



The Productivity Effects of Technological Globalisation in South Africa: Evidence from Dynamic ARDL Modelling

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ABSTRACT

Globalization has profoundly shaped modern economic and social life. On the one hand, it has promoted innovation and knowledge transfers. On the other hand, it has presented challenges within the labor market, exacerbating high levels of inequality and signs of job displacement. Despite growing interest in the socio-economic consequences of technological globalisation, its effect on labor productivity in emerging market contexts remains insufficiently understood. Examines the impact of technological globalisation on labor productivity in South Africa from 1990 to 2022. Autoregressive Distributed Lag (ARDL), Error Correction models (ECM), and Canonical Cointegration Regression (CCR) are employed to examine both long and short run relationships. By disaggregating technological globalisation between its de facto and de jure components, evidence shows that tangled technological cross-border flows drive persistent labour efficiency gains. Though de jure impulses exhibit only short-term gains in productivity levels, with equilibrium adjustment taking approximately 24 years. Causality analysis further revealed that policy responses have been reactive rather than proactive. The findings underscore the need for a more forward-looking industrial and digital infrastructure policy. Likewise, a more responsive education sector that is oriented towards technological skill development, as well as labor market reforms that enable firms to capitalise on the productivity-enhancing opportunities offered through global technological integration.

Keywords: Technological Globalization, Labor Productivity, South Africa, Time-Series, Canonical Cointegration, ARDL.

JEL Codes: F63; F66; 014

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1. INTRODUCTION

Globalization is a topic that is both popular and frequently debated. In light of this, it has been an intriguing scholarly topic. The number of studies directed to the field has increased significantly, especially over the last two decades. From trying to understand its dynamics within areas such as economic growth (Barry, 2010; Beri et al., 2022) to education (Stewart, 1996) and, for the last century specifically, its potential impact on labor market outcomes (Fang et al., 2021; Uwadinma, 2023), the body of knowledge surrounding this process has expanded rapidly. As a result, globalization as a process has been linked to various economic and social outcomes, most notably, which have presented ambiguous findings in various regions across the globe. It is a contentious phenomenon with diverse perspectives. Some argue that it is impossible to provide a singular conceptualization and that doing so would limit its meaning. Others reiterate that it is transformational and thus necessitates a clear functional conceptualization (Al-Rodhan & Stoudmann, 2006). For a large part of the discourse, scholars have focused on the acceleration of global economic interconnections, the growth of international corporations and financial markets, and emphasized the increasing interconnectedness of economies, societies, and cultures (Pannilage, 2017; Lane, 2023). More modern understandings, though, have acknowledged that integration has extended well beyond its economic features. Concomitantly, scholars have moved from one single view to a multidimensional view, recognized as a process that comprises economic, social, and political dimensions (Scholte, 2017; Heimberger, 2021).

For the most part, attention, especially in the economics discourse, has been afforded to the latter dimension, with scholars attempting to understand better the expansion of trade and capital flows and their wider impact on socio-economic conditions (Kohler, 2022). While this has provided significant insight, the understanding of the social dimension has been less evident, particularly the technological component of this process. Technological or informational globalization has reflected the ability to transmit information beyond national borders. It is intended to quantify the real movement and penetration of ideas, knowledge, and image across the globe (Gygli et al., 2019). This feature has become much more prominent, especially over the last decade, where the emergence of new and innovative technologies has seen the sharing of ideas and knowledge occur much more frequently and rapidly. The result of this has been an omnipresent impact with various socio-economic processes notably augmented. According to Archibugi and Pietrobelli (1999), this has been driven by factors involving global technological collaborations, the generation of innovations by transnational corporations, and the more recent emergence of artificial intelligence (AI), all of which have increasingly influenced aspects pertaining to resource efficiency, the creation of new forms of industrial organization, and ultimately a believed enhancement of standards of living.

Apart from these areas, technological globalization's association with the functioning of labor markets has increasingly been afforded attention. Didier (2024) mentions that the connections between businesses and individuals in the labor market have changed significantly as a result of modern technological penetration. On one hand, scholarly research has shown strong associations to enhance employment probabilities, especially for those with skills that complement these innovations. Though on the other hand, its disruptive effects, mainly through job destruction and job displacement, have likewise been well documented.

Empirical evidence overwhelmingly supports the idea that developed countries have notably gained from technological integration (De Propriis, 2024; Khan et al., 2024). Authors mainly report these gains to pay premiums, notable production innovations, and enhanced efficiency in global supply chains. Additionally, the comparative advantage in services-led industries and high-skilled technology exports makes realizing the potential benefits of technological penetration much easier (Arogyaswamy & Hunter, 2019). Contrastingly, for the developing world, the relationship is considered more complex (Korinek & Stiglitz, 2021). Much of the East Asian miracle was attributed to manufacturing-based technology exports, which accelerated the cross-border exchange of information and ideas. Technological integration for the area instilled key processes of learning-by-doing, whilst the exposure to foreign markets and information networks enhanced the need for quality education to remain competitive, contributing to productivity gains (Ghodsi et al., 2024). For other developing regions, the impact of technological globalization has been less clear. For example, in sub-Saharan Africa, scholars have suggested that an increasing adoption and penetration of advanced technologies has advanced labor market conditions (Fakunle et al., 2023). Though others point out that it has been detrimental to the region's progress in improving productivity in labor inputs. This is attributed to the devaluing of comparative advantages of the developing world, due to the disruptive technologies' resource and labor-saving nature. More so, and in contrast to their high-income counterparts, these countries are still in the process of industrialization, lacking the needed automated, digitized, and global knowledge networks, whilst facing notable challenges including digital divides (WTO, 2019; Dinga et al., 2023).

Relative to these regional dynamics, the relationship between technological globalization and labor market dynamics in South Africa has presented itself as complex, shaped by both historical and contemporary factors. Unlike many other countries where external structural adjustment programs drove integration into the global economy, South Africa's economic, social, and political integration was largely domestically driven, particularly after the end of apartheid (de Jongh, 2020; de Jongh & Moeng, 2023). Prior to this period, the country was mostly isolated from the globe. Though with the move to a more democratic era, policy adoption was directed to a more neoliberal stance so closely associated with the process of globalization (Salahuddin et al., 2020). In this respect, much belief was directed towards improvement in various socio-economic domains. The use of Washington Consensus reforms in this regard initially did show similarities to the East Asian miracle, at least up until 2002. Liberalization of trade and financial markets ensued, the formation of new political and international partnerships followed, and new technological applications proliferated (increases in internet access, patent applications, etc.) (Mosala et al., 2017). Consequently, various development outcomes improved, with GDP growth averaging just over 3.4% and manufacturing growth (industrial output) over 3.1% (up from 1.5% the decade prior). Though despite this progress, the benefits have not been realized, specifically considering the country's labor market.

Compared to other developing regions, the South African labor market has faced several unique challenges. Even before 1994, unemployment had been relatively high when compared to similar developing regions. In fact, these levels have averaged at just over 26 percent since 1994, mainly attributed to notable structural challenges (ILO, 2025). Absorption into the labor

market has been significantly impeded by skill mismatches, immobility, rigidity, and an education sector that has struggled to meet the demands of the private sector (Habiyaemye et al., 2022). So too has wage growth been subdued (Mhlana, 2023). Taking this into consideration, labor productivity has exhibited interesting trends, reflecting the nation's transition to a more globalized, post-apartheid economy (Bhorat et al., 2019). From 1994 to 2010, productivity levels showed an average growth of approximately 2% in line with the performance of most of the developed world (Quantec, 2025). Though, since the global financial crisis (GFC), this growth has stagnated (Mosomi et al., 2020).

These trends have been difficult to understand within the technological integration context. Research within the field has been particularly limited and inconclusive (Radlo & Tomeczek, 2022; Bettiol et al., 2024). Nonetheless, South Africa has shown a similar trajectory in their technological globalization performance as most upper-middle-income countries (KOF Swiss Economic Institute, 2025). Interestingly, though, the *de facto* performance has been higher when compared to the *de jure* features of this integration. While the country has shown progress with a growing ICT sector and increasing internet and mobile penetration, its high-tech exports remain limited, comprising a small fraction of total export earnings (Mapuva, 2010; Roberts, 2022).

Additionally, the country faces a significant digital divide, with internet access in rural areas lagging far behind urban regions (Faloye & Ajayi, 2023). This has resulted in a dual economy, where high- and low-productivity sectors coexist, limiting overall economic growth and exacerbating high income inequality levels (Ranchhod & Daniels, 2020; Kahn et al., 2022). Better labor market outcomes in this respect have accrued greatly to workers who can adapt to technological advancements and those with the needed digital skills.

Taking all of this into account, this study seeks to analyze the impact of technological globalization on labor productivity in South Africa. In doing so, it presents an important source of reference and an interesting case study. In light of South Africa's economic importance for the broader sub-Saharan African region, whilst likewise considering the country's unique integration path, it provides much-needed insight into how technological globalization shapes productivity outcomes in the emerging market context. Furthermore, given the structural nature of the labor market challenges and the differentiation between *de facto* and *de jure* measures, it seeks to provide novel insight into how these relationships unfold in contexts of enduring employment frictions whilst accounting for actual technological flows and the policies and institutions that seek to guide these flows. Adding to this novelty, it provides some temporal insight to better understand technological globalization's disruptive and transformative features within varying time periods.

2. LITERATURE REVIEW

2.1. Theoretical perspectives on globalization and labor productivity

In this context, the particular insight into the relationship between technological globalization and labor productivity has been contentious. In fact, two strands of literature posit contrasting ideas. The first, mainly informed by the position of modernization and endogenous growth theorists, points to an enabling relationship, suggesting that as workers move from lower to higher productivity sectors, technological globalization speeds up transformation by bringing

new technologies that increase productivity (Szirmai & Verspagen, 2015). It thus promotes an environment that is favorable to ongoing productivity gains by enabling the transfer of innovation and knowledge across national boundaries (Grossman & Helpman, 2021). As a fundamental component of structural change, this global spread of novel technologies promotes structural transformation (Owusu, 2021). It leads to improvements in output efficiency (Acemoglu & Restrepo, 2018), allowing labor to become more adept, ultimately advancing development through endogenous mechanisms (Akpan, 2003; Hess et al., 2023).

The alternative line of thought suggests that not all countries are set to benefit from technological expansion equally. Scholars from this viewpoint draw from the insights of most World Systems theorists, who argue that technological globalization reinforces the core-periphery divide (Wallerstein, 1979). Here, advanced economies (the core) are assumed to adopt novel technologies to enhance labor productivity. In contrast, peripheral economies struggle to keep up, resulting in uneven development and persistent global inequalities (Knez, 2023). Core countries have the infrastructure, capital, and skilled personnel necessary to embrace and develop new technologies, leading to considerable increases in labor productivity (SIÉ, 2023). In contrast, peripheral nations often lack these resources as they are still in a process of industrialization, limiting their ability to integrate modern technologies, which exacerbates the gap between rich and poor globally. These uncertainties become more apparent when considering differences across regions.

2.2. Empirical evidence

In relation to these dynamics, numerous studies have offered varying insight into this relationship, with results across regions showing notable differences. For example, Skare and Soriano's (2021) study examined how globalization affects the adoption of digital technologies using advanced panel data modelling methodologies. Data were collected for 183 countries, and results showed that digital technology adoption rates increase in proportion to the degree of globalization. Moreover, they are strongly associated with increased multifactor productivity. Similarly, Audi et al. (2021) investigated how globalization and its disaggregated components have affected the development of information and ICT development in 87 industrialized and developing nations between 2000 and 2019. Using pairwise and panel least squares estimation for empirical analysis, the study discovered that globalization, especially in developing nations, had a favorable impact on ICT advancement, showcasing that the effects of globalization vary between stages of development. Koyuncu and Unver (2018) empirically examined whether there is a long-term relationship between labor productivity and globalization to understand this association, using balanced panel data from 34 OECD nations for the years 2002 to 2012. The panel cointegration test results showed that the labor productivity series and globalization were cointegrated. Furthermore, the findings pointed to a statistically significant positive correlation between labor productivity and globalization in both the short and long term.

In contrast to these findings, insights from developing countries have been shown to be more diverse. In fact, Abramova and Grishchenko (2020) conducted a study that analyzed the relationship between ICT development, labor productivity, and employment in various industries in Russia between 2005 and 2017. Results showed heterogeneous effects of ICT development across different sectors. So too did it point to specific temporal dynamics with

effects largely notable in the long run. Similarly, Dinga et al. (2023) conducted a study to investigate the effects of ICTs and overall globalization on employment and labor productivity.

The data for this study were collected across 33 African economies between 1990 and 2019. Making use of the quantile technique and the dynamic common correlation effect technique, findings pointed to a negative correlation between globalization and ICT use in relation to employment. Contrastingly, it demonstrated that labor productivity is positively impacted by both globalization and ICT development. The most notable contribution pertained to insight relating to both the de jure and de facto measures utilized. Findings exhibited mixed effects on employment across different quantiles. The de facto dimension showed a more positive impact on employment at higher quantiles, while the de jure dimension attributed both positive and negative effects.

Comparably so, examining Nigeria's adoption of digital technology and its effects on labor productivity and economic growth between 1990 and 2019, Chiemeké and Imafidor (2020) utilized an Augmented Solow Model by adopting a structural vector autoregressive framework (SVAR) and VAR Granger causality. The findings of the study suggested that short-term shocks brought about by the adoption of digital technology have a negative and considerable effect on labor productivity and economic growth. However, the influence of these innovative digital technologies turns beneficial in the medium term, illuminating possible temporal effects.

3. RESEARCH METHODOLOGY

3.1. Data and sample period

The study adopts a quantitative research design and a functional research philosophy. Secondary time-series data from 1990 to 2022 was utilized. The selected time period was determined by the availability of data, and accounting for South Africa's integration process commencing in the early 1990s. A total of 33 observations were included with data sourced from the World Bank Development Indicators, KOF Swiss Economic Institute, the South African Reserve Bank (SARB), the United Nations (UN), and Quantec. The variables under consideration are shown in Table 1 below which provides a summary of their descriptions and the databases from which they were sourced.

Table 1. Variable description and data sources

Variable	Description	Source
Labor productivity (LP)	An index calculated from the Employment-output ratio, calculated as real value added at factor cost divided by total employment.	Quantec (2025)
Technological globalization (TG)	Measured through a general technological globalization index. Also, two sub-indices: <i>de jure</i> and <i>de facto</i> . De jure measure captures dynamics of 3 variables relating to the number of patents, the % of high-tech exports, and used internet bandwidth. De Jure measure focuses on conditions, institutions that facilitate flows proxied by access to internet, press freedom and television access.	KOF Swiss Economic Institute (2025)
Gross fixed capital formation (GFCF)	Gross fixed capital formation as a percentage of GDP. Proxied for capital stock.	SARB (2025)
Mean years of schoolings (MYS)	UN education sub-index. Ranges from 0 – 100 with higher values indicating higher levels of human capital.	UN (2025)

To capture the levels of the key explanatory variable, i.e., technological globalization, the study used the technological globalization sub-index developed by the KOF Swiss Economic Institute. So too its disaggregated measures (*de jure* and *de facto*), with the aim of contributing to the area of the body of knowledge, which, to the best of our knowledge, has been missing especially in the SSA context (Dinga et al, 2023). The selection of the index to serve as a proxy for technological globalisation is done in accordance with three key theoretical and empirical considerations. Firstly, in its design, it accounts for the real movement of ideas, knowledge, and information across borders, providing a *de facto* account of this feature of technologically induced integration. Using patent counts and high-tech exports as proxies within the index offers insight into countries' innovative capacity and the degree of integration into technological-intensive global value chains (Archibugi & Iammarino, 2002; Ghodsi et al., 2024).

Furthermore, levels of used internet bandwidth capture actual volume of cross-border information flows, whilst also detailing digital infrastructure, both of which are foundational to knowledge transfer (Akpan, 2003). The index also provides the opportunity, through the *de jure* component, to gain insight into how institutional and policy conditions interrelate with productivity dynamics through proxies including internet access, press freedom, and television reach. Secondly, this approach and the use of the indicator follow suit with previous studies (Koyuncu & Unver, 2018; Skare & Soriano, 2021), which have also applied the indicator to give insight into the globalisation-productivity nexus, lending consistency and credibility to the findings. Thirdly and finally, the selection of the indicator is driven by empirical viability, considering the time-series approach undertaken. Whilst indicators such as the IMF Fintech index or the World Digital Competitiveness index may capture modern digital economic aspects such as artificial intelligence diffusion and platform-based gig-labour dynamics more comprehensively, data limitations on these metrics would notably limit the viability of the

econometric estimation approach, given the need for consistent and frequent data observations.

Additionally, mean years of schooling (used as a proxy for human capital levels) as well as the gross fixed capital formation (as % of GDP) were all used as control variables. These variables were selected based on their inclusion in similar studies (Munir & Bukhari, 2019; Williams et al., 2022) as well as their established theoretical importance in affecting labor productivity (Korkmaz & Korkmaz, 2017). Specifically, their relevance is grounded in neoclassical and modern growth theory. For levels GFCF, the role within this nexus pertains to capital to labour ratios, which impart evidence on the augmentation of the productive capacity of labour, through economies of scale and lowering of transaction costs, especially in a more technology-driven world (Solow, 1956; Cahu et al., 2022). MYS, in turn, reflects the stock of human capital, which, consistent with endogenous growth suppositions (Lucas, 1988; Romer, 1990) and Mincer's (1974) human capital theory, suggests that productivity largely depends on accumulated knowledge. In a technologically globalised world, this capacity is key to ensuring workers complement rather than are replaced by technologically driven processes (Acemoglu & Restrepo, 2018). All the variables were transformed to their natural logarithms before being included in the modelling, to ensure measurement consistency and avoid possibilities of heteroscedasticity.

3.2. Econometrics methods of analysis

The econometric analysis was conducted across several steps. The first involved the use of various descriptive analysis techniques (summary statistics) including the mean, median, minimum and maximum values to understand the trend of technological globalization and labor productivity over the sample period. Thereafter various econometric methods were employed to analyze the relationships, including unit root tests which aimed to assess the stationarity of the data as well as correlation analysis. Subsequent to this, the analysis proceeded with an Autoregressive Distributed Lag (ARDL) estimation. This was done mainly to achieve the primary objective of the study but so too in an effort to provide insight into possible temporal dynamics and specific elasticities between levels of technological globalization (and its de facto and de jure measures) and labor productivity. In this respect three different estimations were undertaken with the objective to identify and compare possible differences between how actual flows of technological integration affect labor productivity and the conditions, rules and institutions that enable these flows. As robustness check, the study employed canonical cointegration regression (CCR) estimation to determine if results were consistent even when using a different estimation approach.

3.3. Model specification

The ARDL model developed by Pesaran et al. (2001), was utilized as the main estimation technique in the study considering its advantages in comparison to comparable econometric methodologies. Khan et al. (2021) here allude to the fact that it can be used in instances in which variables are not integrated in a similar order. In the latter case, first-order integration of all variables is required. On the other hand, the ARDL model can be estimated when variables present a mixture of these variables or are stationary at $I(0)$ and/or $I(1)$. Moreover, the model has demonstrated its ability to yield precise and reliable findings even with smaller sample sizes (Reda & Nourhan, 2020). In fact, Narayan (2005) alludes to the Monte Carlo simulation evidence which indicates the robustness of these estimation techniques producing unbiased long

run coefficients with as few as 30 observations. Three models were used in order to precisely achieve the study's objective, model 1 provides insight on an overall basis whilst model 2 represents the de facto model and model 3 represents the de jure estimation.

$$\Delta LLP = \varphi_0 + \sum_{j=1}^k \eta_j \Delta LLP_{t-j} + \sum_{j=1}^k \alpha_j \Delta LTG_{t-j} + \sum_{j=1}^k \gamma_j \Delta LGFCF_{t-j} + \sum_{j=1}^k \delta_j \Delta LMYS_{t-j} + \omega_1 \Delta LLP_{t-1} + \omega_2 \Delta LTG_{t-1} + \omega_3 \Delta LGFCF_{t-1} + \omega_4 \Delta LMYS_{t-1} + \mu_t \quad (1)$$

$$\Delta LLP = \varphi_0 + \sum_{j=1}^k \eta_j \Delta LLP_{t-j} + \sum_{j=1}^k \alpha_j \Delta LTGdf_{t-j} + \sum_{j=1}^k \gamma_j \Delta LGFCF_{t-j} + \sum_{j=1}^k \delta_j \Delta LMYS_{t-j} + \omega_1 \Delta LLP_{t-1} + \omega_2 \Delta LTGdf_{t-1} + \omega_3 \Delta LGFCF_{t-1} + \omega_4 \Delta LMYS_{t-1} + \mu_t \quad (2)$$

$$\Delta LLP = \varphi_0 + \sum_{j=1}^k \eta_j \Delta LLP_{t-j} + \sum_{j=1}^k \alpha_j \Delta LTGdj_{t-j} + \sum_{j=1}^k \gamma_j \Delta LGFCF_{t-j} + \sum_{j=1}^k \delta_j \Delta LMYS_{t-j} + \omega_1 \Delta LLP_{t-1} + \omega_2 \Delta LTGdj_{t-1} + \omega_3 \Delta LGFCF_{t-1} + \omega_4 \Delta LMYS_{t-1} + \mu_t \quad (3)$$

here ΔLLP refers to the change in the natural logarithm of labor productivity, $\Delta LTGDF$ the change in the natural logarithm of technological globalization in de facto terms, $\Delta LTGDJ$ the change in the natural logarithm of technological globalization in de jure terms, $\Delta LGFCF$ the change in the natural logarithm of the gross fixed capital formation and $\Delta LMYS$ the change in the natural logarithm of mean years of schooling and the μ_t error term. The short-run coefficients are presented by $\eta_j, \alpha_j, \beta_j, \gamma_j, \delta_j$ while k showcases the number of lags included in both models. Furthermore, the long-run coefficients are expressed by $\omega_1, \omega_2 \dots \omega_n$. Following equations 1, 2 and 3 as shown above, the study formulates the following hypotheses:

Null hypothesis (H_0): No co-integration between the variables

Alternative hypothesis (H_1): Presence of co-integration between the variables

To evaluate these hypotheses, a bounds test is conducted, where an F-statistic is calculated and compared to upper- and lower-bound critical values as determined by Pesaran et al. (2001). If the calculated F-statistic is found to exceed the critical values, the null hypothesis (indicating the absence of co-integrating variables) can be rejected in favor of the alternative hypothesis. However, if the calculated F-statistic is found to be lower than both these values, then the null hypothesis cannot be rejected. Following this process, the next step was to estimate an error correction model (ECM) to identify the rate of return to equilibrium and the short-term dynamics between the variables. Furthermore, it served to confirm if indeed the variables were cointegrated. The models utilized for this purpose can be represented are represented in equations 4 to 6 below:

$$\Delta LLP = \varphi_0 + \sum_{j=1}^k \eta_j \Delta LLP_{t-j} + \sum_{j=1}^k \alpha_j \Delta LTG_{t-j} + \sum_{j=1}^k \beta_j \Delta LGFCF_{t-j} + \sum_{j=1}^k \delta_j \Delta LMYS_{t-j} + \theta ECT_{t-1} + \mu_t \quad (4)$$

$$\Delta LLP = \varphi_0 + \sum_{j=1}^k \eta_j \Delta LLP_{t-j} + \sum_{j=1}^k \alpha_j \Delta LTGdf_{t-j} + \sum_{j=1}^k \beta_j \Delta LGFCF_{t-j} + \sum_{j=1}^k \delta_j \Delta LMYS_{t-j} + \theta ECT_{t-1} + \mu_t \quad (5)$$

$$\Delta LLP = \varphi_0 + \sum_{j=1}^k \eta_j \Delta LLP_{t-j} + \sum_{j=1}^k \alpha_j \Delta LTGdj_{t-j} + \sum_{j=1}^k \beta_j \Delta LGFCF_{t-j} + \sum_{j=1}^k \delta_j \Delta LMYS_{t-j} + \theta ECT_{t-1} + \mu_t \quad (6)$$

The error correction component in both of these equations is represented by ECT_{t-1} , and its coefficient is shown by θ . The speed at which the impulses adjust back to equilibrium is determined using the latter. Finally, the analysis employed the Toda-Yamamoto Granger causality test to ascertain the existence of any causal links among the variables. The model checks for causality by determining if the lagged values of the coefficients of the variables that are included equal zero. If it is found that these values are not equal to zero, however, it is indicative of the absence of causality.

4. RESULTS AND DISCUSSION

4.1. Descriptive analysis

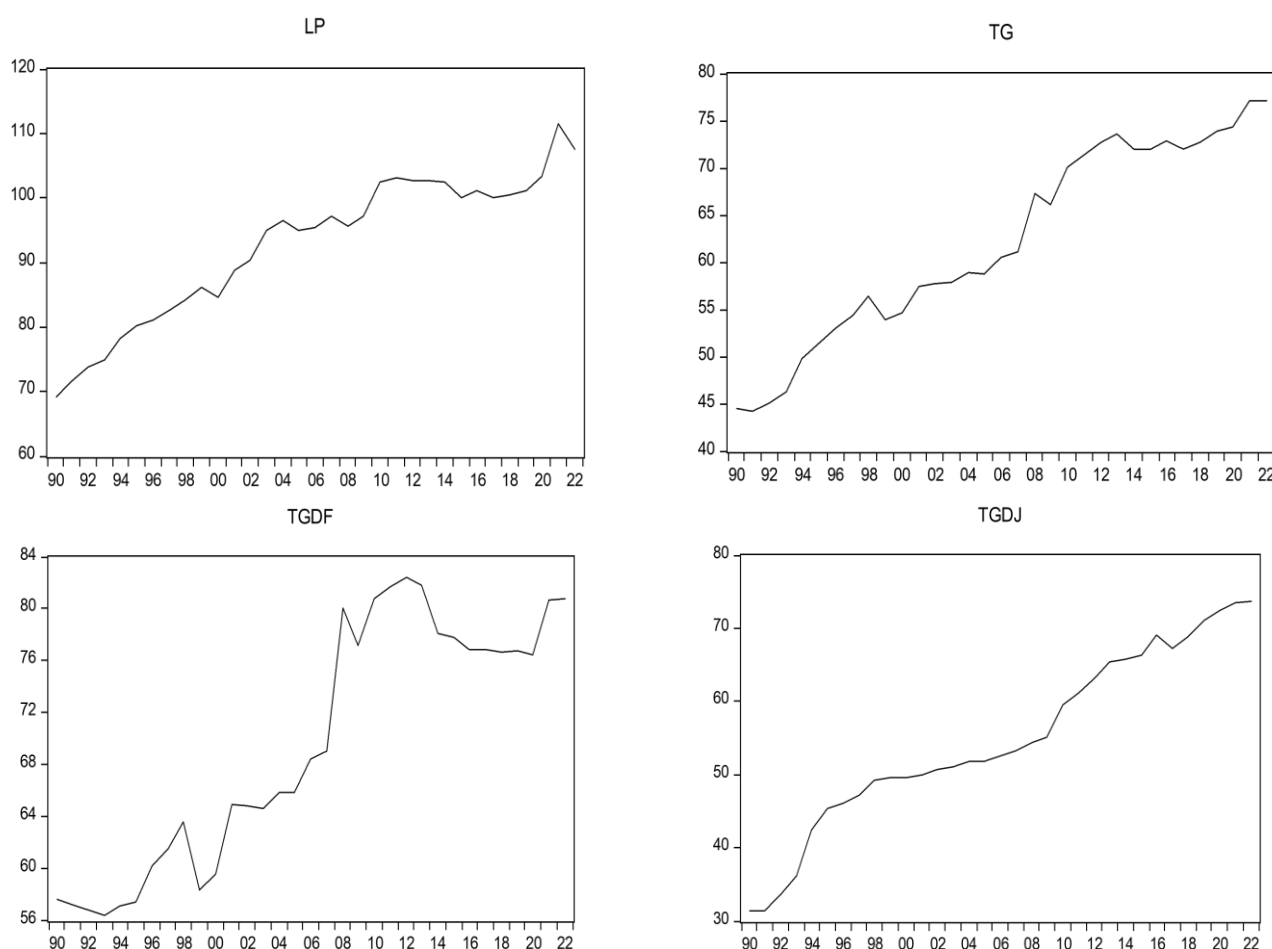
As an initial step in the analysis, the study provides a summary of the characteristics of each variable considered (outlined in Table 1). From the results shown, it indicates that labor productivity, Throughout the study period, maintained moderate levels, with an average score of 92.60 over the last 32 years. Both the maximum value and minimum value indicate that labor productivity fluctuated during the sample period also shown in Figure 1. Notable increases were experienced from the early 1990s. Though since the GFC in 2008, much like the rest of the world, productivity levels have stagnated. In relation to technological globalization, encompassing both practical (de facto) and formal (de jure) dimensions, has shown moderate integration, with the country mostly on par with the expected upper-middle income average (Kof Swiss Economic Institute, 2025). There are some notable differences between the de facto and de jure measures with the former attributing a higher score. This alludes to more actual technological flows and exchanges across borders when compared to the presence of institutions and policies to regulate these flows.

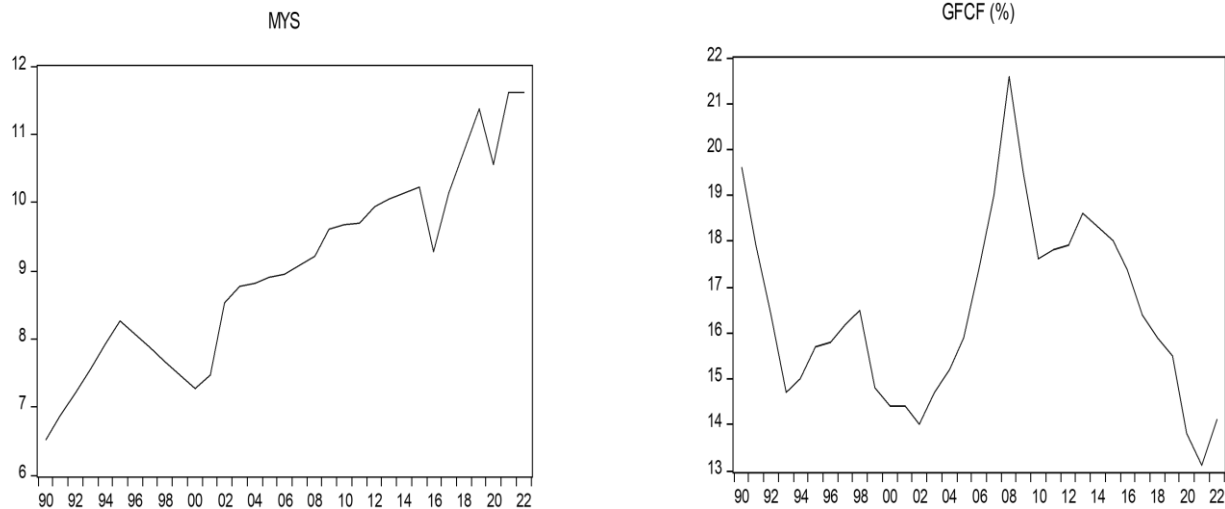
Table 1. Descriptive statistics

	LP	TG	TGDF	TGDJ	GFCF	MYS
Mean	92.595	62.159	69.492	54.827	16.457	8.997
Median	95.578	60.465	68.384	52.547	16.200	8.950
Maximum	111.438	77.153	82.386	73.568	21.600	11.606
Minimum	69.256	44.240	56.358	31.309	13.100	6.514
Std. Dev.	11.251	10.491	9.430	12.215	1.977	1.394
Skewness	-0.534	-0.180	-0.043	-0.201	0.486	0.152
Kurtosis	2.184	1.716	1.398	2.239	2.726	2.130
Observations	33	33	33	33	33	33

Upon review of Figure 1b, the country experienced notable flows from the latter part of 2002 after recovery of the dot com bubble. This period onwards has seen the increasing raise of internet-based services, smart phones, social media and most recently AI technology. The lower average and minimum and max scores considering the de jure measure can be partly attributed to notable challenges including the digital divide, which is largely plagued rural areas which has been perpetuated by the lack of adequate digital infrastructure (Faloye & Ajayi, 2023).

Figure 1 (a-f). Trends in the selected variables (1990–2022)





In the analysis of the mean years of schooling (MYS), the average is approximately 9.00 years, indicating a moderate level of education among the population. The minimum values of 6.51 and maximum value of 11.606 do show that over time notable improvements in human capital levels have been made. Finally, upon review of GFCF levels over the study period, Figure 1f shows just how volatile private investment and capital formation has been in the country. Whilst attributing declines during the transition period in the early 1990s, capital formation seemed to greatly improve with the adoption of the neoliberal framework in the early 2000s. For most part before the GFC this was sustained with maximum scores of 21.6 (% of GDP) attributed in 2007. Yet much like many other developing countries, since then these levels of investment have retracted.

4.2. Correlation analysis

Following the completion of the descriptive analysis, the study advanced to investigate the relationships among the variables under examination. In relation to the previous discussion, the results of the correlation analysis presented in Table 2 demonstrate positive and statistically significant correlations (at least at the 5% level) among most of the variables included. In contrast most of the negative correlations were associated with the levels of GFCF (apart from LP). More importantly though the results show no notable signs of highly correlated variables. The only correlation coefficient that exceeded the 0.8 threshold pertained to the correlation between the de jure and de facto measures of trade globalization. Though high, these variables are used in separate estimations and thus do not pose any collinear concerns in the subsequent steps in the analysis.

Table 2. Correlation analysis

Probability	LP	TG	TGDF	TGDJ	HC	GFCE
LLP	1.000 ----					
LTG	0.759 (18.856***)	1.000 ----				
LTGDF	0.715 (12.642***)	0.760 (19.117***)	1.000 ----			
LTGDJ	0.641 (15.453***)	0.776 (25.182***)	0.877 (10.215***)	1.000 ----		
LMYS	0.711 (12.333***)	0.636 (14.824***)	0.878 (10.161***)	0.730 (14.099***)	1.000 ----	
LGFCF	0.002 (0.012)	0.071 (0.399)	-0.285 (-1.655)	-0.096 (-0.543)	-0.042 (-0.238)	1.000 -----

Note: () shows *t*-stats. *** indicates significance at the 1% level of significance, ** at the 5% level of significance, * at the 10% level of significance.

4.3 Unit root analysis

After the completion of the correlation analysis, the study proceeded to assess the stationary properties of the data. Here the Augmented Dicker-Fuller (ADF) and Phillips-Peron (PP) unit root tests were utilized. This was done to assess whether the variables were stationary at level or integrated at first difference. The outcomes of these tests are shown in Table 3 and 4 below. Considering the results for both tests, all variables were integrated at the first order of integration, confirming the adequacy of both the ARDL estimation and CCR estimation (robustness check) to determine the different elasticities between the variables under consideration.

Table 3. Augmented Dickey-Fuller (ADF) unit root test results

Variables	Levels				First difference				I(0)/I(1)
	Intercept		Trend & Intercept		Intercept		Trend & Intercept		
LLP	-2.373	0.156	-2.147	0.501	-5.604	0.000***	-5.968	0.000***	I(1)
LTG	-0.931	0.766	-2.109	0.521	-6.755	0.000***	-6.772	0.000***	I(1)
LTGDF	-1.162	0.678	0.384	0.998	-4.486	0.001***	-4.810	0.003***	I(1)
LTGDJ	-2.509	0.122	-2.277	0.433	-5.548	0.000***	-5.976	0.000***	I(1)
LGFCF	-2.483	0.129	-2.441	0.353	-3.782	0.007***	-3.721	0.035**	I(1)
LMYS	-0.787	0.809	-3.113	0.121	-6.404	0.000***	-6.306	0.000***	I(1)

Note *** indicates significance at the 1% level of significance, ** at the 5% level of significance, * at the 10% level of significance.

Table 4. Phillips-Peron (PP) unit root tests

Variables	Levels				First difference				I(0)/I(1)
	Intercept		Trend & Intercept		Intercept		Trend & Intercept		
LLP	-2.166	0.222	-2.159	0.495	-5.855	0.000***	-5.979	0.000***	I(1)
LTG	-0.930	0.765	-2.163	0.493	-6.679	0.000***	-6.712	0.000***	I(1)
LTGDF	-0.809	0.803	-2.056	0.549	-6.627	0.000***	-6.517	0.000***	I(1)
LTGDJ	-1.370	0.584	-2.099	0.526	-4.422	0.001	-4.580	0.005***	I(1)
LGFCF	-2.163	0.223	-2.154	0.498	-3.606	0.011**	-3.523	0.054*	I(1)
LMYS	-0.447	0.888	-3.147	0.113	-8.352	0.000***	-8.650	0.000***	I(1)

Note *** indicates significance at the 1% level of significance, ** at the 5% level of significance, * at the 10% level of significance.

4.4. Bounds testing for co-integration and long-run analysis

After determining the stationarity properties of the data, the study aimed to assess the impact of technological globalization on labor productivity in South Africa, utilizing three distinct models. This was done for two reasons. Firstly, using a general indicator for TG would allow for comparison with most of the body of knowledge that has utilized this similarly. Furthermore, by disaggregating these into the de facto and de jure components in models 2 and 3, respectively, the study adds novelty to the discourse surrounding this nexus. Whilst the de facto measure allows for an assessment of the actual technological advancements and their direct influence on labor productivity, the de jure estimation accounts for the effect of institutions and policies governing technological exchanges and cross-border penetration on labor productivity. The models were selected using automatic lag selection, guided by the Akaike Information Criterion (AIC). Based on this approach, the first model was estimated as an ARDL (4,4,0,3), the second as an ARDL (4,4,1,4), and finally model three as an ARDL (4,3,4,3). Subsequently, bounds testing was conducted to determine the presence of long-run relationships, with the results presented in Table 5. The calculated F-statistics for Model 1 ($f\text{-stat.} = 7.405$) and Model 2 ($f\text{-stat.} = 6.429$) suggest strong evidence (at 1% significance level) of long-run relationships between the variables. Though for the de jure model, this possible cointegration is only confirmed at the 10% significance level.

Table 5. Bounds test results for model 1, 2 and 3

Model	Estimated F-value	Pearson critical values			Presence of Co-integration
		Sig. level	Lower Bound	Upper Bound	
Model 1 DV: LLP	7.405***	10%	2.676	3.586	Co-integration confirmed at 1% sig. level.
		5%	3.272	4.306	
		1%	4.614	5.966	
Model 2 DV: LLP	6.429***	10%	2.676	3.586	Co-integration confirmed at 1% sig. level.
		5%	3.272	4.306	
		1%	4.614	5.966	
Model 3 DV: LLP	3.704*	10%	2.676	3.586	Co-integration confirmed at 10% sig. level.
		5%	3.272	4.306	
		1%	4.614	5.966	

Note *** indicates significance at the 1% level of significance, ** at the 5% level of significance, * at the 10% level of significance.

Following the bounds testing, long-run coefficients were estimated, as presented in Table 6. Results here point to positive coefficients for both the overall technological globalization index as well as the de facto measure. Both here attribute significant influences (at least at the 5% significance level) on the levels of labor productivity in South Africa. Though from estimation 3, the de jure measure seems to have a negative and statistically non-significant (not even at the 10% level) impact. These results infer that much of the variation in productivity levels are driven by the tangible flows of technological exchanges and integration. It does speak to the rapid penetration of technological goods and innovation which have far outpaced the implementation of adequate policy responses (Chen & Martincus, 2022). This relates to the use of modern technologies and the benefits these have had on labor input in the production process. As noted in the literature, it can accrue to the associated knowledge transfers, efficiency gains in supply chain management as well as potential skills development. This finding is consistent with those reported by Koyuncu and Unver (2018). Furthermore, corroborating these findings, results from Table 6 show consistency in the coefficients from the CCR estimation (robustness check). Given the elasticity coefficients reported (0.743 to 0.766), it further infers an inelastic relationship which points to the fact, that South Africa does not fully capture the productivity potential of one unit increase in technological integration. This is consistent with the structural constraints documented including labor market rigidities, skill mismatches as well as digital infrastructure deficits (Habiyaemye et al., 2022; Akoobhai, 2023).

Though these findings affirm the positive impact of technological globalisation, these aggregate gains should be contextualised within the country's broad distributional landscape. Scholarly evidence has shown that benefits from the broader integration process has largely accrued to workers in digitally connected, formal and urban located sectors (Ranchod & Daniels, 2020). This dynamic is perpetuated with the presence of a dual economic structure where high and low productivity sectors co-exist, and those employed in the former, located rurally without the needed skills are largely bypassed from these benefits, potentially reinforcing existing income disparities (Kahn et al., 2022). Furthermore, given that the

persistence of efficiency gains are driven by the de facto features (high-tech trade, digital infrastructure expansion) and not the de jure elements, it compounds this issue. Access to the de facto features itself is unequally distributed, concentrated in urban economic centres with established digital infrastructure (Faloye & Ajayi, 2023). Therefore, in the absence of sound institutional and regulatory redistributive policy, the way technological integration unfolds in the context of labor market processes risks reinforcing rather than narrowing the income gap.

Table 6. ARDL and CCR long-run elasticities

	ARDL estimation						CCR estimation					
	Overall (1) DV: LLP		De Facto (2) DV: LLP		De Jure (3) DV: LLP		Overall (4) DV: LLP		De Facto (5) DV: LLP		De Jure (6) DV: LLP	
LTG	0.766	(0.287) [2.668**]					0.743	(0.206) [3.608***]				
LTGDF			0.946	(0.292) [3.249***]					1.075	(0.162) [6.629***]		
LTGDJ					-0.010	(0.014) [0.454]					0.200	(0.187) [1.073]
LGFCF	0.044	(0.015) [2.910***]	0.047	(0.015) [3.173**]	0.074	(0.003) [2.294**]	-0.031	(0.096) [-0.326]	0.405	(0.089) [4.556***]	0.199	(0.113) [1.759*]
LMYSI	0.314	(0.317) [0.991]	-0.244	(0.402) [-0.852]	0.129	(0.086) [0.147]	-0.079	(0.219) [0.721]	-0.131	(0.138) [-0.946]	0.351	(0.239) [1.466]
C	0.027	(0.845) [0.323]	3.335	(1.029) [3.238**]	1.169	(1.460) [0.800]	1.733	(0.378) [4.582***]	1.403	(0.275) [5.100***]	2.427	(0.380) [6.387***]

Note *** indicates significance at the 1% level of significance, ** at the 5% level of significance, * at the 10% level of significance. () represents the standard errors; [] shows t-stats.

Results pertaining to the control variables, shown in Table 6, show some interesting insight. Whilst both proxies pertaining to the capital input and quality of the labor are accounted for, across the three different ARDL estimations it seems that the levels of GFCF was the only statistically significant measure (at least at the 5% significance level). This thus confirms the positive relationship between labor productivity gains and the capital inputs required to achieve these gains in the South African context. It confirms the benefits that capital deepening has to offer labor production processes specifically, relating to the lowering of transaction costs, realizing potential economies of scale as well as allowing the creation of more specialized high-productivity jobs (Cahu et al., 2022). Though this is expected, concerningly as was shown in the descriptive analysis, both these features over the last 15 years have either shown signs of stagnation or deterioration. These results are even more pertinent considering the notable linkage between labor productivity and standards of living for an emerging market like SA (Turok & Visagie, 2023). Surprisingly coefficients for the mean years of schooling (as proxy for human capital stock) show different relationships, with a lack of consistency and the absence of any statistically significant impulses in both the main ARDL and the CCR estimations. Considering the strong association of human capital for labor efficiency, this might possibly be reflective of the challenges within the South African labor market, pertaining to the mismatch of skills and the struggles to ensure a more responsive education system (Akoobhai, 2023).

4.5. ECM results and short-run analysis

Following the confirmation of co-integration among the variables, an ECM model was estimated to assess the speed of adjustment back to equilibrium. Table 7 presents the results for all three models, highlighting the short-run coefficients and the error correction terms. Notably, the error correction terms for the three specified models were negative and statistically significant, indicating effective error correction in the co-integrating relationships. These ECM coefficients ranged from -0.042 for the de jure model to -0.363 for the de facto model. In this respect, de facto induced distortions to equilibrium in labor productivity (de facto) are corrected quite rapidly, that is over 2.75 years ($1/0.363$). Though in comparison, the de jure induced variations will last for approximately 23.8 years. This does relate to the speed of tangible and frequent technological flows and their diffusion (Woo & Magee, 2021) versus the implementation of intangible policies and the provision of needed infrastructure which takes time (Goyal et al., 2021) to induce technological productivity gains. The gulf between these two speeds of adjustments is a notable finding and highlights important implications. Policy responses to technological induced cross-border shocks must be seen as long-term rather than quick effective productivity enhancing levers. Rather, strategies that aim to reverse stagnating labor efficiency (as seen in the descriptive analysis) in the country need to seek to facilitate de facto flows. This can include better public-private partnership formation, targeted foreign direct investment and digital connectivity expansion, especially in rural areas, all which offer a more immediate productivity dividend. In addition to these results, Table 7 provides insight into the short run elasticities between the variables under consideration.

Given the dynamic nature of the estimation, results show how past productivity levels have affected the current efficiency of labor inputs in the country. From all three estimations, the results suggest that past productivity shocks will most likely induce dampening future effects. This most possibly points to the findings also reported in the long run with significant labor market rigidities that have come to characterize much of the South African labor market environment (Mazorodze, 2024). In this respect, stringent labor laws and the high costs of bureaucracy all seem to limit the adaptability of employers in their labor inputs in response to external technological impulses.

In addition to this, results for the relationship between general technological globalization and the efficiency of labor inputs reveal a statistically significant and positive effect. Even when disaggregating the measure and considering the lagged effects between its de facto and de jure metrics, these results seem to be consistent. Whilst the results for the general and de facto estimations correspond to those shown in the long run, de jure dynamics only seem to affect productivity in the short term. Given the disaggregation, this confirms the persistent cross border flow and penetration effect that drives lasting efficiency gains (Radło & Tomeczek, 2022). However, the de jure features only seem to have spurious effects, probably due to the rapidly changing technological environment in which policy makers struggle to adequately respond. In this respect it does point to a lack of needed control for governments. Developing countries, at least those within Africa, seem to be mostly recipients of these foreign novel technologies. As such autonomy in labor market regulation potentially is eroded through the diffusion and penetration effects of technological integration.

Table 7. ECM results and short-run coefficients

Variables	Overall (7) ARDL (4,4,0,3)		De facto (8) ARDL (4,4,1,4)		De jure (9) ARDL (4,3,4,3)	
	<i>Coeff.</i>	<i>Std. error</i>	<i>Coeff.</i>	<i>Std. error</i>	<i>Coeff.</i>	<i>Std. error</i>
D(LLP(-1))	-1.097	(0.169) [-6.464***]	-0.799	(0.154) [-5.179***]	-0.594	(0.297) [-1.999*]
D(LLP(-2))	-0.619	(0.169) [-3.655***]	-0.174	(0.174) [-2.782**]	-0.036	(0.346) [-0.105]
D(LLP(-3))	-0.422	(0.146) [-2.889***]	-0.308	(0.148) [-2.085*]	-0.381	(0.280) [-1.355]
D(LTG)	0.489	(0.147) [3.320***]				
D(LTG(-1))	0.667	(0.184) [3.616***]				
D(LTG(-2))	0.635	(0.164) [3.861***]				
D(LTG(-3))	0.447	(0.152) [2.943**]				
D(LTGDF)			0.208	(0.074) [2.806**]		
D(LTGDF(-1))			0.189	(0.072) [2.625**]		
D(LTGDF(-2))			0.353	0.083 [4.228***]		
D(LTGDF(-3))			0.293	0.081 [3.619***]		
D(LTGDJ)					0.458	(0.152) [3.171***]
D(LTGDJ(-1))					0.927	(0.519) [1.787]
D(LTGDJ(-2))					0.895	(0.465) [1.924*]
D(LGFCF)			-0.003	(0.003) [-1.007]	-0.426	(0.216) [-1.971*]
D(LGFCF(-1))					0.977	(0.408) [2.388**]
D(LGFCF(-2))					0.505	(0.230) [2.192*]
D(LGFCF(-3))					0.921	(0.336) [2.742**]
D(LMYS)	0.035	(0.088) [0.399]	0.061	(0.067) [0.909]	1.634	(0.999) [1.636]
D(LMYS(-1))	0.017	(0.086) [0.209]	-0.013	(0.063) [-0.203]	0.852	1.583 [0.538]
D(LMYS(-2))	0.156	(0.082) [1.900*]	0.195	(0.063) [3.082***]	1.026	(0.618) [1.659]

Variables	Overall (7) ARDL (4,4,0,3)		De facto (8) ARDL (4,4,1,4)		De jure (9) ARDL (4,3,4,3)	
	<i>Coeff.</i>	<i>Std. error</i>	<i>Coeff.</i>	<i>Std. error</i>	<i>Coeff.</i>	<i>Std. error</i>
D(LMYS(-3))			0.148	(0.075) [1.983*]		
CointEq (-1)	-0.336	(0.051) [-6.547***]	-0.363	(0.052) [-6.899***]	-0.042	(0.013) [-3.116***]
<i>R-squared:</i>		0.802		0.833		0.775
<i>Durbin-Watson:</i>		2.185		2.677		2.073
<i>Jaque-Bera (Normality):</i>		1.438		1.722		0.628
<i>LM test (Serial correlation):</i>		1.848		2.119		1.555
<i>Breusch-Pagan-Godfrey</i> <i>(Heteroscedasticity):</i>		0.760		1.474		0.971

Note *** indicates significance at the 1% level of significance, ** at the 5% level of significance, * at the 10% level of significance

For the control variables used, interestingly for the short term, automatic lag selection procedures showed that of the three estimations, GFCF only increased short-run model predictability, when included in the de jure estimation. Here evidence suggest that previous changes in capital investment induce future productivity gains and vice versa. The lagged effects most likely point to a learning curve effect, much similar to those reported by Gradzewicz (2021). With the initial change in investment attributing a negative shock, the lagged effects correspondingly show positive changes in productivity. Though in relation to the mean years of schooling, although the evidence points to positive impulses when human capital levels are increased, none of these were considered statistically significant, not even at the 10% level of significance.

4.6. Toda-Yamamoto Granger causality analysis

Following the short-run analysis, the Toda-Yamamoto Granger causality approach was employed. The results from Table 8 reveal a nuanced web of causal relationships, primarily suggesting a one-way causation from labor productivity levels (LLP) to de jure technological globalization (LTGDJ) as well as de facto trade globalization causing changes in its de jure feature. In addition to this GFCF seems to also exhibit causal relationships with the de jure feature of technological globalization, as well as with productivity levels. These findings suggest that technological globalization policy has been reactive over the study period and not proactive. Changes in productivity, capital formation (which has been technology friendly) and modern technology adoption and integration have seemed to spur on the needed policy responses with in the South African context.

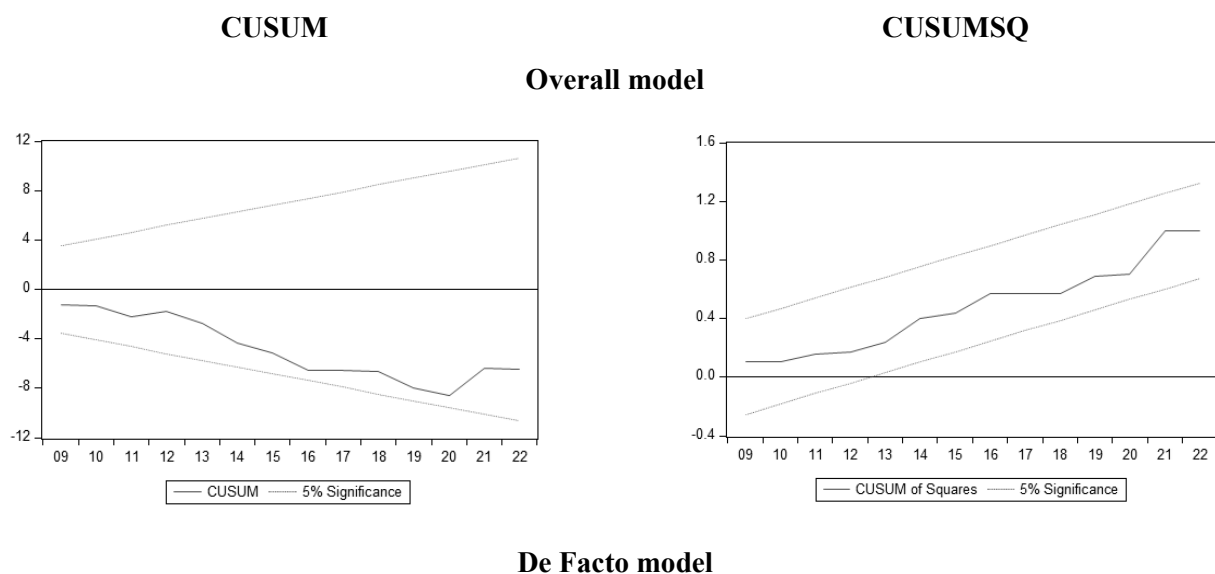
Table 8. Toda-Yamamoto Granger causality test

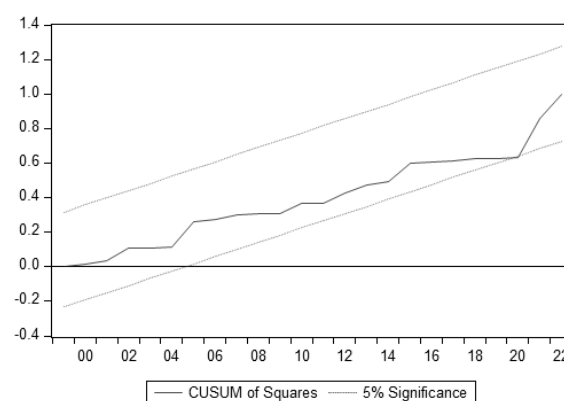
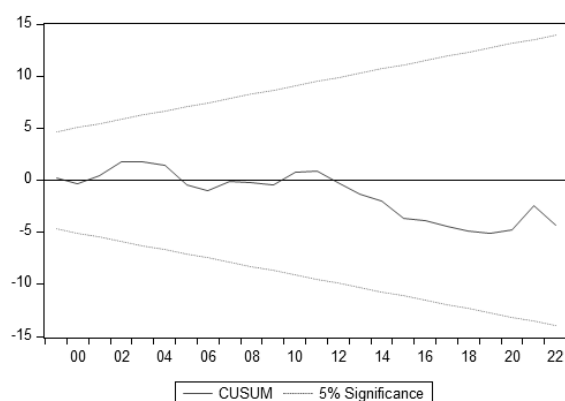
Variable	Dependent variable					
	LLP	LTG	LTGDF	LTGDJ	LGFCF	LMYS
LLP	-----	0.276 (0.599)	1.948 (0.163)	4.961 (0.026**)	1.274 (0.259)	0.053 (0.818)
LTG	0.791 (0.374)	-----	0.561 (0.454)	4.908 (0.027**)	2.410 (0.121)	0.123 (0.726)
LTGDF	0.611 (0.434)	1.743 (0.187)	-----	5.280 (0.022**)	2.175 (0.140)	0.172 (0.678)
LTGDJ	0.811 (0.367)	1.948 (0.163)	0.535 (0.464)	-----	2.135 (0.144)	0.137 (0.711)
LGFCF	7.041 (0.008***)	0.421 (0.516)	0.003 (0.984)	4.775 (0.029**)	-----	0.039 (0.843)
LMYS	0.002 (0.969)	0.327 (0.567)	0.045 (0.831)	1.041 (0.307)	0.379 (0.538)	-----

Note () shows the p-values *** indicates significance at the 1% level of significance, ** at the 5% level of significance, * at the 10% level of significance

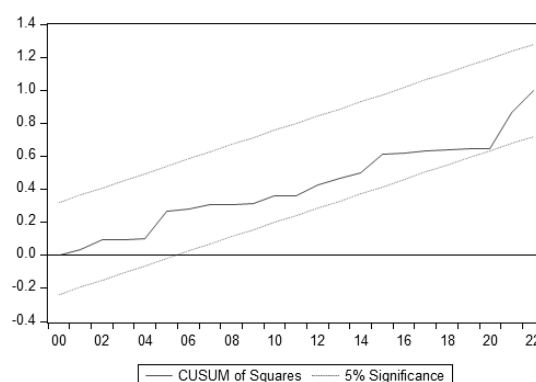
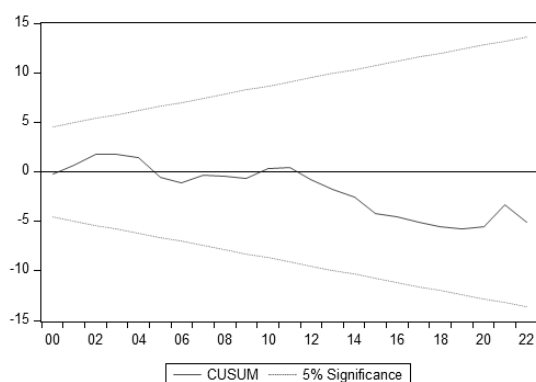
4.7. Stability tests

As the final stage of the analysis, both CUSUM and CUSUM of square (CUSUMSQ) tests were utilized to assess the stability of the ECM models that were employed. The CUSUM lines for models 1, 2 and 3 are shown in Figure 2a -f. The results as shown suggest that these remain within the critical bounds, which indicates that the model's parameters are stable over the sample period. This suggests that the relationship modelled does not significantly change, providing confidence in the validity of the results.

Figure 2 (a-f): CUSUM and CUSUMSQ estimates for ECM estimations



De Jure model



Source: Authors' own construction

5. CONCLUSION AND RECOMMENDATIONS

The study had the primary objective to analyze the impact of technological globalization on labor productivity in South Africa. In doing so, the findings show important and novel insight into a dynamic that is shaped not only by the external globalization forces but also by the internal conditions of the South African economy. From these perspectives, the study shed light on the intricate features. South Africa has attributed a unique integration process, with self-adopted integration and liberalization of the economy, post-apartheid, showing notable signs of just how beneficial integration, at least on a technological and information level, could be to their development endeavors. Despite these positives, the country's labor market conditions have been less than ideal, with the last three decades characterized by high structural unemployment levels, notable skills mismatches, and rigid regulatory conditions.

Taking this into consideration, the analysis provides evidence that points to the positive, persistent, and significant impact of technological globalization on labor productivity, mainly driven by its de facto features. In other words, real engagement and cross-border exchanges through multinational investments, digital infrastructure expansion, and R & D activities provide the associated labor efficiency benefits captured in the literature. These attributes have advantages in the form of knowledge transfers, production process enhancement, and capital deepening. The latter is also confirmed in the analysis, with the study pointing to noteworthy learning effects inherent in this nexus. Though despite these findings and considering that

productivity levels have stagnated over the last decade, the study raises important implications. The analysis here points to the weakening of specific structural drivers of labor productivity. Much like others around the world, GFCF levels, particularly in technology and the needed infrastructure, have declined. Whilst displaying these similarities, the country's own unique challenges, specifically relating to labor market rigidity, seem to constrain the economy's ability to leverage technological integration to improve labor efficiency. As pointed out in the causality analysis and the slow speed of adjustment in the ECM models, much of the public sector's response in its policy orientation has been slow to adjust to the rapidly changing nature of the country's technological landscape. Reform in this respect has been reactive as opposed to proactive, inferring policy shifts that follow market developments as opposed to driving them.

Within this context, the study provides notable evidence of the productivity dividends offered through technological globalisation, yet acknowledges important caveats in the broader socio-economic context of the country. Central to these are a declining investment landscape, stagnating efficiency levels, and most importantly, persistent inequality that has been driven by a dual economic structure. The latter has presented a particular concern within the nexus considered, posing a notable challenge in the way efficiency gains are realised. Taking this into consideration and ensuring meaningful induced change through global technological integration, the study recommends a more strategic and forward-looking policy approach. This should pertain to a better-aligned technological and industrial policy focus, with local firms encouraged to penetrate more value-adding technological global value chains. Moreover, given the decline in investment, the government should prioritize the formation of enhancing and inequality-reducing public-private partnerships. This can be driven through needed nudges, such as tax incentives and much-needed infrastructure funding, to spur the revitalization of capital formation and the digital infrastructure development required for rural areas. Finally, much-needed focus is to be directed towards addressing labor market challenges, both from the demand and supply sides, if long-term productivity gains are to be realized. This requires a policy to prioritize a more responsive education sector that focuses on digital and technological skill development. So too can a more flexible labor regulatory environment allow employers to be more responsive to the rapidly changing technological world, to allow for productivity gain maximization. Keeping these important considerations in mind, the study does have its limitations, mainly pertaining to the inability to disaggregate productivity according to skill level. So too has the sample size constrained the number of factors and the quality of proxies that can be controlled for in the analysis. Future studies should adopt more longitudinal designs, should the data become available, specifically pertaining to alternative technological globalisation metrics. Skill level insights can additionally point to possible job displacement and inequality considerations.

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