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Abstract

The present study examines the relevance of globalization in lifelong gender inclusive education for structural transformation. The focus of the research is on 41 countries in Africa using data from 2004 to 2021. The generalized method of moments (GMM) is employed to assess the problem statement within the remit of interactive regressions. Gender inclusive lifelong learning is measured as gender inclusive education acquired during the three levels of education, notably: primary, secondary and tertiary inclusive education stages. Total globalization and corresponding components (social, economic and political dynamics) are employed as moderators. The attendant sub-components of economic (i.e., trade and financial) and social (i.e., interpersonal, informational and cultural) globalization are also employed for robustness purposes. The hypotheses that globalization and gender inclusive lifelong learning individually influence structural transformation are not validated. Furthermore, the hypothesis that globalization dynamics moderate lifelong gender inclusive education to promote structural transformation is also not validated. Clarification as to why the hypotheses are not validated is provided. Policy implications are discussed.

Keywords: globalization; gender; inclusive education; structural transformation; Africa
JEL Classification: E60 ; F40 ; F59 ; D60 ; O55

1.Introduction

The present exposition is premised along the lines of assessing how globalization dynamics moderate the influence of lifelong inclusive education on structural transformation in Africa. The positioning of the study is framed on three main foundational elements especially as it pertains to, *inter alia*: (i) the growing importance of lifelong learning and the knowledge economy in driving 21st century economic prosperity and development; (ii) the relevance of involving the female gender in socio-economic activities in order to attain some United Nations' sustainable development goals (SDGs) by the year 2030; (iii) the importance of the concept of structural transformation in Africa and (iv) gaps in the relevant literature, especially in the light of a study positioned on a lifelong gender inclusive education indicator[1]. The attendant four motivational elements are expanded in the same order as highlighted in what follows.

First, the growing pertinence of lifelong learning is vividly articulated in the importance of knowledge economy in 21st century development and economic prosperity (Biao, 2022). According to the narrative, lifelong learning while relevant to both developed and developing countries, can be more leveraged by countries that are comparatively less developed such as those in Africa in order to boost the process of catch-up in economic prosperity. It is worthwhile to also emphasize that the phenomenon of lifelong encompasses human capital that is relevant in the economic development process as a factor of production (Ssozi & Asongu, 2016; Ssozi et al., 2019). Furthermore, following the research concern being considered by this study, globalization is important in the incidence of lifelong learning on infrastructural development because the training and learning processes which are embodied in lifelong learning entail, resources and logistics which are facilitated by globalization dynamics (political, economic and social components of globalization). Furthermore, sub-components of globalization dynamics also articulate the importance of openness in the capacity of lifelong learning to influence infrastructural development, notably, economic globalization which is composed of trade and financial components and social globalization which entails, interpersonal, cultural and informational globalization dynamics (Woo & Jun, 2020; Bickley et al., 2021).

Second, it is pertinent for more women to be formally integrated into the economy for a plethora of positive reasons, including the facilitation of economic development and progress towards the attainment of gender-oriented sustainable development goals (SDGs) projected by the United Nations for the year 2030. As substantiated by Ostry et al. (2018), gender economic inclusion is essential for a multitude of favorable externalities, *inter alia*, females have a higher propensity of being risk-averse or having a fear of unfavorable consequences (Croson & Gneezy, 2009), especially from uncalculated and unhealthy competition (Harbaugh et al., 2002). For instance, it has been established by Christiansen et al. (2016) that engaging more women in the corporate board of large companies engenders marginal effects in the knowledge-intensive and high-tech manufacturing services.

Third, structural transformation is relevant to the contemporary economic development of SSA. Accordingly, despite its advantages, African countries performed worse than other developing countries in structural transformation. Africa's share in global manufacturing value

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[1] Gender is used in the title of the study because the indicators of lifelong learning are conceptually defined in terms of gender parity. Accordingly, the concept of gender as understood within the context of the study refers of women versus men and thus gender-inclusion in the study is used interchangeably with women-inclusion or female inclusion. At times reference is also made to the female gender in order to articulate the specific context of gender as used in the study.

added saw a 0.1% decline from 2000 to 2008, whereas Asia's portion in global manufacturing value added improved by about 12% during the same period (Kuete & Asongu, 2023). According to the narrative, Africa's structural transformation, described by the progress of the manufacturing sector from the perspective of value added (Mijiyawa, 2017; Nguimkeu & Zeufack, 2019), is not flourishing as observed in other regions. Africa continues to have a low share in manufacturing GDP, and this trend has lingered since the 1990s (Kuete & Asongu, 2023).

Fourth, with regard to gaps in the extant literature, studies on the determinants of the structural transformation process in Africa and other developing countries are limited and inundated by micro-level research. These studies investigate how exports affect the performance of manufacturing firms in Africa (e.g., Bigsten et al., 2004; Fafchamps et al., 2008; Kuete & Asongu, 2023). They also identify the inhibitors, such as size impact, competition, and governance (Bigsten et al., 2003), alongside the bottlenecks impeding the success and survival of firms in Africa that are in the manufacturing sector (Diao et al., 2021). Most African macroeconomic studies have analyzed the factors enabling and hampering the success of industrial policies (see Marti & Senkubuge, 2009; Altenburg, 2011). But scarcely any studies have examined the role of infrastructure quality. Among the few studies, various authors highlighted different types of infrastructure. For example, Danmaraya and Hassan (2016) have been concerned with electricity infrastructure, while other authors, like Asongu and Odhiambo (2020a) and, inter alia, Muller (2021), focused on ICT infrastructure.

To our knowledge, with the exception of Azolibe and Okonkwo (2020), African-centric studies have not focused on the nexus between infrastructure progress and development of the industrial sector, especially in terms of distinguishing several versions of infrastructure and employing a macroeconomic approach. The underlying study entails 17 sub-Saharan African nations. The present exposition distinguishes itself from the latter in a plethora of ways. But the most notable is the study's sample size, which covers up to 41 African countries. The study's broad coverage allows us to observe greater degrees of freedom in expected findings and provide more generalizable policy recommendations.

Within the remit of extant studies which have proposed lifelong indicators, the present exposition builds on Tchamyou (2020) and Asongu and Tchamyou (2019) who have conceived and defined lifelong learning in terms of combined education obtained from the primary level through the tertiary level. It follows that the lifelong learning measure is understood in the underlying literature as representing the student population that has successfully completed primary, secondary and tertiary levels of education. The present exposition builds on the underlying stream of literature by conceiving and measuring lifelong learning in the same framework, with the exception that gender inclusive lifelong learning is not considered as lifelong involving both males and females. Hence within the remit of the present exposition, only the education of women is taken into account. In other words, gender inclusive lifelong learning is understood in terms of females who have gone via tertiary education passing through, obviously primary education and secondary education. It follows that in accordance with the extant studies (Asongu & Tchamyou, 2019; Tchamyou, 2020), the principal component analysis (PCA) is used to measure the composite index of gender inclusive lifelong learning, such that the first principal component (PC) articulates the female educated population that has gone via the three levels of education.

In the light of the above, still building on the extant lifelong learning literature (Asongu & Tchamyou, 2019), it is imperative to emphasize that relative to developed countries in which

comprehensive lifelong indicators have been established, not least, because of comparatively higher statistical capacity, in developing nations such as those in Africa, the absence of the relevant and robust statistical capacity dynamics renders the exercise of providing a comprehensive lifelong learning indicator very difficult. Still in accordance with the extant studies (Asongu & Tchamyou, 2019), "*To date only two macro level studies, i.e. the European Lifelong Learning Indicators (ELLI) instrument developed by the EU (2010) and the Composite Learning Index (CLI) instrument developed by the Canadian Council on Learning (undated.), have dealt with this issue*" (Luo, 2015, p.19). The underlying indicators in the passage lifted verbatim from prior exposition, cannot be used in the present study because the proposed lifelong learning indicators are not apparent for African countries, notably: (i) the CLI which is a Canadian-centric measurement to assess the improvement of lifelong learning is exclusively limited to Canada and (ii) the alternative ELLI indicator for the assessment of lifelong learning is exclusively limited to European countries. Given these concerns, the present study exclusively relies on the highlighted African-centric lifelong learning studies by measuring lifelong learning using the first principal component of three heights of education by means of PCA.

Of the studies that are highlighted, the closest research in the studies to the present positioning is Asongu and Bouanza (2023) which has investigated how gender inclusive education moderates the effect of globalization on structural transformation in Africa. The present exposition departs from the underlying study in two perspectives. On the one hand, lifelong gender inclusive education is considered as opposed to individual components of inclusive education, in the light of the narrative on the relevance of lifelong inclusive education in the preceding paragraphs. On the other hand, instead of employing distinct educational proxies as moderators as done in the underlying study, lifelong learning is used as the main channel. In substance, the positioning of the study is different from the underlying study in terms of problem statement: an assessment of the incidence of globalization in the effect of lifelong gender inclusive education on structural transformation as opposed to an examination of the incidence of individual education dynamics in the impact of globalization dynamics on structural transformation. Furthermore, in the assessment of the robustness, more factors in the conditioning information set are involved in the corresponding regressions. The generalized method of moments (GMM) is employed to assess the problem statement within the remit of interactive regressions. The hypotheses the globalization and gender inclusive lifelong learning individually influence structural transformation are not validated. Furthermore, the hypothesis that globalization dynamics moderate lifelong gender inclusive education to promote structural transformation is also not validated. Clarification as to why the hypotheses are not validated is provided and policy implications are discussed especially as it pertains to improving the quality of human capital and giving globalization a human face in order to expect a more significant influence on structural transformation.

The rest of the study is structured in the following manner. The extant literature and hypotheses development are emphasized in Section 2 whereas the data and methodology are covered in Section 3. Section 4 shows the empirical results and attendant discussion while the last section concludes with implications and future research directions.

2. Theoretical framework and hypotheses development

It is important to recall that the present study examines the relevance of globalization in lifelong gender inclusive education for structural transformation. It follows that in the light of the problem statement, the main channel is lifelong gender inclusive education whereas the

moderator is globalization. In other words, the study aims to assess how globalization moderates the incidence of lifelong gender inclusive education on structural transformation. The theoretical narrative is tailored such that globalization influences how human capital understood within the perspective of lifelong gender inclusive education affects structural transformation. After the exposition of each theoretical underpinning, the corresponding theory is contextualized by clearly articulating how the attendant theory is in line with the problem statement of the study. Moreover, after the three theoretical underpinnings are discussed, there is another paragraph synthesizing how considered theoretical underpinnings are in accordance with the problem statement.

The theoretical underpinnings on the relevance of globalization in the incidence of gender inclusive education on structural transformation are largely borrowed from the extant literature on nexuses between institutions, the knowledge economy and economic development (Amavilah et al., 2017; Hasan & Bousrih, 2020). In accordance with the extant literature, the "new economy" also understood as the knowledge economy which was first mentioned in the 1950s in scholarly circles entails an improvement of existing factors of production in the economy, to the extent that, the economy does not exclusively rely on labour and capital as the main factors of production, but also considers knowledge as a fundamental driver of economic development. In other words, the extant literature is in line with the perspective that in a knowledge economy, the production of goods and services is also substantially contingent on knowledge-intensive activities. This narrative is in line with the present exposition because such knowledge-driven economic activities are influenced by the globalization process, *inter alia*. Hence, the premise of assessing how globalization influences the importance of lifelong learning on structural transformation. There are a number of theories which elucidate the nexuses being considered in this study. The corresponding theories are clarified in what follows in three main strands, notably: (i) the innovation growth theory of Schumpeter; (ii) the exogenous theory as well the neoclassical growth theory of Robert Solow and (iii) the theory of endogenous growth (Amavilah *et al*., 2017; Hasan & Bousrih, 2020).

First, with regards to the innovative growth theory of Schumpeter, it is worthwhile to note that according to the postulation, changes in the economic sphere are fundamental in boosting learning opportunities and entrepreneurial innovation. Within the context of the present exposition, the underlying changes can be driven by globalization while the corresponding learning process and entrepreneurial innovation dimension of the theoretical underpinning are articulated by gender inclusive lifelong learning and manufacturing value added, respectively. It is worthwhile to note that manufacturing value added which is a proxy for structural transformation in this study can also be considered as a form of entrepreneurial innovation. It follows that the perspective of Schumpeter that innovation is the outcome of worthwhile combinations accord with this study, not least, because the empirical exercise consists of interacting globalization dynamics (i.e., political, economic and social) with lifelong learning in order to influence manufacturing value added (i.e., structural transformation).

Second, the importance of the role globalization in lifelong learning for structural transformation can also be understood within the remit of the exogenous growth theory which was first proposed by Robert Solow. According to the corresponding theoretical insights, demand and supply conditions can affect the productivity of an economy. Moreover, such demand and supply conditions can be contingent on *inter alia*, a combination of factors such as the interaction between globalization and gender inclusive education within the framework of lifelong learning as conceived and understood within the remit of the present exposition (Amavilah *et al*., 2017; Hasan & Bousrih, 2020). In summary, it follows that the theory of

Solow is one of interconnections between elements that drive demand and supply in order to ultimately influence production activities. Within the framework of the present study, such conditions are understood in terms of nexuses between globalization dynamics (i.e., political, economic and social) and lifelong learning from a gender inclusive perspective.

Third, another theoretical insight from which to understand the linkages currently being assessed in this study is the theory of endogenous economic growth which shows the insights from imperfect competition and the importance of potential changes in economic prosperity. Accordingly, economic prosperity and structural transformation are understood as driven by internal factors and not exclusively by external factors (Amavilah *et al*., 2017; Hasan & Bousrih, 2020). While the preceding paragraph dealing with the exogenous growth theory highlights external factors, the premise of the internal factors within the remit of the endogenous growth model in this study is articulated with gender inclusive lifelong learning. In other words, gender inclusive lifelong learning as understood within the remit of the present study is exclusively an internal factor that can drive structural transformation and by extension, economic prosperity. The dimension of lifelong learning within the framework of theory merits more emphasis, especially as it pertains to the aspect of human capital and knowledge which are proxied in this study using lifelong learning.

In the light of the above, human capital quality is contingent on human development investments in the country (e.g., education and health) and thus, this presupposes the creation of human capital conditions that are worthwhile in driving competition and structural transformation, especially as it pertains to the constant need to improve skills and adapt to requirements in the job marker by means of lifelong learning opportunities. It is also worthwhile to note that the concept of knowledge which is understood within the endogenous growth theory as a worthwhile element of human capital is also articulated in this study by means of lifelong learning. Accordingly, the concept of lifelong learning as understood within the framework of the present exposition embodies, basic education from the primary through secondary education and ultimately, also emphasizing elements of the research & development (R&D) which are more likely to be apparent in the tertiary level of education.

Building on the above, the theoretical propositions of the present exposition are sound because they build on three relevant theoretical underpinnings that are conducive to the examination of nexuses between globalization and lifelong education in order to affect structural transformation and by extension, economic development. Moreover, as recently argued by Saba et al. (2024), globalization and openness policies also induce development in the knowledge economy sector, particularly in countries that consistently update local knowledge and learning networks and standards to match the global learning and knowledge acquisition guidelines that promote cross-country trading and financial activities that obviously engender structural transformation. Furthermore, a country's knowledge economy sector develops when the economic sector improves, especially if the improvement drives value added in the industrial sector. The development in this sector spurs both domestic and international competition across related sectors, which usually entails technological advancement and further positive externalities on structural transformation.

In the light of the above, the following testable hypotheses are considered within the remit of the empirical analysis of this study:

Hypothesis 1: Gender inclusive lifelong learning influences structural transformation.

Hypothesis 2: Globalization affects structural transformation

Hypothesis 3: Globalization moderates' gender inclusive lifelong learning to positively affect structural transformation

The direct effect of both lifelong learning gender inclusive education and globalization have been formulated as first order direct effects in Section 2. However, it is important to recall that even if first order direct effects are not significant, second order indirect effects can be significant because the absence of significance in linear additive models does not rule-out the possibility that non-linear combinations of the corresponding variables can yield significant effects. This is essentially because in the real world, these considered variables do not exclusively act in isolation but are contingent on complementary factors as discussed and argued in the theoretical formulations. Whether the investigated nexuses are significant is a matter of empirical validity which is the object of the section that follows.

3.Data and methodology
3.1 Data

The present exposition focuses on 41 countries in Africa using data for the period 2004-2021. Following the inquiry closest to the current positioning (Asongu & Bouanza, 2023), three principal sources of data are employed for the study, notably: (i) the World Bank's World Development Indicators (WDI); (ii) the International Labour Organization (ILO) and (iii) the KOF from the Swiss Economic Institute. The sampled list of 41 countries is disclosed in Appendix 1 while the definitions of the variables with their attendant sources are provided in Appendix 2.

In accordance with the relevant literature on the subject (Asongu & Odhiambo, 2022; Asongu et al., 2023a), the dependent variable which is employed to address structural transformation is manufacturing added value while indicators that are used to proxy for globalization from a complementary strand of the literature (Dreher *et al*., 2008; Asongu et *al*., 2020a) include: (i) economic characteristics (financial, investment and trade flows, *inter alia*); (ii) political components (entailing, memberships to international organizations, the number of embassies in the country and the number of agreements at the international level that the country is signatory to) and (iii) social factors (reflected by cultural proximity, interpersonal nexuses and the flow of information). In what follows, the underlying globalization dynamics are discussed to elaborate detail.

It is worthwhile to emphasize that globalization is employed as the moderating or policy variable in the study, in line with the elements of the motivation discussed in the introduction. Following Tifuh (2022), the KOF index of globalization encompasses a plethora of factors, entailing, trade openness and capital flows, *inter alia*, social and political elements of openness to the world. These thus, also entail contacts of cross border nature that constitute the interaction between citizens and the government. Building on the narrative, the index is worthwhile, not least, because it captures the underlying components of globalization highlighted in the previous paragraph. From a definitional point of view, in accordance with Osinubi and Asongu (2021), the KOF index of globalization entails the three main dimensions of globalisation, namely: political, economic and social dimensions of the phenomenon. Moreover, while trade and financial globalisation are components of economic globalisation, the corresponding components of social globalisation are cultural, informational and interpersonal. In accordance with the study that is closest to the positioning of the present research, the political sub-

components are not available in the light of data availability constraints. Hence, while the sub-components of social and economic globalisation are considered within the remit of the study, the sub-components of political globalisation are not considered in view of constraints in data availability at the time of the study.

In line with the motivational elements of the study, the main channel or mechanism being considered is gender inclusive lifelong learning which is proxied by means of principal components analysis (PCA) as the gender inclusive combined knowledge that is gained during the primary, secondary and tertiary education levels. The use of PCA to proxy for lifelong learning follows the extant literature on the subject (Tchamyou, 2020; Asongu & Tchamyou, 2019). The PCA from which the lifelong indicator is derived is provided in Table 1. Building on Tchamyou (2020), the Kaiser 1 criterion is employed in retaining the first principal component (PC) which reflects about 83.7% of the combined information in the three levels of education. It follows that the first PC is enough to be employed as the lifelong indicator because more than 83.00% of females who go through primary education end-up enrolled at the university level, after going through secondary school. The corresponding second PC reflects about 14% of the combined information with a corresponding eigenvalue of less than one. It is worthwhile to note that, according the Kaiser 1 criterion employed for the study, the retained PC used for the lifelong learning index should reflect a corresponding eigenvalue that is higher than one. The information retained by the corresponding third PC component is less than 2%. All three levels of education are also employed for the purpose of measuring lifelong learning because in accordance with Asiedu (2014), all levels of education are fundamental in structural transformation, especially when economies are characterized by features of early-stage industrialization such as is the case of the sampled countries. Moreover, the underlying narrative is in accordance with this study from two main perspectives. On the one hand, most of the sampled countries are at the initial level of industrialization and on the other hand, the present exposition has structural transformation as outcome variable, which is closely linked to the process of industrialization.

In accordance with the extant productivity and manufacturing value added literature, five main control variables are adopted in the conditioning information set in order to take into account variable omission bias, namely: population growth, GDP per capita, urban population, natural resource and private domestic credit (Diao et al., 2017; Osinubi & Asongu, 2021; Efobi et al., 2019; Asongu et al., 2020b; Asongu & Odhiambo, 2023). The population growth control variable is employed in the main estimation whereas the remaining four control variables are used in the robustness check analyses. It is worthwhile to note that, even when the last-four are employed in the robustness check analyses, these are employed in distinct specifications in order to avoid instrument proliferation. It is worthwhile to note that, even when the collapse option is employed in the GMM specification, concerns pertaining to instrument proliferation are still apparent when many independent and control variables are involved in the estimation exercise. It follows that, in accordance with the extant GMM-centric literature, there is naturally a choice between accounting for variable omission bias (i.e., with many control variables) and having robust models (Osabuohien & Efobi, 2013).

It is expected that population growth should negatively affect manufacturing value added in the sampled countries, in accordance with Osinubi and Asongu (2021). This is essentially because according to the authors, population growth in the African continent has not been associated with improvements in job opportunities pertaining to structural transformation. The signs of the last-four control variables are discussed in Section 4.2, concurrently with the presentation of the relevant robustness checks findings. A list of the sampled countries is disclosed in Appendix

1 whereas the variables are defined in Appendix 2. Appendix 3 and Appendix 4 respectively, provide insights into the summary statistics and correlation matrix.

Table 1. Principal Component Analysis (PCA) for Inclusive Education (Educatex)

Principal Components	Component Matrix (Loadings)			Proportion	Cumulative Proportion	Eigen Value
	PSE	SSE	TSE			
First PC (Educatex)	0.582	0.614	0.531	0.837	0.837	2.513
Second PC	-0.539	-0.196	0.818	0.142	0.980	0.428
Third PC	0.607	-0.764	0.217	0.019	1.000	0.057

PC. Principal Component. PSE. School enrollment, primary and secondary (gross), gender parity index (GPI). SSE. School enrollment, secondary (gross), gender parity index (GPI). TSE. School enrolment, tertiary (gross), gender parity index (GPI).

3.2 Methodology

Building on Asongu et al. (2023b), the extant GMM-centric literature (Arellano & Bond, 1991; Fayissa et al., 2008), manufacturing value added is the dependent variable. In line with Barro's standard growth model, we add a lagged outcome variable to the right-hand side of the equation to show some of the persistence dimensions in the outcome variable.

The estimation procedure for the standard system GMM gives the following equations in level (1) and first difference (2):

$$MVA_{it} = \emptyset_0 + \emptyset_1 MVA_{it-\tau} + \emptyset_2 LL_{it} + \emptyset_3 Glo_{it} + \emptyset_4 Inter_{it} + \sum_{k=1}^{5} \delta_k W_{hit-\tau} + \varphi_i + \omega_t + \varepsilon_{it}$$

(1)

$$MVA_{it} - MVA_{it-\tau} = \emptyset_1 (MVA_{it-\tau} - MVA_{it-2\tau}) + \emptyset_2 (LL_{it} - LL_{it-\tau}) + \emptyset_3 (Glo_{it} - Glo_{it-\tau}) + \emptyset_4 (Inter_{it} - Inter_{it-\tau}) + \sum_{k=1}^{5} \delta_k (W_{hit-\tau} - W_{hit-2\tau}) + (\omega_t - \omega_{t-\tau}) + (\varepsilon_{it} - \varepsilon_{it-\tau})$$

MVA : represents manufacturing value added used as a proxy for structural transformation; θ_0 shows the constant; LL reflects gender inclusive lifelong learning ;Glob represents the matrix of globalization indicators (i.e., general globalization index, political globalization, economic globalization and social globalization); W represents the vector of control variables (namely, population growth, GDP per capita, urban population, natural resources and private domestic credit) ; τ is the unit coefficient of autoregression given that a lagged year is sufficient to capture past information; ω_t denotes the time-specific constant of the study; φ_i shows the effects that are country-specific and ε_{it} reflects the error term.

The empirical strategy employed to estimate the preceding equations is Roodman's (2009) improvement of Arellano and Bover (1995). Research evidence shows that Roodman's (2009) contribution has manifold advantages, for instance, accounting for dependence across countries by controlling for time fixed effects and limiting the proliferation of instruments (Asongu & Odhiambo, 2018, 2019; Boateng et al., 2018; Tchamyou et al., 2019a, 2019b). Another advantage of the GMM approach is the possibility of accounting for some of the aspects of endogeneity. For example, it addresses reverse causality or simultaneity via an internal

instrumentation process. It uses time-invariant indicators to control for cross-sectional dependence that doubles as a control for an aspect of endogeneity known as the unobserved time-invariant heterogeneity.

It is also worthwhile to note that, regardless of the efficiency of non-overlapping intervals in mitigating instrument proliferation that bias corresponding GMM estimates, using data averages in GMM is problematic because they interpret the corresponding estimated coefficients as short-term linkages (Asongu, 2013). Also, we cannot employ other empirical strategies for nonlinear estimation, like the Panel Threshold Regression technique (Hansen, 1999) as well as the Panel Smooth Transition Regression (González et al., 2005; González et al., 2017), owing to the premise that an unbalanced dataset is used in this study.

3.3 Identification, exclusive restrictions and simultaneity

As argued by Asongu et al. (2023b), proper specification of GMM estimation relies on clarifying concerns related to identification, exclusive restrictions, and simultaneity. In subsequent paragraphs, we expand on these three relevant concerns in the same chronological order.

First, the process of identification involves choosing three main sets of variables that match the required specifications: the outcome variable, the endogenous explaining, predetermined or suspected endogenous indicators, and strictly exogenous variables. In line with Asongu et al. (2023b), the outcome variable is structural transformation, the endogenous explaining variables are the independent variables of interest (i.e. lifelong learning and globalization) and control variables (population growth, GDP per capita, urban population, natural resource and private domestic credit), while the strictly exogenous variables are time-fixed impacts. The unlikelihood for time-fixed impacts to be endogenous after a first difference motivates their selection as strictly exogenous variables, in line with the related literature (Roodman, 2009; Tchamyou & Asongu, 2017).

Second, with respect to the exclusive restrictions, emphasis is laid on assessing the robustness of the identification process. In other words, exclusive restrictions determine if strictly exogenous variables, as defined, influence the manufacturing value added exclusively via control as well as the independent variables of interest (i.e., variables that are predetermined or endogenous explaining). GMM-centric literature adopts the Difference in Hansen Test (DHT) to examine whether the assumption of exclusive restriction holds true or false (Asongu et al., 2023b). Accepting the null hypothesis confirms that the strictly exogenous variables show strict exogeneity. The concomitant identification process broadly aligns with non-contemporary approaches to instrumentation which require that for the instruments to influence the outcome indicator exclusively through the underlying exogenous components of the independent variables, the Sargan/Hansen test should not be valid (Lalountas et al., 2011; Amavilah et al., 2017; Agbloyor et al., 2013). Third, with regard to the issue of simultaneity, our study accounts for reverse causality as we employ forward orthogonal variations as opposed to first differences to permit parallel or equilateral conditions that are worthwhile in restricting the relationship between the lagged outcome variable and country-specific impacts, which represent a source of endogeneity. Accordingly, we utilize Helmert changes to purge fixed impacts while accounting for simultaneity or reverse causality (Arellano & Bover, 1995; Roodman, 2009).

4. Empirical analysis

The empirical results are disclosed in this section. Section 4.1 focuses on the direct effect of gender inclusive lifelong learning on structural transformation (i.e., the assessment of Hypothesis 1) while Section 4.2 is concerned with the direct impact of globalization on structural transformation (i.e., the examination of Hypothesis 2). Moreover, Section 4.3 is focused on the indirect effects of globalization and lifelong learning on structural transformation (i.e., the investigation of Hypothesis 3). Robustness checks are engaged in Section 4.4 before further discussion of results are provided in Section 4.5. Prior to discussing the empirical results, it is relevant to clarify the main information criteria used to assess the validity of the empirical results.

It is worthwhile to note that four main information criteria are employed in the assessment of whether the assessed models withstand empirical validity (Asongu et al., 2023a). In essence: (i) the Arellano and Bond autocorrelation test in first order should be significant while the corresponding second order test should not be significant in order for the study to establish the absence of autocorrelation in the residuals. (ii) The instruments should also be valid in the perspective that the Sargan and Hansen overidentifying restrictions tests should not be valid. The underlying validity presupposes that their null hypotheses which are the position that the instruments are valid are not rejected. It is also relevant to note that while the Sargan is not robust, but not affected by instrument proliferation, the Hansen test is robust but dampened by the proliferation of instruments. Building on the attendant GMM-centric literature, the way forward is to adopt the Hansen test and mitigate the proliferation of instruments by ensuring that for every specification that number of instruments is less than the corresponding number of countries. (iii) The Difference in Hansen Test (DHT) is also employed to further assess the validity of the instruments, especially as it pertains to the adopted instruments influencing the outcome variable exclusively via the exogenous components of the independent variables of interest (i.e., globalization moderators and lifelong learning channel) and corresponding control variable. It follows that a rejection of the null hypothesis of the DHT is the position that the instruments are not strictly exogenous. Accordingly, p-values of the Sargan and Hansen OIR tests as well as p-values of the DHT that are less than 0.100 indicate that the null hypotheses of the corresponding tests on the validity of instruments are not rejected. (iv) In order to assess the overall validity of the model, the Fisher statistics is disclosed. Accordingly, the corresponding test should be significant in order for the estimated models to be valid from an overall standpoint.

4.1 Direct effect of lifelong gender inclusive education on structural transformation

The findings in Table 2 are relevant in assessing Hypothesis 1 which posits that gender inclusive education influences structural transformation in the sampled countries. The findings are disclosed in five main specifications taking into account the five considered elements of the conditioning information set. While the information criteria for the validity of estimated models shows that the estimated models are valid, the investigated hypothesis is not valid because gender inclusive education does not significantly influence structural transformation. The negative significant effect of population growth is in line with the narrative in the data section on the expected signs from the control variables. Accordingly, when the population increases by 1, manufacturing value added decreases by 0.662 units. The positive effect of GDP per capita on manufacturing value added and the negative nexus between urban growth and manufacturing value added are in line with the extant literature (Raihan et al., 2023; Kuete & Asongu, 2023).

Table 2. Lifelong Gender Inclusive Education (EDUCATEX) **and Structural Transformation**

	Dependent variable: Manufacturing Value Added (MVA)				
	(1)	(2)	(3)	(4)	(5)
L.MVA	**1.067***	**1.017***	**0.970***	**1.037***	**1.029***
	(0.141)	**(0.093)**	**(0.123)**	**(0.147)**	**(0.078)**
EDUCATEX	-0.263	-0.148	0.199	0.187	-0.009
	(0.341)	(0.297)	(0.312)	(0.456)	(0.178)
Population growth	**-0.662***				
	(0.238)				
Log (GDP per capita)		**0.407***			
		(0.235)			
Urban growth			**-0.466****		
			(0.173)		
Natural resources				-0.030	
				(0.031)	
Private credit					0.018
					(0.019)
Time Effects	Yes	Yes	Yes	Yes	Yes
Constant	0.923	**-3.047***	1.999	-0.008	-0.718
	(1.670)	**(1.614)**	(1.673)	(1.961)	(0.978)
AR(1)	**(0.034)**	**(0.029)**	**(0.034)**	**(0.023)**	**(0.032)**
AR(2)	**(0.740)**	**(0.843)**	**(0.840)**	**(0.855)**	**(0.764)**
Sargan OIR	**(0.397)**	**(0.684)**	**(0.595)**	**(0.761)**	**(0.957)**
Hansen OIR	**(0.578)**	**(0.659)**	**(0.662)**	**(0.687)**	**(0.858)**
DHT for instruments					
a)Instruments in levels					
H excluding group	**(0.138)**	**(0.275)**	**(0.171)**	**(0.175)**	**(0.311)**
Dif(null, H=exogenous)	**(0.887)**	**(0.788)**	**(0.919)**	**(0.935)**	**(0.967)**
Fisher	2588.42***	6062.82***	1593.43***	1837.23***	4845.83***
Instruments	27	27	27	27	27
Countries	36	36	36	36	34
Observations	267	267	267	267	256

***, ** , *: respectively denote the 1%, 5% and 10% levels of significance. DHT: shows the Difference in Hansen Test used to assess the Exogeneity of Instruments Subsets. OIR: Over-identifying Restrictions Test. Dif: Difference. Bold values have two principal significances. On the one hand, the significance of the Fisher statistics and estimated coefficients. On the other hand, the non-rejection of the null hypotheses of: (a) autocorrelation absence in the AR(1) & AR(2) tests and; (b) the instruments that are valid based on the Sargan and Hansen OIR tests. na: not applicable given that at least one estimated coefficient that is indispensable for the computation of net effects does not reflect significance. For the estimated coefficients, values in parentheses reflect standard errors while for the information criteria (i.e., AR, Sargan, Hansen, DHT and IV tests), p-values are disclosed.

4.2 Direct effect of globalization on structural transformation

This section provides findings that are relevant for the assessment of Hypothesis 2 which is premised on the position that globalization influences structural transformation in the sampled counties. Table 3 shows findings on the nexus between globalization and structural transformation while Table 4 and Table 5 disclose the corresponding results for economic globalization and social globalization dynamics, respectively. The information criteria for the validity of results in all three tables show that the findings are valid. However, the investigated Hypothesis 2 is consistently not valid across the corresponding tables, not least, because globalization does not significantly influence structural transformation.

Table 3. Globalization and Structural Transformation

	Dependent variable: Manufacturing Value Added (MVA)			
	(1)	(2)	(3)	(4)
L.MVA	**0.953***	**0.942***	**0.867***	**0.859***
	(0.050)	**(0.066)**	**(0.081)**	**(0.052)**
Globalization (kofgi)	0.045			
	(0.049)			
Economic Globalization (kofecgi)		-0.002		
		(0.012)		
Social Globalization (kofsogi)			0.066	
			(0.058)	
Political Globalization (kofpogi)				0.029
				(0.026)
Population growth	0.017	0.084	0.075	**0.101***
	(0.067)	(0.061)	(0.063)	**(0.056)**
Time Effects	Yes	Yes	Yes	Yes
Constant	-2.268	-0.028	-1.917	-0.610
	(2.115)	(0.878)	(1.916)	(1.470)
AR(1)	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**
AR(2)	**(0.980)**	**(0.978)**	**(0.996)**	**(0.976)**
Sargan OIR	**(0.337)**	**(0.238)**	**(0.342)**	**(0.392)**
Hansen OIR	**(0.227)**	**(0.157)**	**(0.134)**	**(0.158)**
DHT for instruments				
a)Instruments in levels				
H excluding group	(0.017)	(0.009)	**(0.090)**	(0.016)
Dif(null, H=exogenous)	**(0.937)**	**(0.942)**	**(0.280)**	**(0.805)**
Fisher	**10584.20***	**5633.55***	**6096.32***	**3955.67***
Instruments	26	26	26	26
Countries	41	41	41	41
Observations	600	600	600	600

***, ** , *: respectively denote the 1%, 5% and 10% levels of significance. DHT: shows the Difference in Hansen Test used to assess the Exogeneity of Instruments Subsets. OIR: Over-identifying Restrictions Test. Dif: Difference. Bold values have two principal significances. On the one hand, the significance of the Fisher statistics and estimated coefficients. On the other hand, the non-rejection of the null hypotheses of: (a) autocorrelation absence in the AR(1) & AR(2) tests and; (b) the instruments that are valid based on the Sargan and Hansen OIR tests. na: not applicable given that at least one estimated coefficient that is indispensable for the computation of net effects does not reflect significance. For the estimated coefficients, values in parentheses reflect standard errors while for the information criteria (i.e., AR, Sargan, Hansen, DHT and IV tests), p-values are disclosed.

Table 4. Economic Globalization and Structural Transformation

	Dependent variable: Manufacturing Value Added (MVA)	
	(1)	(2)
L.MVA	**0.932*****	**0.941*****
	(0.080)	**(0.071)**
Trade Globalization (koftrgi)	-0.009	
	(0.010)	
Financial Globalization (koffigi)		0.001
		(0.009)
Population growth	0.077	0.042
	(0.062)	(0.063)
Time Effects	Yes	Yes
Constant	1.077	0.600
	(1.156)	(0.756)
AR(1)	**(0.001)**	**(0.001)**
AR(2)	**(0.993)**	**(0.988)**
Sargan OIR	(0.027)	**(0.495)**
Hansen OIR	(0.075)	**(0.252)**
DHT for instruments		
a)Instruments in levels		
H excluding group	(0.004)	(0.020)
Dif(null, H=exogenous)	**(0.892)**	**(0.948)**
Fisher	**3823.41*****	**8284.61*****
Instruments	26	26
Countries	41	41
Observations	600	600

***, ** , *: respectively denote the 1%, 5% and 10% levels of significance. DHT: shows the Difference in Hansen Test used to assess the Exogeneity of Instruments Subsets. OIR: Over-identifying Restrictions Test. Dif: Difference. Bold values have two principal significances. On the one hand, the significance of the Fisher statistics and estimated coefficients. On the other hand, the non-rejection of the null hypotheses of: (a) autocorrelation absence in the AR(1) & AR(2) tests and; (b) the instruments that are valid based on the Sargan and Hansen OIR tests. na: not applicable given that at least one estimated coefficient that is indispensable for the computation of net effects does not reflect significance. For the estimated coefficients, values in parentheses reflect standard errors while for the information criteria (i.e., AR, Sargan, Hansen, DHT and IV tests), p-values are disclosed.

Table 5. Social Globalization and Structural Transformation

	Dependent variable: Manufacturing Value Added (MVA)		
	(1)	(2)	(3)
L.MVA	0.874***	0.877***	0.915***
	(0.104)	(0.058)	(0.060)
Interpersonal Globalization (kofipgi)	0.026		
	(0.034)		
Informational Globalization (kofingi)		0.027	
		(0.022)	
Cultural Globalization (kofcugi)			0.007
			(0.012)
Population growth	0.070	0.049	0.062
	(0.068)	(0.070)	(0.067)
Time Effects	Yes	Yes	Yes
Constant	-0.407	-0.637	0.020
	(0.721)	(1.092)	(0.549)
AR(1)	(0.001)	(0.002)	(0.001)
AR(2)	(0.965)	(0.959)	(0.990)
Sargan OIR	(0.207)	(0.240)	(0.311)
Hansen OIR	(0.160)	(0.079)	(0.156)
DHT for instruments			
a)Instruments in levels			
H excluding group	(0.018)	(0.020)	(0.013)
Dif(null, H=exogenous)	(0769)	(0.433)	(0.866)
Fisher	1823.41***	10181.34***	10555.45***
Instruments	26	26	26
Countries	41	41	41
Observations	600	600	600

***, **, *: respectively denote the 1%, 5% and 10% levels of significance. DHT: shows the Difference in Hansen Test used to assess the Exogeneity of Instruments Subsets. OIR: Over-identifying Restrictions Test. Dif: Difference. Bold values have two principal significances. On the one hand, the significance of the Fisher statistics and estimated coefficients. On the other hand, the non-rejection of the null hypotheses of: (a) autocorrelation absence in the AR(1) & AR(2) tests and; (b) the instruments that are valid based on the Sargan and Hansen OIR tests. na: not applicable given that at least one estimated coefficient that is indispensable for the computation of net effects does not reflect significance. For the estimated coefficients, values in parentheses reflect standard errors while for the information criteria (i.e., AR, Sargan, Hansen, DHT and IV tests), p-values are disclosed.

4.3 Indirect effects of globalization and lifelong learning on structural transformation

The empirical results on indirect effects are disclosed in this section in Tables 6-8. Accordingly, Table 6 shows results on the relevance of globalization in moderating lifelong gender inclusive education for structural transformation. Accordingly, in the attendant table, total globalization

as well as the corresponding three main sub-components (i.e., political, economic and social) are considered. Table 7 on the other hand, decomposes the economic globalization component into its trade and financial globalization elements in order to further assess the linkages while in Table 8, the elements of social globalization (i.e., interpersonal, cultural and informational globalization dynamics) are also considered in order to examine if the underlying sub-components of social globalization significantly moderate lifelong learning in order to ultimately affect structural transformation in the sampled countries.

Table 6. Globalization, Inclusive Education and Structural Transformation

	Dependent variable: Manufacturing Value Added (MVA)			
	Globalization (kofgi)	Economic Globalization (kofecgi)	Social Globalization (kofsogi)	Political Globalization (kofpogi)
L.MVA	**0.901*****	**0.832*****	**0.934*****	**0.935*****
	(0.070)	**(0.069)**	**(0.077)**	**(0.075)**
Educatex	0.300	-0.385	0.213	0.297
	(0.451)	(0.266)	(0.287)	(0.617)
Globalization	0.021			
	(0.044)			
Globalization x Educatex	-0.019			
	(0.015)			
Economic Globalization		**-0.047***		
		(0.023)		
Economic Globalization x Educatex		0.014		
		(0.009)		
Social Globalization			-0.009	
			(0.023)	
Social Globalization x Educatex			-0.016	
			(0.010)	
Political Globalization				**0.027***
				(0.015)
Political Globalization x Educatex				-0.009
				(0.009)
Population growth	**-1.128*****	-0.379	**-1.147*****	**-0.983*****
	(0.325)	(0.233)	**(0.313)**	**(0.301)**
Time Effects	Yes	Yes	Yes	Yes
Constant	2.894	**4.690*****	**4.105*****	1.494
	(0.185)	**(0.183)**	**(0.156)**	(0.181)
Net Effects	na	na	na	na
AR (1)	**(0.025)**	**(0.029)**	**(0.020)**	**(0.031)**
AR (2)	**(0.734)**	**(0.679)**	**(0.735)**	**(0.572)**
Sargan OIR	**(0.668)**	**(0.099)**	**(0.620)**	**(0.614)**
Hansen OIR	**(0.482)**	**(0.669)**	**(0.139)**	**(0.793)**
DHT for instruments				
a)Instruments in levels				
H excluding group	**(0.407)**	**(0.424)**	**(0.198)**	**(0.194)**
Dif(null, H=exogenous)	**(0.478)**	**(0.696)**	**(0.187)**	**(0.976)**
b)IV(years, eq(diff))				
H excluding group				
Dif(null, H=exogenous)				
Fisher	**164774.10*****	**22463.08*****	**635571.86*****	**103810.49*****
Instruments	34	34	34	34
Countries	36	36	36	36
Observations	263	263	263	263

***, ** , *: respectively denote the 1%, 5% and 10% levels of significance. DHT: shows the Difference in Hansen Test used to assess the Exogeneity of Instruments Subsets. OIR: Over-identifying Restrictions Test. Dif: Difference. Bold values have two principal significances. On the one hand, the significance of the Fisher statistics and estimated coefficients. On the other hand, the non-rejection of the null hypotheses of: (a) autocorrelation absence in the AR(1) & AR(2) tests and; (b) the instruments that are valid based on the Sargan and Hansen OIR tests. na: not applicable given that at least one estimated coefficient that is indispensable for the computation of net effects does not reflect significance. For the estimated coefficients, values in parentheses reflect standard errors while for the information criteria (i.e., AR, Sargan, Hansen, DHT and IV tests), p-values are disclosed.

Following the extant literature on the subject (Nchofoung & Asongu, 2022a, 2022b; Nchofoung et al., 2021, 2022), in order to examine whether Hypothesis 3 is valid or not, the net effects and/or thresholds should be computed. The computation of attendant net effects and thresholds

is to avoid the pitfalls of interactive regression documented in Brambor et al. (2006). According to the authors, given that multicollinearity is not taken into account in interactive regressions, in order to assess the influence of the considered channel or mechanism on the outcome variable, the conditional incidence involving the moderator (i.e. which are globalization dynamics within the remit of our study) should also be taken into consideration. Still building on the corresponding literature, the highlighted net effects and/or thresholds cannot be computed if at least one of the components required for the computation is not significant. Within the framework of the study, the main channel or mechanism is inclusive lifelong learning while the moderators disclosing interactive effects are dynamics of globalization (i.e., political, economic and social). In other words, unconditional effects are articulated by the main channels whereas the conditional linkages are put in perspective by the corresponding interactive effects.

It is important to clarify that in scenarios in which both globalization and gender inclusive lifelong learning individually affect manufacturing value added, while the interactive effect is negative, the individual effects cannot be interpreted in isolation because in interactive regressions, the estimated coefficients are not interpreted distinctly, in order to avoid the pitfall of interactive regressions documented in Brambor et al. (2006). This is essentially because interpreting the estimates in isolation will be interpreting the estimated coefficients as in linear additive models, which is inaccurate because the concern of multicollinearity (potentially linked to the association between the interactive term and the individual components) is overlooked in interactive regressions (Brambor et al., 2006). Accordingly, the underlying concern of multicollinearity is taken into account by computing the net effect. Accordingly, the net effect is computed by combining both the conditional or interactive effect with the unconditional effect of the gender inclusive education channel, in line with contemporary interactive regression literature (Tchamyou et al., 2023).

Table 7. Economic Globalization, Inclusive Education and Structural Transformation

| | Dependent variable: Manufacturing Value Added (MVA) | |
	Trade Globalization (koftrgi)	Financial Globalization (koffigi)
L.MVA	**0.824***	**1.037***
	(0.060)	**(0.077)**
Educatex	-0.776	-0.163
	(0.485)	(0.197)
Trade Globalization	-0.016	

	(0.013)	
Trade Globalization x Educatex	0.021	
	(0.013)	
Financial Globalization		-0.021
		(0.017)
Financial Globalization x Educatex		-0.007
		(0.006)
Population growth	-0.381	**-0.742*****
	(0.310)	**(0.248)**
Time Effect	Yes	Yes
Constant	**3.169*****	**2.580****
	(1.050)	**(1.032)**
Net Effects	na	na
AR (1)	**(0.026)**	**(0.025)**
AR (2)	**(0.902)**	**(0.950)**
Sargan OIR	**(0.084)**	**(0.346)**
Hansen OIR	**(0.801)**	**(0.715)**
DHT for instruments		
a)Instruments in levels		
H excluding group	**(0.315)**	**(0.259)**
Dif(null, H=exogenous)	**(0.919)**	**(0.880)**
b)IV(years, eq(diff))		
H excluding group		
Dif(null, H=exogenous)		
Fisher	**4,790,000*****	**97925.68*****
Instruments	34	34
Countries	36	36
Observations	263	263

***, ** , *: respectively denote the 1%, 5% and 10% levels of significance. DHT: shows the Difference in Hansen Test used to assess the Exogeneity of Instruments Subsets. OIR: Over-identifying Restrictions Test. Dif: Difference. Bold values have two principal significances. On the one hand, the significance of the Fisher statistics and estimated coefficients. On the other hand, the non-rejection of the null hypotheses of: (a) autocorrelation absence in the AR(1) & AR(2) tests and; (b) the instruments that are valid based on the Sargan and Hansen OIR tests. na: not applicable given that at least one estimated coefficient that is indispensable for the computation of net effects does not reflect significance. For the estimated coefficients, values in parentheses reflect standard errors while for the information criteria (i.e., AR, Sargan, Hansen, DHT and IV tests), p-values are disclosed.

In the light of the above information criteria for both the validity of the assessed models as well the validity of the tested hypothesis, the following findings can be established in Tables 6-8. The tested hypothesis is not overwhelmingly valid because the net effects cannot be feasibly computed. As previously clarified, such net effect articulated the relevance of globalization dynamics in the incidence of lifelong learning on structural transformation. The established invalidity of the tested hypothesis withstands empirical scrutiny in Table 6 (i.e., on total globalization and corresponding components), Table 7 (i.e., with respect to sub-components of economic globalization) and Table 8 (i.e., in relation to sub-dimensions of social globalization). Furthermore, the significant control variables reflects the expected sign.

Table 8. Social Globalization, Inclusive Education and Structural Transformation

	Dependent variable: Manufacturing Value Added (MVA)		
	Interpersonal Globalization (kofipgi)	Informational Globalization (kofingi)	Cultural Globalization (kofcugi)
L.MVA	**0.875*****	**0.964*****	**0.980*****
	(0.099)	**(0.080)**	**(0.055)**
Educatex	0.388	-0.220	0.253
	(0.288)	(0.275)	(0.265)
Interpersonal Globalization	0.001		
	(0.017)		
Interpersonal Globalization x Educatex	**-0.015***		
	(0.008)		
Informational Globalization		0.003	
		(0.025)	
Informational Globalization x Educatex		-0.003	

		(0.007)		
Cultural Globalization				0.006
				(0.015)
Cultural Globalization x Educatex				**-0.028****
				(0.011)
Population growth	**-0.649****		**-1.056*****	**-1.068*****
	(0.272)		**(0.302)**	**(0.307)**
Time Effects	Yes		Yes	Yes
Constant	**2.981***		**2.917****	**3.122*****
	(1.476)		**(1.358)**	**(1.064)**
Net Effects	na		na	na
AR (1)	**(0.033)**		**(0.013)**	**(0.027)**
AR (2)	**(0.754)**		**(0.519)**	**(0.893)**
Sargan OIR	**(0.661)**		**(0.757)**	**(0.563)**
Hansen OIR	**(0.218)**		**(0.439)**	**(0.435)**
DHT for instruments				
a)Instruments in levels				
H excluding group	**(0.327)**		**(0.380)**	**(0.156)**
Dif(null, H=exogenous)	**(0.215)**		**(0.445)**	**(0.687)**
b)IV(years, eq(diff))				
H excluding group				
Dif(null, H=exogenous)				
Fisher	**14329.88*****		**338076.10*****	**16741.12*****
Instruments	34		34	34
Countries	36		36	36
Observations	263		263	263

***, ** , *: respectively denote the 1%, 5% and 10% levels of significance. DHT: shows the Difference in Hansen Test used to assess the Exogeneity of Instruments Subsets. OIR: Over-identifying Restrictions Test. Dif: Difference. Bold values have two principal significances. On the one hand, the significance of the Fisher statistics and estimated coefficients. On the other hand, the non-rejection of the null hypotheses of: (a) autocorrelation absence in the AR(1) & AR(2) tests and; (b) the instruments that are valid based on the Sargan and Hansen OIR tests. na: not applicable given that at least one estimated coefficient that is indispensable for the computation of net effects does not reflect significance. For the estimated coefficients, values in parentheses reflect standard errors while for the information criteria (i.e., AR, Sargan, Hansen, DHT and IV tests), p-values are disclosed.

4.4 Robustness checks

Given that that the tested Hypothesis 3 is not valid in the main models and that only one element was involved in the conditioning information set (i.e., control variables) in order to avoid instrument proliferation, a robust check in Table 9 is worthwhile in order to assess whether the involvement of other elements in the conditioning information set affects the established findings in the previous section. To this end, four main dimensions are further controlled in the empirical exercise, namely: the development level, urbanization, the natural resource curse hypothesis and the importance of financial access. The involvement of more control variables is premised on the empirical evidence that: (i) income levels are positively associated with manufacturing added value (i.e., the development level) (Asongu et al., 2020a). However, the effect could also be insignificant and at times even negatively significant in the light of the nature of the sample. For instance, as documented in contemporary African-centric studies (Bicaba *et al*., 2017; Tchamyou, 2020; Tchamyou *et al*., 2019; Asongu *et al.*, 2020a, 2020c), the period of recent growth resurgence in Africa has not been translated into the equitable distribution of the fruits of economic prosperity, which obviously could lead to the average income not significantly affecting the outcome variable because the distribution of wealth corresponding to the recent economic growth resurgence is more skewed in favour of the wealthier elements of society.

Table 9. Robustness checks: controlling for development level, urbanization, natural resources curse hypothesis and financial access

	Dependent variable: Manufacturing Value Added (MVA)			
	Development level	Urbanization	Natural resource curse hypothesis	Financial access

	(1)	(2)	(3)	(4)
L.MVA	**0.878***	**0.990***	**0.876***	**0.961***
	(0.068)	**(0.043)**	**(0.088)**	**(0.077)**
Educatex	0.018	0.432	0.290	0.281
	(0.286)	(0.416)	(0.381)	(0.420)
Globalization	**0.099****	-0.052	**0.125***	-0.018
	(0.044)	(0.038)	**(0.065)**	(0.055)
Globalization x Educatex	-0.014	-0.009	**-0.021***	-0.011
	(0.008)	(0.010)	**(0.012)**	(0.015)
Log (GDP per capita)	0.237			
	(0.267)			
Urban growth		**-0.346****		
		(0.155)		
Natural resources			**-0.025***	
			(0.009)	
Private credit				**0.034***
				(0.019)
Time Effects	Yes	Yes	Yes	Yes
Constant	**-5.263****	**4.087***	-4.398	0.627
	(1.980)	**(2.163)**	(2.633)	(2.958)
Net Effects	na	na	na	na
AR (1)	(0.038)	(0.024)	(0.038)	(0.043)
AR (2)	**(0.999)**	**(0.750)**	**(0.752)**	**(0.962)**
Sargan OIR	**(0.839)**	**(0.577)**	**(0.848)**	**(0.975)**
Hansen OIR	**(0.751)**	**(0.550)**	**(0.731)**	**(0.728)**
DHT for instruments				
a)Instruments in levels				
H excluding group	**(0.640)**	**(0.440)**	**(0.601)**	**(0.645)**
Dif(null, H=exogenous)	**(0.662)**	**(0.537)**	**(0.659)**	**(0.628)**
b)IV(years, eq(diff))				
H excluding group				
Dif(null, H=exogenous)				
Fisher	359457.23***	458977.48***	833421.91***	306013.51***
Instruments	34	34	34	34
Countries	36	36	36	34
Observations	263	263	263	252

*****, **, *: respectively denote the 1%, 5% and 10% levels of significance. DHT: shows the Difference in Hansen Test used to assess the Exogeneity of Instruments Subsets. OIR: Over-identifying Restrictions Test. Dif: Difference. Bold values have two principal significances. On the one hand, the significance of the Fisher statistics and estimated coefficients. On the other hand, the non-rejection of the null hypotheses of: (a) autocorrelation absence in the AR(1) & AR(2) tests and; (b) the instruments that are valid based on the Sargan and Hansen OIR tests. na: not applicable given that at least one estimated coefficient that is indispensable for the computation of net effects does not reflect significance. The mean value of globalization is 49.252. For the estimated coefficients, values in parentheses reflect standard errors while for the information criteria (i.e., AR, Sargan, Hansen, DHT and IV tests), p-values are disclosed.

(ii) The level of urbanization can negatively influence structural transformation, especially when such is linked to poor organization (Raihan et al., 2023). (iii) Owing to the natural resource curse hypothesis, the exploitation of natural resources has not significantly and positively influenced structural transformation in the sampled countries (Ajide, 2022). (iv) Financial access is an incentive for structural transformation because it provides the much-needed opportunities of funding that are worthwhile for the relevant economic activities (Konte & Tetteh, 2023).

In the light of the above, while the tested Hypothesis 3 is still not validated, control for the development level, urbanization, natural resources and financial access reflect estimated coefficients that are consistent with expectations from the narrative in the previous paragraphs. It follows that the invalidity of the tested hypothesis still withstands empirical scrutiny even when varying elements of the conditioning information set are considered within a robustness framework of the study.

4.5. Further discussion of results

The invalidity of the investigated hypotheses can be further clarified from three main perspectives; notably: (i) insufficient human capital that is relevant in driving the structural transformation process; (ii) misalignments between men and women leveraging on the globalization process and (iii) globalization not tailored to improve structural transformation in the sampled countries, especially by means of moderating human capital for an overall positive incidence. The three insights are discussed in what follows in the same chronological order as highlighted.

First, the invalidity of the tested hypotheses can be traceable to the premise that human resources have not been sufficiently developed in the sampled countries in order for such human resources to effectively leverage on the opportunities associated with globalization dynamics in order to significantly influence the structural transformation process in the sampled countries. Human capital could be associated with training linked to globalization activities and hence, in situations where effective and robust training is not apparent, the corresponding schooled population may not effectively improve the manufacturing sector by leveraging the available opportunities from the attendant globalization premises.

Second, another reason for the investigated hypotheses that are not validated could be traceable to the misalignment apparent between men and women, especially as it pertains to employing both types of gender and using the female gender as much as the male gender in order to engender positive externalities on manufacturing value added contingent on the moderating importance of globalization. This is consistent with the extant literature positing that while gender variations are apparent in the labour market (Shurchkov 2012; Eswaran, 2014; Azmat & Petrongolo 2014; Azmat et al., 2016; Ostry et al., 2018), hiring more educated women can engender enhanced productivity within and across firms. The invalidity of the tested hypotheses could thus be traceable to manufacturing firms not involving many women compared to men when building their human resources. This is consistent with evidence from the corresponding firm-related literature, especially considering studies on gender composition in firms' boards and how the underlying affects firm performance. Accordingly, Dezsö and Ross (2012) have found that firms which adopt strategies that entail a combination of gender inclusiveness and innovation are positively associated with increasing firm value while Christiansen et al. (2016) have established similar evidence for the representativeness of females at the corporate board levels in big corporations in knowledge-intensive, high-technology manufacturing and service sectors.

Third, another spectrum from which to understand the invalidity of the tested hypotheses is the prism of globalization that is not oriented toward providing a human face, especially as it pertains to countries on which globalization policies are imposed that are for the most part, developing countries such as those in the African continent. Hence, granting that globalization is still skewed towards increasing the wealth of the already rich nations at the expense of poorer countries, such a globalization phenomenon cannot effectively moderate gender inclusive lifelong learning for a significant positive outcome on manufacturing value added. This is consistent with studies advocating for globalization policies to be more humane (Verkhovets & Karaoğuz, 2022; Seoane, 2022), especially for countries in the African continent in which, the globalization forces are constraining the population in corresponding countries to consume what they do not produce and produce what they do not consume (Byiers & Woolfrey, 2023; Chipato, 2023).

Before concluding, it is relevant to clarify that while the investigated hypotheses are not overwhelmingly valid, the theoretical underpinning and corresponding empirical analyses are

sound and thus, the findings should be reported nonetheless in an effort to fight a concern of publication bias or the file drawer problem in research circles which is a practice of preferring significant, expected and strong results as opposed to respectively, insignificant, unexpected and weak results. It follows that the findings are also consistent with a strand of literature on the need to report findings even when such findings are not significant in order to promote transparency in research circles and by extension, fight publication bias (Rosenberg, 2005; Franco et al., 2014; Boateng et al., 2018).

5.Concluding implications and future research directions

5.1 Conclusion

The present study examines the relevance of globalization in lifelong gender inclusive education for structural transformation. The focus of the research is on 41 countries in Africa using data from 2004 to 2021. The generalized method of moments (GMM) is employed to assess the problem statement within the remit of interactive regressions. Gender inclusive lifelong learning is measured as gender inclusive education acquired during the three levels of education, notably: primary, secondary and tertiary inclusive education stages. Total globalization and corresponding components (social, economic and political dynamics) are employed as moderators. The attendant sub-components of economic (i.e., trade and financial) and social (i.e., interpersonal, information and cultural) globalization are also employed for robustness purposes. The following main finding is established. The hypotheses that globalization and gender inclusive lifelong learning individually influence structural transformation are not validated. Furthermore, the hypothesis that globalization dynamics moderate lifelong gender inclusive education to promote structural transformation is also not validated. Clarification as to why the hypotheses are not validated is provided. Policy implications are discussed in what follows, in two main strands, notably, in terms of: (i) promoting quality and gender inclusive education and (ii) giving globalization an inclusive face.

5.2 Policy implications

First, in order for human resources to be fully relevant in structural transformation, contingent on the globalization process, education at schools should be tailored to be in accordance with needs of improving value in the manufacturing industry as well as employing as many men as women. To these ends, emphasis on technical education and involvement of more women in the emphasized technical education are worthwhile. These, *inter alia*, are necessary so that both agricultural products as well as natural resources are transformed into value added goods in the manufacturing sector.

Second, policies of globalization should be tailored such that the human face is apparent in the light of the involvement of more women in various economic sectors, especially the manufacturing sector. The policy recommendation is motivated by the documented evidence that complementing men with women on an equal basis in the globalization process engenders a higher effect of gender economic inclusion on economic development externalities (Ostry et al., 2018), including manufacturing added value. Accordingly, increasing the participation of women in the manufacturing sector with the prospect of globalization increases productivity not only because more workers are involved but also because a previously scares female factor of production is now available.

Third, in our view, whether policy implications are predictable or not is a matter of empirical validity or invalidity. Accordingly, our intuitions and predictions may or may not withstand

empirical scrutiny which is why empirical analyses are needed to validate or reject these intuitions and predictions. Accordingly, it is essentially because the associations are not strong enough that the policy recommendations are tailored such that the independent variables of interest should be enhanced both in terms of quality and quantity in order to expect significant influences on structural transformation. In essence, while the associations are not strong and thus, the theoretical underpinnings motivating the study are not validated for the most part, on the grounds of the same theoretical underpinnings, it can be suggested that improving the underlying independent variables of interest can engender significant effects.

Fourth, implications of the findings also speak to scholarly circles on the relevance of insignificant, unexpected and weak results, compared to respectively, significant, expected and strong findings. Accordingly, insignificant results have as much policy implications as significant results. Hence, the suggested policy implications which build on the insignificance of gender inclusive lifelong learning and globalization individually and collectively influencing structural transformation, is an indication that policy makers still have much to do to get the much-needed quality human capital and inclusive globalization that are essential for structural economic transformation in the sampled countries.

5.3 Limitations and future research directions

The findings in the study obviously allow space for further research, especially in the light of understanding why the nexuses are not overwhelmingly valid on the one hand and on the other, how globalization can be given a human face in order to make the investigated linkages empirically worthwhile. Moreover, future studies could also be concerned with other SDGs, apart from the gender inclusive dimension which has been the primary focus of the present exposition. It is also worthwhile for future studies to consider primary data, especially within the remit of learning heritages which have been posited by Biao (2022) to be consistent with Africa's circumstances and correspondingly, more in line with the continent's economic development trajectory.

It also worthwhile to note that gender inclusive lifelong learning entails three dimensions of gender-related education (i.e., at the primary, secondary and tertiary levels). While we could not find data on other measures of quality education as well as data on the proportion of gender involved in manufacturing value added, it is very likely that these indicators when developed and found, are highly correlated with the gender inclusive lifelong learning indicator used as the independent variable of interest in this study. This shortcoming on the need to control for additional measures of quality education can be considered in future studies in order to provide scholars and policy makers with more clarity and insights into the investigated nexuses.

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Appendices

Appendix 1. List of countries (41) of the study

Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Congo. Dem. Rep., Congo. Rep., Cote d'Ivoire, Djibouti, Egypt. Arab Rep., Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Kenya, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, South Africa, Sudan, Zambia and Zimbabwe

Source. Autors' construction

Appendix 2. Definitions and sources variables

Variables	Signs	Definitions	Sources
Manufacturing value added	MVA	Manufacturing, value added (% of GDP). Manufacturing refers to industries belonging to ISIC divisions 15-37. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3. Note: For VAB countries, gross value added at factor cost is used as the denominator.	WDI (World Bank)
	PSE	School enrollment, primary and secondary (gross), gender parity index (GPI). Gender parity index for gross enrollment ratio in primary and secondary education is the ratio of girls to boys enrolled at primary and secondary levels in public and private schools.	WDI (World Bank)
Inclusive education	SSE	School enrollment, secondary (gross), gender parity index (GPI). Gender parity index for gross enrollment ratio in secondary education is the ratio of girls to boys enrolled at secondary level in public and private schools.	WDI (World Bank)
	TSE	School enrolment, tertiary (gross), gender parity index (GPI). Gender parity index for gross enrollment ratio in tertiary education is the ratio of women to men enrolled at tertiary level in public and private schools.	WDI (World Bank)
	Educatex	First Principal Component of School enrollment, primary and secondary (gross), secondary (gross), and tertiary (gross), gender parity index (GPI).	PCA
Globalization	kofgi	This is the aggregation of the three dimensions of globalization (KOF) as displayed in the KOF globalization index.	KOF Swiss Economic Institute
Economic globalization	kofecgi	A measure of economic globalization, obtained by aggregation of variables such as trade and investment flows, as well as restrictions to these flows.	KOF Swiss Economic Institute

Social globalization	kofsogi	A measure of social globalization, obtained by aggregation of variables such as personal contact, information flow and cultural proximity	KOF Swiss Economic Institute
Political globalization	kofpogi	A measure of political globalization, obtained by aggregation of variables such as number of foreign embassies, memberships in international organisations and of international treaties entered into by the country.	KOF Swiss Economic Institute
Trade globalization	koftrgi	A sub-dimension of the measure of economic globalization, obtained by aggregation of variables on exports and imports of goods and services, trade regulation, trade taxes, tariff rates and free trade agreements.	KOF Swiss Economic Institute
Financial globalization	koffigi	A sub-dimension of the measure of economic globalization, obtained by aggregation of variables on foreign direct investments, portfolio investments, international debt, international reserves (excluding gold), Exchange Arrangements, investment restrictions and Exchange Restrictions	KOF Swiss Economic Institute
Interpersonal globalization	kofipgi	A sub-dimension of the measure of social globalization, obtained by aggregation of variables on migration, tourism, foreign students and number of airports hosting international flights	KOF Swiss Economic Institute
Informational globalization	kofingi	A sub-dimension of the measure of social globalization, obtained by aggregation of variables on Internet bandwidth, international patents, high technology export, number of television sets per capita, internet access	KOF Swiss Economic Institute
Cultural globalization	kofcugi	A sub-dimension of the measure of social globalization, obtained by aggregation of variables on trade in cultural goods, trade in personal, cultural and recreational services, a subcomponent in the Balance of Payments, expression and belief, associational and organizational rights, rule of law and personal autonomy and individual rights.	KOF Swiss Economic Institute
Population growth	popgrowth	Population growth (annual %)	WDI (World Bank)
Log (GDP per capita)	lgdppc	Logarithme of Gross Domestic Product (GDP) per capita	WDI (World Bank)
Urbanization	urbangrowth	Urban population (% of total population)	WDI (World Bank)
Natural resources	tnr	The sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents, expressed as a percentage of GDP.	WDI (World Bank)
Private credit	dcps	Domestic credit to private sector (% of GDP)	WDI (World Bank)

WDI: World Bank Development Indicators of the World Bank.

Appendix 3. Summary Statistics

Variables	Obs	Mean	SD	Min	Max
Manufacturing value added	671	10.1	5.733	0.233	35.215
School enrollment, primary and secondary	444	0.919	0.107	0.599	1.176
School enrollment secondary	452	0.872	0.179	0.332	1.215
School enrolment tertiary	406	0.712	0.31	0.064	1.494
Educatex	310	-0.1	1.561	-4.652	2.767
Globalization	697	48.499	8.56	28.086	72.047
Economic globalization	697	43.902	10.403	23.415	84.887
Social globalization	697	41.724	12.088	15.317	78.315
Political globalization	697	59.722	14.819	21.45	91.388
Trade globalization	697	41.011	11.536	19.704	83.502
Financial globalization	697	46.822	11.915	20.863	86.575
Interpersonal globalization	697	42.017	14.518	10.921	81.152
Informational globalization	697	51.746	12.381	22.384	84.085
Cultural globalization	697	31.136	13.56	8.9	72.725
Population growth	738	2.419	.944	-5.28	5.627
Log (GDP per capita)	719	7.19	.949	5.565	9.527
Urbanization	738	3.515	1.377	-4.98	7.596
Natural resources	728	12.013	11.635	0.002	66.06
Private credit	671	21.972	23.584	0	142.422

S.D: Standard Deviation.

<div align="center">Appendix 4: Correlation matrix</div>

Variables	Dependent variable	Inclusive education dynamics				Globalization dynamics									Control variables				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1) mva	1.000																		
(2) pse	0.085	1.000																	
(3) sse	0.074	0.920	1.000																
(4) tse	0.155	0.633	0.804	1.000															
(5) educatex	0.109	0.929	0.984	0.863	1.000														
(6) kofgi	0.266	0.575	0.559	0.574	0.612	1.000													
(7) kofecgi	0.148	0.610	0.648	0.693	0.697	0.737	1.000												
(8) kofsogi	0.200	0.701	0.726	0.730	0.772	0.814	0.754	1.000											
(9) kofpogi	0.197	-0.006	-0.081	-0.098	-0.065	0.553	-0.063	0.048	1.000										
(10) koftrgi	0.135	0.563	0.548	0.572	0.602	0.705	0.928	0.698	-0.023	1.000									
(11) koffigi	0.132	0.559	0.650	0.717	0.686	0.655	0.920	0.689	-0.093	0.708	1.000								
(12) kofipgi	0.224	0.597	0.649	0.678	0.687	0.643	0.695	0.933	-0.162	0.620	0.662	1.000							
(13) kofingi	0.139	0.614	0.647	0.618	0.674	0.811	0.617	0.895	0.238	0.546	0.590	0.758	1.000						
(14) kofcugi	0.215	0.722	0.701	0.693	0.759	0.808	0.750	0.918	0.111	0.738	0.640	0.791	0.726	1.000					
(15) popgrowth	-0.345	-0.501	-0.602	-0.732	-0.651	-0.575	-0.708	-0.787	0.166	-0.636	-0.672	-0.823	-0.574	-0.739	1.000				
(16) lgdppc	0.215	0.446	0.552	0.707	0.603	0.723	0.661	0.839	0.088	0.558	0.670	0.838	0.709	0.752	-0.773	1.000			
(17) urbangrowth	-0.344	-0.309	-0.417	-0.638	-0.478	-0.526	-0.605	-0.665	0.080	-0.539	-0.583	-0.720	-0.451	-0.633	0.845	-0.710	1.000		
(18) tnr	-0.357	-0.233	-0.265	-0.244	-0.267	-0.393	-0.275	-0.300	-0.257	-0.199	-0.305	-0.214	-0.349	-0.310	0.248	-0.230	0.291	1.000	
(19) dcps	0.102	0.470	0.551	0.689	0.606	0.680	0.699	0.783	0.032	0.662	0.627	0.713	0.691	0.742	-0.714	0.701	-0.570	-0.215	1.000