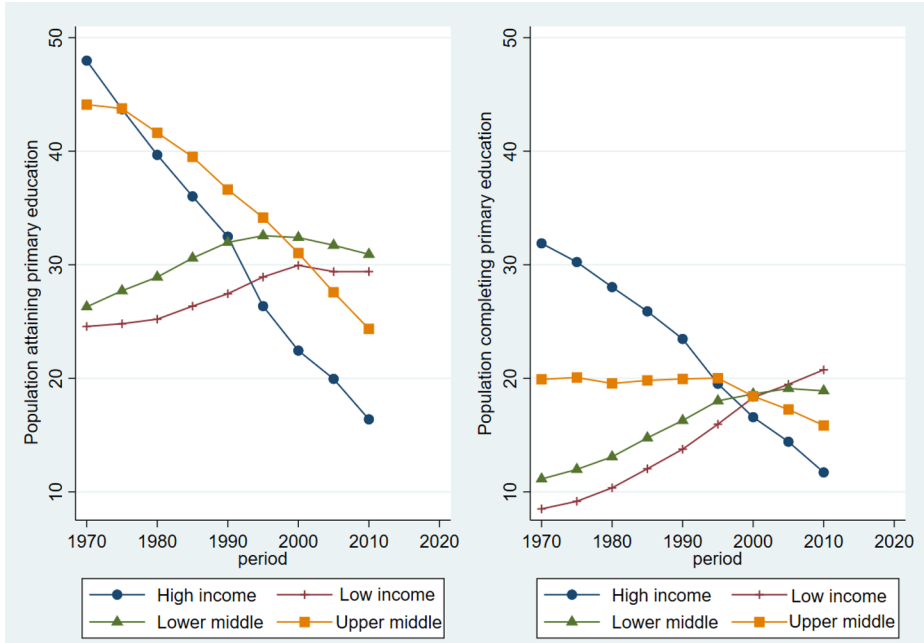


Source: authors' calculation.

Fig. 4. Dropout ratio by country group.

Source: authors' calculation.

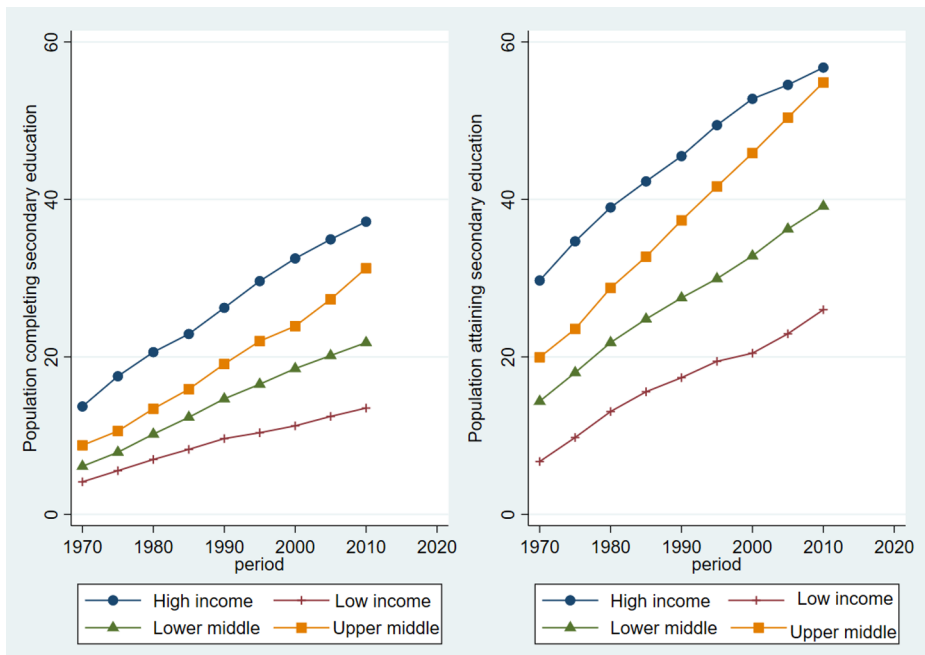
Fig. 5. Evolution of attainment and completion of primary schooling by country group, 1970-2020.



Source: authors' calculation.

Considering the evolution of primary and secondary enrolment and dropout rates, several startling facts are observed: the population enrolment in primary education is decreasing over time for upper-middle and higher-income countries while stagnant for lower-middle and low-income countries (Fig. 5). Despite free education for all schemes, the overall trend is unfavourable, which intrigues us to ask a genuine question: are we really witnessing a learning and teaching crisis?

Fig. 6. Evolution of attainment and completion of secondary schooling by country group, 1970-2020.

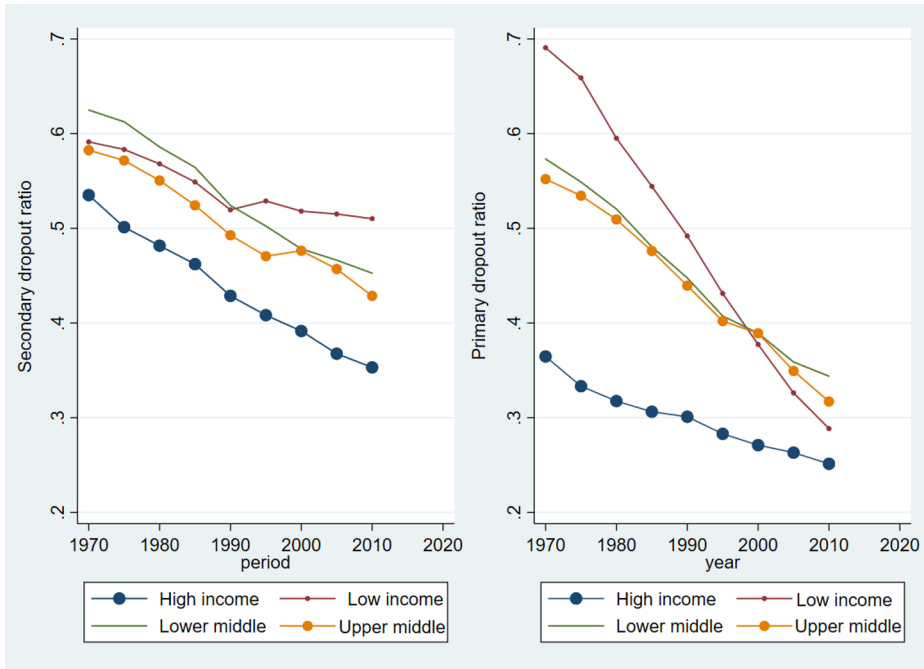


Source: authors' calculation.

The percentage of the population attaining secondary education is increasing over time across all income groups, but completion rates remain unimpressive (Fig. 6). For example, in the year 2010, the attainment percentage for different country groups varied between 20% to 60%, while the completion lies between 15% to 40%.

Further, the dropout rates for secondary and primary levels have shown a decline, but the declining rates are higher for primary than for secondary schooling. For low-income countries, the dropout ratio for primary schooling has gone down from 0.7 in 1970 to 0.3 in 2008 (Fig. 7). For other country groups, the overall rates are falling. The secondary schooling dropout rates for the low-income group have fallen from 0.6 to 0.5, while the decrement is between 0.6 and 0.4 for other groups. Overall, the dropout rates at secondary schools are still very high; secondary schooling witnesses high enrolment but high dropouts on the other side.

Fig. 7. Dropout ratio for primary and secondary schooling by country group, 1970-2020.



Source: authors' calculation.

According to human capital theories, formal education has a significant role in human capital and skill formation. Education and professional training are essential investments in human capital; hence, human capital develops progressively in the formal schooling field. The varied picture of formal schooling at different levels has a profound impact on human capital returns to schooling. There exist better techniques for imparting reading skills quickly in the early primary years, but less is known about how to accelerate learning in the secondary school years. This is especially a challenge for disadvantaged populations. The returns to secondary education have sharply declined over time due to which dropout ratio for secondary schooling has been relatively stable as compared to primary education over the period of 1970-2015.

We experience fewer returns for secondary-level schooling, which generates various repercussions over the decision to continue schooling after primary levels. The high dropout ratio, along with low enrolments in the middle level of schooling in all country

groups, is a matter worth giving serious attention to, as the secondary level of education works as a connecting thread between primary and tertiary levels. The lower quality of secondary schooling leads to lower human capital formation due to high dropouts at this level, or vice versa. ‘Missing child’ in middle school indicates that the country is facing a ‘middle-income trap’: a large mass with primary education due to the universalisation of education and a small, able group with high incomes and innate abilities to afford higher education. This divergence between the two groups further generates income and wealth inequality. Inequality in education begets inequality in wealth and income.

5. Conclusion

This study aims to examine the relationship between educational attainment and the formation of human capital in the context of changing skill demands driven by technological evolution. This study uses the skill-biased technological change model and further explains how the structure of the educational system influences the distribution of human capital across countries. Technological advancements and the increasing use of artificial intelligence have raised the demand for cognitive and analytical skills while reducing the demand for routine middle-skill tasks.

The patterns of empirical evidence presented in this study demonstrate the differences in the outcomes of the schooling process between income groups. While the outcomes of primary education have improved significantly with the implementation of the policy of universalisation of education, outcomes in secondary education are low, and dropout rates are high. This study identifies a critical point around 7 years of schooling, marking the transition from primary to secondary education. During this period, students drop out of school and are unable to accumulate the required level of intermediate skills to participate in the economy.

These findings indicate that secondary education plays a vital part in the human capital formation process. For instance, a large proportion of school dropouts and a relatively lower proportion of completers in this educational level undermine the development of a skilled labour force, leading to structural problems in educational

attainment. Thus, a dual structure emerges, with a large population at a relatively lower educational level and a smaller proportion at a higher level. This phenomenon, in terms of skill-based technological advancements, may result in labour polarisation and a widening wage gap, as technological improvements tend to favour those with higher levels of education and skill.

In conclusion, these findings indicate that the effectiveness of education systems in facilitating the transition from primary to secondary education is vital to human capital formation and, ultimately, economic development. Thus, without addressing this critical educational level, countries risk a shortage of a skilled labour force, considering the emergence of a technology-based economy.

The findings of the present study have significant policy implications for the education system and labour market policies in the age of technological advancements and change.

Improving access and completion of secondary education should be an important policy priority. Secondary education is an important link between primary and advanced education. Therefore, policies that reduce dropouts in secondary education are important for improving human capital formation. The government must work to improve the quality of secondary education, provide financial support for disadvantaged groups, and develop institutional mechanisms to facilitate an easy transition from primary to secondary education.

Education has to change to accommodate the new skills demanded by the digital and AI labour market. The education system must update its curriculum to incorporate digital literacy, analytical reasoning, and problem-solving skills, in line with the changing labour market. Secondly, the education system must improve the quality of STEM and vocational and technical education, as they are the backbone of the era of technological advancement. Thirdly, targeted interventions to address inequalities in access to and the quality of education across income groups must be implemented. For instance, conditional cash transfers, scholarship programmes, and other educational support programmes in the community can be effective in reducing dropout rates.

Addressing inequality in access to quality education is crucial in the context of widening income and wealth gaps.

Lastly, there is a need to develop policies in lifelong learning and skills development to complement formal education systems. This is because, with the changing nature of technology, workers will need to continually upgrade their skills to remain relevant. This will help in avoiding labour market displacement. In conclusion, improving secondary education and aligning education systems with the changing demands of technology will play a crucial role in developing labour markets. This will help foster more inclusive labour markets, which will benefit from technological changes.

Disclosure of Interest: The authors have no competing interests to declare that are relevant to the content of this article

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