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ORIGINAL RESEARCH

Impact of Technology on Macro-Level Employment and the Workforce: What are the Implications for Job Creation and Job Destruction in Ghana?

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Abstract
Technology whilst creating jobs has destroyed many jobs. The destructive power of technology has led many workers in developing countries, especially Ghana to fight against its introduction. We investigate the effect of technological change on job creation and destruction in Ghana using longitudinal data from the World Development Indicator covering 1990 to 2018. By running the ARDL model, the summative technology-related job destruction is higher in the short run whilst job creation is higher in the long run. Thus, technology has a compensation effect on job destruction and job creation, due to its labour-saving nature. The short and long-run job destruction is higher with increasing importations, interest rate, and minimum wages, however, economic growth, FDI, and exportation increase job creation. Since technology results in higher job destruction, it is important to equip workforce with the technological knowledge before the introduction of new technology.

Keywords Ghana · Job creation · Job destruction · Technological change · Minimum wage

JEL J01 · O33

1 Introduction

In recent years, the remarkable drop in the absolute number of formal workers in the Ghanaian economy has been a source of controversy and public concern. The long-term employment relationship is an important feature of many developing countries as an estimated 30% to 70% of the labour force in developing countries is employed in informal jobs (Bosch & Esteban-Pretel, 2012; Jumpah et al., 2020). As indicated by Liu (2018), the dynamics of the labour market are associated with the creation of new jobs and the destruction of old ones at the firm level. Earlier reiterated by Mortensen and Pissarides (1994),

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firms' wages and job productivity are key determinants of their employment decisions. For most developing countries, insecure employment and poor wages are continuing problems. Further, the effect of advanced technology on job destruction and creation is an important subject of investigation as it is assumed to displace much of the working labour force, creating widespread unemployment, human hardship, and social disruption. Worst still, the relevant literature on job destruction and creation has concentrated primarily on developed and advanced countries, with little or no reference to developing countries including sub-Saharan Africa. The purpose of this paper is, therefore, to investigate how job gain or job loss (employment) in Ghana responds to international trade, technology, foreign direct investment, and minimum wage shocks.

In Ghana, economic growth has slowed, if not frozen, likewise, and more importantly, foreign firms repatriate their profits to their home countries or to a tax haven (Junankar, 2013), preventing these revenues from being recycled in developing countries to increase aggregate demand. Worst still, is the introduction of technology into the labour market. Many activities that employees engage in have been automated, yet the traditional educational systems have not kept pace with the changing nature of technology and the way in which work, resulting in many employers saying they cannot find enough employees with the skills they need. The popular belief is that old jobs are lost with the arrival of new technologies, thus, technology is labour-saving (Van Roy et al., 2018), but they are eventually replaced by new, more productive job prospects. Mortensen and Pissarides (1998) postulate that new technology increases job creation at a given wage, which is consistent with the introduction of new technology. In spite of this, merely positing that new jobs are created when old ones are destroyed does not necessarily suggest that the economy will be at the same level of employment or settle at a higher level of employment. Thus, the study addresses the effect of technology on employment gain or loss.

Aside from technology, trade, interest rate, and foreign direct investment have an effect on employment status. For instance, Dutt et al. (2009) reported that from the comparative advantage point of view trade is likely to worsen unemployment in capital abundant countries but is expected to reduce unemployment in labour abundant countries, whilst Anyanwu (2014) finds a greater impact of trade openness on unemployment for women than men but in general an increase in trade openness results in lower aggregate and unemployment in sub-Saharan Africa.

In labour economic theories, wages and job productivity are major drivers in determining the volume of employment creation and destruction. (Mortensen & Pissarides, 1994). While the common causes of unemployment from the micro perspective have been widely discussed in the literature (Ampadu-Ameyaw et al., 2020; Kezban, 2008; Mago, 2014), the macro-perspective is still at the infantile stage of discussion. The objective of this paper is to analyse the evidence for a trade-off between employment and productivity. The study asks five questions in particular: First, does technological change impact job destruction and job creation in Ghana? Second, does an increase in the minimum wage and interest rate have an impact on Ghana's employment? Third, do foreign direct investment and taxes work to modify employment? Fourth, how does an increase in technology impact employment creation in Ghana? Finally, what is the speed of adjustment in a rigid labour market? The purpose of this paper is to answer these questions by using the macro-level time series data to analyse job destruction and job creation in sub-Saharan Africa, specifically, Ghana. The rest of the paper is presented as follows: The next section is the literature review, where the theoretical and empirical literature are discussed. Section III presents the methodology followed to achieve the objective of the study. Section IV presents the rigorous estimate of the determinants of job creation and job destruction using autoregressive distributed lag

(ARDL) regression. The study offers the discussion of the findings in Section V while section VI offers some tentative conclusions and policy recommendations.

2 Literature Review

2.1 Composition of Ghana's Economy

Ghana's economy is a mix of state and private enterprise. Prior to independence, the government's primary responsibilities were limited to the provision of essential services like water, electricity, roads, and postal delivery. Soon after gaining independence, the government began building numerous state-owned businesses in both agriculture and industry in an effort to increase its influence over the economy. Measures were taken to entice international investors to operate either independently or in collaboration with the government in order to make up for the lack of money and entrepreneurial capabilities in the local economy (Britwum, 2022). There was a noticeable decrease in governmental engagement in economic problems between 1966 and 1972, though, the government, remained the biggest single employer of labor and continued to offer essential services (Asravor & Sackey, 2022). Policymakers reverted to the idea of a centralized economy following the coup in 1972. A strategy of increased nationalization and state control was implemented, imports were reduced, industrial projects that had been shelved following Nkrumah's assassination were revived, and the substantial debt due to four British corporations was repudiated. Following a two-year suspension of foreign loans and aid, the government finally decided on a repayment schedule for its obligations in 1974.

In a more recent time, the private services sector accounts for around three-fifths of the GDP, followed by agriculture which constitute about one-fifth and industry at about one-fourth. Except for agriculture, all these sectors were mostly controlled by private businesses, including banking, trade, and industry. In 2021, the share of agriculture in Ghana's gross domestic product was 19.71 percent, industry contributed approximately 28.26 percent and the services sector contributed about 45.93 percent (Ghana Statistical Service, 2021). The government of Ghana has implemented two subsidy policies in agriculture, namely, the Planting for Food and Jobs (PFJ), which is an input subsidy program for crop farmers; and the Ghana COVID-19 Alleviation and Revitalization of Enterprise Support Program (Ghana CARES) Broiler Initiative. In the history of Ghana, the agricultural sector is the most subsidized sector (Asravor, 2022). The subsidy of agriculture is in the form of input subsidy, such as, fertilizer subsidy and machinery subsidy (Asravor & Sarpong, 2022). Over the past 60 years, there have been a variety of changes to the Ghanaian labor market. The job landscape has increasingly shifted away from agriculture in favor of services, which to a large part reflects how the economy is changing. The breakdown of employment in Ghana from 2009 to 2019 by economic sector in Ghana shows that the agricultural sector employed 29.75 percent of workers in 2019, followed by the industrial sector with 21.05 percent and the service sector with 49.21 percent (Plecher, 2020).

2.2 Theoretical Literature

From a theoretical economics perspective, the controversy on an assessment of the effects of technological change, and technology in general on employment is well-known. Following Piva and Vivarelli (2018) the study uses two main theories, that is, the process innovation and 'compensation mechanisms' and product innovation and employment.

2.2.1 Process Innovation and 'Compensation Mechanisms'

Generally, the traditional schools of thought on technologically induced unemployment, suggest that technology will not result in long-term joblessness. Instead, any unemployment is only temporary, and job losses are more than compensated for overtime by five mechanisms known as compensation factors. The first factor is represented by the new technology's manufacturing, operation, and maintenance. If a company decides to install a new piece of technology, it will require additional labour to develop, operate, and maintain it. An increase in investment is the second compensatory component. Firms will have an incentive to expand operations if new technology boosts their profitability, creating jobs in the process. Third, if technology boosts an organization's efficiency, lowering costs (as is usually the case), the firm expands its supply of the goods and services it provides. This raises aggregate supply across the economy, lowering overall prices and enhancing consumer purchasing power. The establishment of entirely new industries is the fourth compensation effect. Technological advancements can and have resulted in the emergence of new fields of work, resulting in a profusion of new job prospects. Finally, technology has the potential to boost individual workers productivity, making them more valuable to their employers. As a result, their wages may grow, increasing their spending and, as a result, the economy's aggregate demand and output. To keep up with the increase in productivity, employment will have to rise as well (Wallis, 1960). All these compensation components are considered to interact throughout the macro economy, limiting long-term employment losses. Indeed, as economist Wassily Leontief points out, this process existed in the nineteenth and twentieth centuries (Leontief, 1983).

From classical economists' point of view, two opposite views have been competing. The first view suggests that the working class feared being dismissed due to the introduction of innovation (Ricardo, 1951). Conversely, the political and academic debate was largely theoretically dominated by ex-ante confidence in the existence of market compensation mechanisms for fired workers. In the first half of the nineteenth century, classical economists put forward a theory that Marx called the 'compensation theory' (Marx, 1961) which is based on diverse market compensation mechanisms which are created by changes in technology and might partially or totally counterbalance the initial labour-saving impact of process innovation (Calvino & Virgillito, 2018; Vivarelli, 2014; Vivarelli & Pianta, 2000). The first and foremost channel for compensating the initial job losses relates to the 'introduction of new machines' and the process by which innovations displacing workers are able to create new jobs in the capital sectors where these new machines are fabricated (Say, 1964). Nevertheless, the size of this effect can only partially as labour-saving technologies affect the capital goods sector as well (Marx, 1961). Secondly, the compensation mechanism implies the 'decrease in prices', and the innovations process involves the displacement of workers, they easily determine

the reduction of the unit costs of production (Piva & Vivarelli, 2018). In a competitive market, this dynamic reduces final prices as well and, in turn, decreasing prices encourage a new demand for products and, so, additional production and employment (Steuart, 1966).

A third compensation mechanism hinges on the decision to 'support new investments' as delays in translating the decline in costs due to technological adoption leads to decreases in prices whilst increases in profits may be accrued by the innovative entrepreneurs. The increase in profits when invested will result in new productions and job opportunities (Ricardo, 1951). Fourthly, the compensation mechanism hovers around the impact of new technologies on the labour market, more specifically, its effect on the 'reduction in wages'. Focusing on the labour-market only, the direct effect of job-destructive technologies may be directly compensated in case of free competition and full substitutability between labour and capital (Piva & Vivarelli, 2018). Under this assumption, technological unemployment suggests a decrease in wages that would stimulate less expensive technologies and more labour-intensive methods. Finally, the compensation mechanism is linked to 'increases in incomes' which directly contrast the 'reduction in wages' and this suggests that there might be competition between technology and employment.

2.2.2 Product Innovation and Employment

With reference to product innovation, evidence shows that the introduction of new products and the successive emergence of new markets leads to a job-creation effect. Classical economists such as Say (1964) have recognized the labour-intensive impact of product innovation, and presented an optimistic view of the positive employment benefits associated with the introduction of new products (Marx, 1961). Vivarelli (2014) and Bogliacino and Pianta (2010) concur that product innovations have a beneficial influence on employment since they allow for the manufacture of entirely new or differentiated mature commodities. Also, the effect of product innovation on job creation may be positive or negative. The 'welfare impact' of the establishment of new production branches is associated with the 'substitution effect' (Hall et al., 2008; Harrison et al., 2008) leading to the destruction of the old and the creation of a new one. Further, the balance between the direct labour-saving effect of the innovation process and the counterbalancing effects of compensation and product innovation can significantly diverge depending on different historical periods and institutional/social frameworks (Freeman & Soete, 1994).

2.3 Empirical Literature

Balsmeier and Woerter (2019) examined the effect of the adoption of digital technologies on labour in Switzerland. The authors found that increased investment in digitalization is associated with increased employment of high-skilled workers and reduced employment of low-skilled workers, with a slightly positive net effect. The main effects are almost entirely driven by firms that employ machine-based digital technologies, such as robots. Van Roy et al. (2018) examined the economic insights on the employment impact of technological change using longitudinal data covering manufacturing and service sectors over the 1998–2011 period for 11 European countries using system generalized methods of moment (GMM-SYS) and least squares dummy variable corrected (LSDVC) estimates. They found a significant labour-friendly impact of R&D expenditures yet, this positive

employment effect appears to be entirely due to medium and high-tech sectors, while no effect can be detected in low-tech industries. Secondly, capital formation is found to be negatively related to employment which suggests a labour-saving effect due to the embodied technological change incorporated in gross investment. Frey and Osborne (2017) using a Gaussian to process data from the US Department of Labour forecast that 47% of the occupational categories are at high risk of automation, including a wide range of service/white-collar/cognitive tasks which is likely to results in the widespread unemployment in the United State.

According to Brynjolfsson and McAfee (2014), the unemployment being experienced is partially attributable to the economic crisis and can be seen as an expression of a structural adjustment characterized by an exponential growth in computers' processing speed having an even bigger impact on jobs, skills, and the whole economy. In their empirical studies, Autor et al. (2013) found significant negative labour-market effects of international trade between the USA and China on the US economy and conclude: "Rising imports cause higher unemployment, lower labour force participation, and reduced wages in local labour markets that house import-competing manufacturing industries" (Autor et al., 2013). Also, Klapper and Richmond (2011) present evidence from Cote d'Ivoire indicating that rates of job creation and destruction in the period 1976–1997 reached 14.7% and 15.3%, respectively, whereas overall the study finds that about 8% of the jobs created are due to firm entry. In addition, 8.3% of job destruction is a result of the shrinking nature of incumbent firms. By the same token, Moser et al. (2010), studies the simultaneous job creation and destruction measures at the firm level for German businesses and found that job creation responded negatively to wage costs but was unaffected by shocks to productivity caused by sales fluctuation. Abbey et al. (2017), found a positive effect of export on employment-generating suggesting that exporting firms are larger firms. The positive effect could be explained by the abundant unskilled workers currently available, and which are unemployed. Graetz and Michaels's (2018) estimation results indicate that the use of technology reduces employment, but this reduction is not significant to create unemployment rather, it reduces the hours of both low and middle-skilled workers.

In Australia, Swastika and Masih (2016) found enough evidence of a positive long-term relationship between interest rate and unemployment, and a negative long-term relationship between inflation and unemployment. Swastika and Masih (2016) report that interest rate is the strongest exogenous variable, followed by the inflation rate, in determining unemployment. Johnstone et al. (2019) indicated that in the US, the financial crisis was associated with a dramatic weakening of the labour market with unemployment rising from 5% (7.6 million) in December 2007 to 10.2% (15.7 million) in October 2009.

Also, in their study of the African situation when it comes to technology adoption, Hjort and Poulsen (2019) used a sample-wide data from Africa on the impact of technology on job creation. Their finding shows that technology (digitalization) impact is driven by increased employment in higher-skill occupations, but less educated workers' employment gain less so. Firm level data available for some countries indicate that increased firm entry, productivity, and exporting contribute to higher net job-creation whilst average incomes rise. Also in Kenya, Banga and te Velde (2018) reported increase in digitalization which has resulted in an increase in labour productivity in Kenya but by roughly 2% annual growth. Also, formal manufacturing employment also steadily increased, and while the labour share fell, it recovered somewhat in recent years, indicating the increased volume of high-productivity manufacturing activities taking place in Kenya. Avom et al. (2021) found that the introduction of ICTs generally has two significant opposite effects on job, either by destroying low-skilled jobs and promote high-skilled jobs. In their finding, the introduction

of ICTs in the WAEMU destroyed 0.03% of the low-skilled jobs and created 0.05% high-skilled jobs, hence the net effect of ICT on job is positive. The World Bank (2021) in its study found that subsidizing technology is not enough but should be linked with the sectorial transformation through movement of workers into higher productivity firms and spatial transformation through trade, urbanisation, and connectivity. According to the World Bank This will require expanding lower-skilled jobs in 'global innovator' services, particularly ICT and business services and boosting competitiveness in manufacturing by fully implementing the African Continental Free Trade Area and moving to higher value-added labor-intensive tradable services through Foreign Direct Investment, attracting and cultivating large firms and developing the tourism sector after the pandemic.

3 Methodology

3.1 Theoretical Model

In analysing the data to address the research questions and achieve its objectives, the study follows Davis and Haltiwanger (1992), and Esaku (2020) to compute job creation and destruction rates in Ghana.[1] As indicated by Davis and Haltiwanger (1992), job destruction is calculated by summing employment losses at shrinking and dying establishment within s sector whilst job creation is calculated by summing employment gains at expanding and new establishments within a sector. To express these measures as rates, we divide by the sector size and further aggregate it to the national level. We write the shorten version of the job creation (Eq. 1) and job destruction (Eq. 2) rate in sector s at time t which is aggregated at the national level as:

$$JC_{st} = \sum_{i} \frac{n_{it}}{N_{st}} g_{it} \, forg_{it} > 0 \tag{1}$$

$$JD_{st} = \sum_{i} \frac{n_{it}}{N_{st}} |g_{it}| \, forg_{it} < 0 \tag{2}$$

From Eqs. 1 and 2, $N_{st} = \sum_{i \in s}(e_{it} + e_{it-1})/2$ is defined as the size of sector s calculated in two time periods. s is referred to as the whole manufacturing sector, an industry, or any other type of group of firms classified in a different manner such as their international status. Also, g_{it} is a measure of the growth in employment and e_{it} is the number of workers employed in each sector. From this equation, the destruction rates computed is the total number of destroyed or jobs created over the size of sector. These are all aggregated to the national or country level.

3.2 Empirical Specification

Job creation and destruction using from the Ghanaian data are estimated based on the theoretical model. Job creation is estimated using Eq. 2, as follows:

[1] Please note that these authors used firm level data but in this study all calculations were aggregated to the national level.

$$\text{Job\_creation}_t = \alpha + \beta Job\_Creation_{t-1} + \gamma \text{digitalisation}_t + \delta \text{Export}_t + \pi \text{Import}_t + \varphi \text{DailyWage}_t + \omega \text{InterestRate}_t + \aleph \text{FDI}_t + \vartheta \text{FinCrisis}_t + \rho \text{GDP}_t + \theta \text{TaxSub} + \mu_t \quad (3)$$

Similar model is estimated for job destruction (Eq. 4) but in the case of job destruction, the estimated regression model is presented as follows:

$$\text{Job\_destruction}_t = \alpha + \beta \text{Job\_destruction}_{t-1} + \gamma \text{digitalisation}_t + \delta \text{Export}_t + \pi \text{Import}_t + \varphi \text{DailyWage}_t + \omega \text{InterestRate}_t + \aleph \text{FDI}_t + \vartheta \text{FinCrisis}_t + \rho \text{GDP}_t + \theta \text{TaxSub} + \mu_t \quad (4)$$

3.3 Empirical Strategy

As is the case, to avoid spurious regression of time series variables the stationarity test (Gujarati & Sangeetha, 2007) is performed on all estimated variables. All variables in this study were subjected to a unit root test using the Augmented Dickey Fuller (ADF) test and Phillips–Perron (PP) test. The ADF and PP test is performed to examine the following hypothesis:

$$H_0 : \text{There is unit root or non} - \text{stationary variables}$$

$$H_1 : \text{No unit root or stationary among variables}$$

The null hypothesis (H_0) is only accepted on if stationarity is attained at either level of after differencing the variables. The cointegration test was conducted to examine the existence of the long-run relationship between the variables. The cointegration test is then employed to test the stationary of the residual obtained from the OLS regression. The hypothesis tested is presented as:

$$H_a : \text{There is no cointegration among variables}$$

$$H_b : \text{There is cointegration among variables}$$

where H_a is the null hypothesis and H_b is the alternative hypothesis. Afterwards, the study applied the autoregressive distributed lag (ARDL) approach by Pesaran et al. (2001). The ARDL model is considered as the best econometric method compared to others in a case when the variables are stationary at I(0) or integrated of order I(1) but it fails in the presence of an I(2) variables and has been severally applied in the empirical literature (Asravor & Fonu, 2021; Asravor & Sackey, 2022; Bahmani-Oskooee & Bohl, 2000). The ARDL approach is appropriate for generating short-run and long-run elasticities for a small sample size at the same time and follow the ordinary least square (OLS) approach for cointegration between variables since it affords flexibility about the order of integration of the variables (Duasa, 2007). Equations (3) and (4) can be written in the ARDL form as:

$$\begin{aligned}\Delta\text{Job\_creation}_t =& \propto_0 + \sum_{i=1}^{n} \beta\text{Job\_Creation}_{t-1} + \sum_{i=1}^{n} \gamma\text{digitalisation}_t + \sum_{i=1}^{n} \delta\text{Export}_t + \sum_{i=1}^{n} \pi\text{Import}_t \\ &+ \sum_{i=1}^{n} \varphi\text{DailyWage}_t + \sum_{i=1}^{n} \omega\text{InterestRate}_t + \sum_{i=1}^{n} \aleph\text{FDI}_t + \sum_{i=1}^{n} \vartheta\text{FinCrisis}_t \\ &+ \sum_{i=1}^{n} \rho\text{GDP}_t + \sum_{i=1}^{n} \theta\text{TaxSub} + \text{Job\_creation}_t + \gamma\text{digitalisation}_t + \delta\text{Export}_t \\ &+ \pi\text{Import}_t + \varphi\text{DailyWage}_t + \omega\text{InterestRate}_t + \aleph\text{FDI}_t + \vartheta\text{FinCrisis}_t + \rho\text{GDP}_t + \theta\text{TaxSub} + \mu_t\end{aligned} \tag{5}$$

$$\begin{aligned}\Delta\text{Job\_destruction}_t =& \propto_0 + \sum_{i=1}^{n} \beta\text{Job\_Creation}_{t-1} + \sum_{i=1}^{n} \gamma\text{digitalisation}_t + \sum_{i=1}^{n} \delta\text{Export}_t + \sum_{i=1}^{n} \pi\text{Import}_t \\ &+ \sum_{i=1}^{n} \varphi\text{DailyWage}_t + \sum_{i=1}^{n} \omega\text{InterestRate}_t + \sum_{i=1}^{n} \aleph\text{FDI}_t + \sum_{i=1}^{n} \vartheta\text{FinCrisis}_t \\ &+ \sum_{i=1}^{n} \rho\text{GDP}_t + \sum_{i=1}^{n} \theta\text{TaxSub} + \text{Job\_creation}_t + \gamma\text{digitalisation}_t + \delta\text{Export}_t \\ &+ \pi\text{Import}_t + \varphi\text{DailyWage}_t + \omega\text{InterestRate}_t + \aleph\text{FDI}_t + \vartheta\text{FinCrisis}_t + \rho\text{GDP}_t + \theta\text{TaxSub} + \mu_t\end{aligned} \tag{6}$$

where $\propto_0$ represents drift component and μ_t shows the white noise. The study uses the Akaike information criterion (AIC) for choosing the lag length. After finding the long-run association existing between variables, the study uses the error correction model (ECM) to find the short-run dynamics. The ECM general form of Eqs. (5) and (6) are formulated in Eqs. (7) and (8):

$$\begin{aligned}\Delta\text{Job\_creation}_t =& \propto_0 + \sum_{i=1}^{n} \beta\text{Job\_Creation}_{t-1} + \sum_{i=0}^{n} \gamma\text{digitalisation}_t + \sum_{i=1}^{n3} \delta\text{Export}_t + \sum_{i=0}^{n4} \pi\text{Import}_t \\ &+ \sum_{i=1}^{n5} \varphi\text{DailyWage}_t + \sum_{i=0}^{n6} \omega\text{InterestRate}_t + \sum_{i=1}^{n7} \aleph\text{FDI}_t + \sum_{i=0}^{n8} \vartheta\text{FinCrisis}_t \\ &+ \sum_{i=0}^{n8} \rho\text{GDP}_t + \sum_{i=0}^{n8} \theta\text{TaxSub} + \nabla ECM_{t-1} + \mu_t\end{aligned} \tag{7}$$

$$\begin{aligned}\Delta\text{Job\_destruction}_t =& \propto_0 + \sum_{i=1}^{n} \beta\text{Job\_destruction}_{t-1} + \sum_{i=0}^{n} \gamma\text{digitalisation}_t + \sum_{i=1}^{n3} \delta\text{Export}_t \\ &+ \sum_{i=0}^{n4} \pi\text{Import}_t + \sum_{i=1}^{n5} \varphi\text{DailyWage}_t + \sum_{i=0}^{n6} \omega\text{InterestRate}_t + \sum_{i=1}^{n7} \aleph\text{FDI}_t \\ &+ \sum_{i=0}^{n8} \vartheta\text{FinCrisis}_t + \sum_{i=0}^{n8} \rho\text{GDP}_t + \sum_{i=0}^{n8} \theta\text{TaxSub} + \nabla ECM_{t-1} + \mu_t\end{aligned} \tag{8}$$

where ∇ is the coefficients of ECM for short-run dynamics. ECM shows the speed of adjustment in long-run equilibrium after a shock in the short-run.

3.4 Data Source and Description

The paper uses different dataset to source information for this study. The first database used in the World Development Indicators (WDI) dataset published by the World Bank. Information on export, import, and gross domestic product was sourced from the WDI. The daily minimum wage figures were obtained from the Ministry of Finance and Economic Planning. Job creation and destruction data was sourced from the Ghana Statistical service and the Ghana Investment Promotion Center. The selected annual time series data used for this study covered the period 1980 to 2018. The main independent variable used is investment in Information communication technology (DIGITALIZATION) measured by changes in investment between 1980 and 2018. Digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business. Digitalization refers to enabling or improving processes by leveraging digital technologies and digitized data. Therefore, digitalization presumes digitization. Foreign direct investment (FDI) is net inflow which is the percent of the GDP while financial crisis (FINCRISIS) is a dummy which is one if during that year there was a global financial crisis and zero if otherwise. The log of the minimum wage (LDAILYWAGE) of captures the average annual minimum wage whereas the interest rate (INTERESTRATE) is the rate of return that lenders demand for the ability to borrow their money. Export of goods and services (EXPORTPERCENT) is defined as the value of all goods and other market services provided to the rest of the world measured in current US dollars. Imports of goods and services (IMPORTPERCENT) consist of transactions in goods and services (purchases, barter, and gifts) from non-residents to residents measured in current US dollars. In addition, taxes less subsidies on products (LTAXSUBLCU) measured in current US dollars and the gross domestic product (LGDPUS) is measured in current US dollars.

4 Result

4.1 Stationarity Test: Unit Root Test

This study employs both the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) unit root test to check the stationary of the variables used in the study. The unit root test on the variables were performed using levels, and trends and intercept. The result obtained from the unit root test is summarized and presented in Table 1.

By observing Table 1, it can be seen using intercept, and intercept with trend, LTAXSUBLCU is stationary at level at both 1% and 5% per the PP test. In the case of the ADF, LTAXSUBLCU was stationary at level at both 1% and 5% when the intercept and trend was used. The other variables were not stationary at levels. At first difference, the results confirm that all the variables were stationary, that is, they I(1). Since the variables are of mixed type of I(0) and I(I) and are of mixed order of integration, the Johansen Co-integration test cannot be used, hence the choice of the Auto-regressive Distributive Lag (ARDL) model. Prior to the estimation of the ARDL, the bounds test was performed.

Table 1 Unit root test results

Variables	ADF		PP	
	Intercepts	Intercept and trend	Intercepts	Intercept and trend
At levels				
D(DIGITALIZATION)	−0.5139	−1.7080	−0.5979	−1.8302
D(EXPORTPERCENT)	−2.3901	−2.2317	−2.3909	−2.2298
D(FDIPERCENT)	−1.7261	−1.6786	−1.7261	−1.7143
D(FINCRISIS)	−2.3604	−2.3036	−2.4748	−2.4313
D(IMPORTPERCENT)	−2.3668	−2.2844	−2.3203	−2.0905
D(LDAILYWAGE)	−2.6209	−2.4293	−2.6067	−2.3876
D(LGDPUS)	−0.1551	−2.1357	0.1011	−2.1650
D(LTAXSUBLCU)	−1.6969	−16.8729***	−4.2903***	−18.2150***
D(INTERESTRATE)	−1.2132	−2.2616	−1.2895	−2.3481
At first difference				
D(DIGITALIZATION)	−5.1838***	−5.0597***	−5.2082***	−5.1014***
D(EXPORTPERCENT)	−5.1726***	−5.1790***	−5.1832***	−5.1958***
D(FDIPERCENT)	−4.1750***	−4.1912***	−4.1127***	−4.1664***
D(FINCRISIS)	−4.7958***	−4.7067***	−4.7958***	−4.7067***
D(IMPORTPERCENT)	−5.3573***	−5.6001***	−5.4234***	−7.1458***
D(LDAILYWAGE)	−5.2011***	−5.5552***	−5.2573***	−8.2341***
D(LGDPUS)	−4.3789***	−4.3797***	−4.3789***	−4,3797***
D(LTAXSUBLCU)	13.2173***	−12.2938***	−4.2903***	−18.2150***
D(INTERESTRATE)	−4.4428***	−4.3512***	−4.4250***	−4.3328***

****, ** and * denotes 1, 5 and 10% level of significance, respectively.*

4.2 Bounds Test

The result from the bounds test is presented in Table 2. The F-statistic for the Bounds Test is 21.962 for job destruction and 5.453 for job creation, which clearly exceeds the 1% critical value for the upper bounds for both models. Accordingly, the hypothesis of "no long-run relationship" is strongly reject and the alternative hypothesis of "long-run relationship" accept. Thus, there exists a long-run relationship (co-integration) between the independent variables and the dependent variable.

After establishing the existence of cointegration between the variables, the long and short run estimation involving an error correction term which reflects the speed of

Table 2 Co-integration test

			Critical value at 1% significance level		Critical value at 5% significance level	
Model	K	F-statistics	Bottom bound	Upper bound	Bottom bound	Upper bound
JD	9	21.962***	2.5	3.68	2.04	2.08
JC	9	5.453***	2.5	3.68	2.04	2.08

convergence of short-run disequilibrium towards the long-run equilibrium was performed. This was undertaken using the appropriate ARDL model.

4.3 Long Run

Table 3 displays the long-run parameters of the ARDL model. The result shows that digitalisation, export, FDI, financial crisis, import, interest rate minimum wage, gross domestic product and tax subsidy or holiday has significant impact on job creation and job destruction. The key explanatory variable, digitalisation (technology) has a positive effect on job creation with the elasticity of 0.56 per cent and a negative effect on job destruction with an elasticity of -0.19 per cent. When it comes to job creation, the higher

Table 3 ARDL Long run estimates of Job destruction and Job creations

Variable	Job creation			Job destruction		
	Coefficient	Std. error	t-statistic	Coefficient	Std. error	t-statistic
EMPLYRATIO(-1)	−0.377073	0.522855	−0.721181	1.7705***	0.2267	7.8112
EMPLYRATIO(-2)	−1.198968**	0.219675	−5.45792	−1.5696***	0.3448	−4.552
DIGITALIZATION	0.555285**	0.058808	9.44234	−0.1868**	0.0563	−3.3206
DIGITALIZATION(−1)	0.100128	0.059998	1.668848	−0.1063*	0.0542	−1.963
EXPORTPERCENT	0.292603*	0.051705	5.659075	−0.27935**	0.08173	−3.4181
EXPORTPERCENT(−1)	−0.137947**	0.037853	−3.64432			
FDIPERCENT	0.560295**	0.17574	3.188197	−0.4849**	0.1524	−3.1812
FDIPERCENT(-1)	−0.575971**	0.132724	−4.339599	0.6000**	0.1701	3.5275
FINCRISIS	−3.094179**	0.669309	−4.622946	0.8454	0.5552	1.5229
IMPORTPERCENT	0.561672***	0.093208	6.025986	0.9973***	0.1961	5.0848
IMPORTPERCENT(-1)	−0.291179*	0.101414	−2.871193			
INTERESTRATE	−0.271578**	0.074464	−3.647123	0.0858**	0.0358	2.3994
INTERESTRATE(-1)	0.089749*	0.033455	2.682696			
LDAILYWAGE	−70.29386***	11.92454	−5.894891	99.9670***	19.5978	5.1009
LDAILYWAGE(-1)	23.84036	10.3392	2.305824	8.5633**	2.5714	3.3303
LGDPUS	17.31549**	3.414352	5.071384	−19.2448***	5.2289	−3.6805
LGDPUS(-1)	−2.036069	2.832868	−0.718731	15.7044***	3.3861	4.6379
LTAXSUBLCU	−10.12067**	2.416031	−4.188966	5.5354**	1.9397	2.8538
LTAXSUBLCU(−1)	2.866854**	0.878809	3.262202			
C	613.5735**	129.9646	4.721081	20.4324	70.4974	0.2898
R-squared	0.998615			0.985676		
Adjusted R-squared	0.988918			0.95089		
Sum squared resid	0.140685			0.998656		
Log likelihood	29.27788			4.77929		
F-statistic	102.9821			28.33512		
Prob(F-statistic)	0.001355			0.000079		
Akaike info criterion	−0.58223			1.057657		
Schwarz criterion	0.490381			1.935247		
Hannan-Quinn criter	−0.284733			1.301063		
Durbin-Watson stat	3.516823			3.110801		

interest rate is reported to adversely affect the created jobs in Ghana but increase job destructions. Thus, the results imply that a 1 per cent increase in interest rate decreases job creation by 0.27 per cent but increases job destruction by 0.09 per cent in the long-run. A strong direct causal effects is observed from foreign direct investment (0.56 per cent) towards job creation at 1 per cent level of significance and increase destruction by 0.48 per cent. In years where there is financial crisis, job creation decreased by 3.09 per cent whilst there was an increase in job destruction by 0.09 per cent at 1 per cent significant level. The increase exportation of goods and services to other countries was found to also have a positive impact of 0.29 per cent on the job creation in Ghana at 1 per cent significant level whilst export decrease job destruction by 0.29 per cent.

Further, the elasticity of importation with respect job creation is positive significant in the long run, suggesting that a 1 per cent increase in importation increases job creation by 0.56 per cent in the long-run. In the long-run importation increase job destruction by approximately 1 per cent. Additionally, increase in minimum wage is reported to have a negative elasticity on job creation but a positive elasticity on job destruction. Also, economic growth is positively associated with job creation (17.32 per cent) but has a negative effect on job destruction (-19.24 per cent). Surprisingly, tax subsidy has a negative effect on job creation (elasticity of 10.12 per cent) but a positive effect on job destruction.

4.4 Short Run

Using the Schwarz Bayesian Criterion to select the optimal ARDL (4, 1, 3, 0, 2) specification, the estimated results for the short-run is presented in Table 4. In terms of job destruction, the negative coefficient of 0.37 per cent for exports signal that exports towards other countries lower job destruction or unemployment in the short-run, while the positive coefficient of imports shows that import leads to job destruction in the short-run by 0.65 per cent. Also, the study found that increasing the daily wage increases job destruction but decreases job creation. The finding suggests that increases in the interest rate leads to an increase in job destruction by 0.31 per cent and a decrease in job creation by 0.34 per cent. On the other hand, we found that job destruction reduces with the introduction of foreign

Table 4 Error correction for the ARDL models

Variable	Job creation			Job destruction		
	Coefficient	Std. Error	t-Statistic	Coefficient	Std. Error	t-Statistic
D(EMPLYRATIO(-1))	1.1990***	0.0565	21.2381	1.25773***	0.101191	12.42927
D(DIGITALIZATION)	0.2353***	0.0129	18.2516	−0.79853***	0.073287	−10.8959
D(EXPORTPERCENT)	0.31626***	0.0142	22.2718	−0.37277***	0.049261	−7.567302
D(FDIPERCENT)	0.61342***	0.0278	22.0655	−0.39763***	0.056999	−6.97609
D(IMPORTPERCENT)	0.6755***	0.0313	21.58147	0.64558***	0.18329	3.52218
D(INTERESTRATE)	−0.34212***	0.0137	−24.9723	0.30896	0.192063	1.60862
D(LDAILYWAGE)	−7.1307**	2.0652	−3.4527	7.2317***	0.578189	12.5075
D(LGDPUS)	16.5445***	0.9011	18.36034	−18.48466***	1.760547	−10.4994
D(LTAXSUBLCU)	−1.0121**	0.5003	−2.023	−0.29509	0.817912	−0.36079
CointEq(-1)*	−2.5760***	0.1216	−21.1803	−0.79914***	0.058898	−13.5682

****, and ** represent significant level at 1% and 5%, respectively.*

direct investment but increases job creation. Again, the short-run elasticity of the relationship between technology, job destruction and job creation show that at 1 per cent significant level, technology has a significant positive effect on both job creation and job destruction. Thus, at 1 per cent significant level there is a 0.24 per cent increase in job creation and 0.80 per cent decrease in job destruction associated with increased in digitalisation.

Again, economic growth is positively associated with job creation but negatively associated with job destruction. The stability of the Job creation and job destruction model was proven by the error correction term (CoinEq(-1)*) which are negative as required, and very significant (1 per cent). The error correction term depicts that 2.5 per cent and 0.8 per cent of error in job creation and job destruction, respectively are corrected successfully each year (Table 4). This implies that when job creation and job destruction are above, or below equilibrium level, it adjusts by 2.5 and 0.8 per cent, respectively within the first year.

5 Discussion

Overall, the result of the study shows mixed effect of technology on job creation for Ghana during the period under considering by this study. In the short-run the combined or summative effect of technology on job creation shows a drastic negative effect whereas the long-run combined effect was positive on job creation. The study cast doubt on the classical schools of thought which suggest that technology produces job loss in both the short and long run, hence, unemployment. The finding suggest job losses are more than offset by the mechanisms known as compensation factors (Leontief, 1983; Wallis, 1960). Further confirming the finding of this study, Graetz and Michaels's (2018) estimation results suggests that while the reduction in total employment is not significant, the use of technology in the long run reduces the hours of both low and middle-skilled workers but not cause unemployment. Again, Vivarelli (2014), Vivarelli and Pianta (2000), and Calvino and Virgillito (2018) suggest that diverse market compensation mechanisms which are created by changes in technology might partially or totally counterbalance the initial labour-saving impact of process innovation, confirming the findings of this study. With the introduction of new technology, firms in the short run usually lay off workers, especially the unskilled workers. In spite of this, the adopted new technology created a new to employ more people in the long-run. For instance, in Ghana the introduction of computers led to the laying of many typesetters but in the long-run most firms had to create an IT department which created positions such as IT managers, IT technicians among others.

Also, the rising importation of foreign products in Ghana leads to upwards job destruction and increasing unemployment. This finding shows that the penetration of products from low-cost competitors in the importing countries destroys the jobs already created and raises the unemployment situation in Ghana. Since Ghana is an import-dependent country, the lower level of production and exportation results in lower aggregate and unemployment, especially for the unskilled labour. This finding is similar to those reported by Anyanwu (2014) for sub-Saharan Africa and Autor et al. (2013), both of whom report that rising imports cause higher unemployment, lower labour force participation, and reduced wages in local labour markets. Furthermore, export in both the short and long run has a positive effect of job creation and reduces the jobs that are destroy, thus, exporting firms have the potential to employ more individuals due to the redistribution of labour from the import-substituting sectors towards the exporting sectors. This will lead to the generation of new employment opportunities for the unemployed labour force. This finding

Table 5 Diagnostic tests and sensitivity analysis

Diagnostic statistics		Test statistics	Job creation	Job destruction
Serial correlation	Breusch-Godfrey	F-statistics (Prob.)	0.732(0.4105)	0.936 (0.873)
		Obs.R2 (Prob)	1.560(0.2117)	1.154 (0.387)
Normality	Jarque–Bera	F-statistics (Prob.)	1.751 (0.313)	3.952 (0.161)
Heteroscedasticity	Breusch-Pagan-Godfrey	F-statistics (Prob)	0.414 (0.930)	0.560 (0.836)
		Obs.R2 (Prob)	7.321 (0.837)	8.973 (0.705)
Functional form	Ramsey reset	F-statistics (Prob)	1.103 (0.717)	0.118 (0.7385)

collaborate those reported by Abbey et al. (2017) that shows that a positive effect of export on employment generating among larger firms. In the long run, however, the efficiency gains caused by trade exportation of products from Ghana lead to positive overall employment effects. Furthermore, exporting manufacturing companies are able to expand in the long run and this will usually lead to the employment of more individuals.

More importantly, the finding shows that in both the short-run and long-run the increase in the daily minimum wage is associated with job destruction. The increase in wage increases the wage costs which leads to an increase in the cost of production. Further employers, forced to pay more in wages through the minimum wage legislation will end up hiring fewer workers, which can lead to higher unemployment. The net effect shows that in the short run, the Ghanaian economy will experience a net job destruction s of approximately 0.56 per cent (0.79853—0.2353) whereas the long run relationship shows a net positive effect (job creation) of approximately 0.37 per cent (0.555285—0.1868). In a recent published paper, Asravor and Sackey (2022) report that increase in minimum wage negatively affect all sectors of employment in Ghana, but the agriculture sector is the worst affected by increase wage increases. Some employers will substitute labour for technology, especially unskilled labour and in situation where labour and technology are nearly perfect substitute. This finding also collaborates those of reported by Moser et al. (2010) for the German economy. According to Moser et al. (2010) an increase in average wage may affect some workers negatively in terms of employment, especially the unskilled workers.

In addition, higher interest rates reduce investment made by firms because higher rates increase the cost of borrowing. With the already higher rate of interest in Ghana, businesses might be less willing to expand their businesses due to the higher interest rate. This finding reaffirms those reported by Swastika and Masih (2016) for the Australian economy, which suggest a positive long-term relationship between interest rate and unemployment (job destruction) and interest rate being the strongest exogenous variable when it comes to unemployment. The finding of the study shows that job destruction has increase and job creation has decreased during finding crisis. This finding is consistent those reported by Johnstone et al. (2019) who indicated that in the US, the financial crisis was associated with a dramatic weakening of the labour market with unemployment rising from 5% (7.6 million) in December 2007 to 10.2% (15.7 million) in October 2009. Additionally, as the economy growths, it is likely to experience an increased productive employment whose outcome is both increased employment and increased labour productivity. Thus, the rate of economic expansion determines the absolute limit to which employment and labour productivity growth can occur.

Subsidizing technology leads to increase in technology import but as indicated by most studies (Avom et al., 2021; Banga & te Velde, 2018) in other part of Africa, these technology leads to the destruction of low-skilled jobs but rather increases high-skilled job. According to

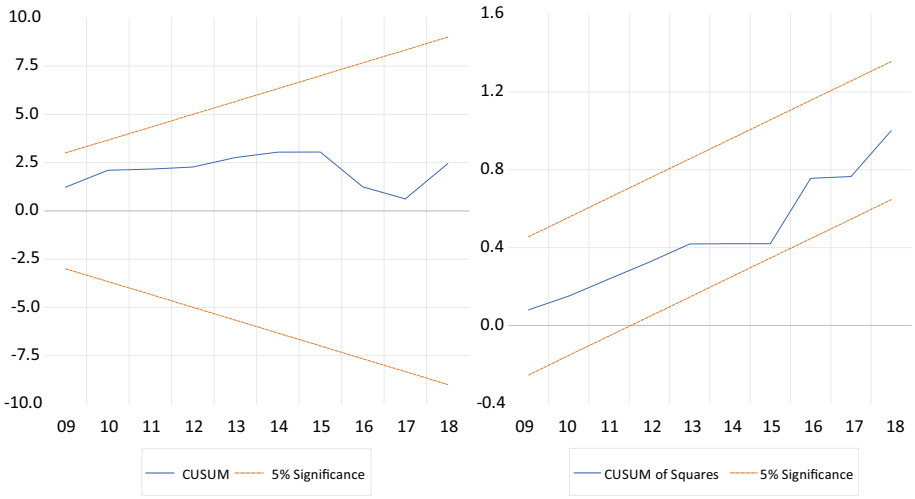

Fig. 1 CUSUM and CUSUM of Squares. (Color figure online)

the World Bank (2021) subsidizing technology is not enough but it should be linked with the sectorial transformation through movement of workers into higher productivity firms and spatial transformation through trade, urbanisation, and connectivity.

6 Diagnostic Tests

Table 5 shows the results of the diagnostic tests undertaken from the ARDL estimates. The LM test from the Breusch-Godfrey test confirms no serial correlation, while Ramsey's RESET test suggests that the model (Eq. 1) has being correctly specified, that is, the correct functional form has been specified. The disturbance terms are normally distributed as revealed by normality test and are homoscedastic, as supported by the heteroscedasticity test.

The study employs cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMQ) test to check the stability of the model. The stability of the short- and long-run estimates overtime is justified by the graphical plots of CUSUM and CUSUM of Squares. If the plot of CUSUM lies within the 5 percent critical bound, then we cannot reject the null hypothesis of the stability of the parameters. Figure 1 shows that the estimated coefficients lie between the upper and lower critical bounds (blue lines in the figure) at the 5% significance level.

It means that this model is robust and stable as both lines, long-run and short-run coefficients, are acceptable over the study period. The diagnostic tests confirm that the models have the desired econometric properties, hence, the models are structurally stable.

7 Conclusion and Policy Implications

This study examines effect of trade, technology, and daily minimum wage on job creation and job destruction in Ghana for the period of 1981–2018. The motivation of this study was as a result of the fact that previous studies on the drivers of job destruction and job creation have done little to econometrically estimate the impact of technology, trade and minimum daily wage. The ARDL method was used to estimate the short and long-run determinants of the long-run and short-run job destruction and job creation in Ghana. First the study conclude that technology process innovation has a compensation effect of job destruction and job creation in Ghana as specified in the theory. The study concludes the existence of high rates of simultaneous job creation and destruction in Ghana. The study concludes that increase usage of technology is associated with high rate of job destruction compared to job creation in the short run, due to the labour-saving nature of technology. In the long run, technology has a positive combined effect of job creation. Further, trade liberalization is associated with both job destruction and job creation in the short and long run. Again, higher interest rates and daily minimum wage increases job destruction due to the higher cost of investment needed to make businesses profitable. Economic growth and foreign direct investment increases job creation. From a policy point of view, the outcome of the study suggests investment in efficient technology and the introduction of innovation is the right direction to job creation in the long run. The study recommends that though economic growth is associated with increase employment, to experience the real impact of economic growth on employment it is important that policy makers (Ministry of Trade and Industry, and Ministry of employment and labour relationship) ensure that growth happens in sectors that have the possibility of absorbing labour at a higher rate and scale. Similar to the World Bank, the study recommends that tax subsidy on digitalized technology should be linked with expanding lower-skilled jobs through movement of workers into higher productivity firms and spatial transformation.

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Data Availability The data used for this study is available on demand. It is secondary in nature and can be assess from the world bank site. Specifically, the data from the World Development Indicator was used for the study.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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