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Innovation and Globalization: Benefactors or Barriers to Inclusive Growth?

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Abstract

Technological advancements are often viewed as drivers of green growth, but they also carry the potential to widen social inequality, particularly in job automation and the transformation of work routines. This study delves into the relationship between technology and inclusive growth, drawing on global data. We introduce a new concept called 'Inequality-Stabilizing Growth' (ISG), which balances economic progress with social equity. The ISG is calculated by combining factors that both decrease and increase inequality within total growth. Our findings indicate that technology or innovation alone does not necessarily lead to greater social equality or inclusive growth. In developed countries, the transfer of technology supports growth that includes more people, but this is not consistently the case in developing nations. The research also highlights a crucial point: focusing solely on growth without inclusive policies may worsen inequality, hindering future economic development. To counter this, we recommend policies that enhance education and financial growth, adapted to different stages of national development, and include fertility control measures in less developed areas. These factors promote social mobility, which is considered a 'key to curbing inequality.'

Keywords: innovation; globalisation; inclusive growth; unified growth theory

JEL codes: C33, D63, F63

1. Introduction

Globalization has been widely recognized as a key driver of strategies like trade-led growth, FDI-led growth, and innovation-led growth. This is exemplified by the economic achievements of the East Asian 'Miracle' countries, as noted by Stiglitz (1996). While globalization has significantly contributed to overall growth, it has also been criticized for exacerbating global inequality, particularly within-country income disparities (Dobson and Ramlogan, 2009; Bourguignon, 2015; Milanovic, 2016). Although globalization may bridge the developmental divide between nations, especially between emerging economies like China and India and their developed counterparts, it can simultaneously amplify income gaps within countries. The 'Elephant Curve' by Lakner and Milanovic (2013) illustrates this phenomenon, indicating a disproportionate distribution of globalization's benefits among different income groups, with middle-income populations in emerging markets and the global elite reaping the most rewards. However, Ravallion (2018) posits that it is technological change, rather than globalization, that primarily fuels rising global inequality. Echoing this sentiment, Jaumotte, Lall, and Papageorgiou (2013) and Furceri and Ostry (2019) have shown that the minimal impact of globalization on inequality results from the counterbalancing effects of its two principal components: trade globalization and financial globalization.

The growing interest in degrowth concepts, characterized by reduced material and energy use (Hickel, 2021), and deglobalization, marked by declining global interdependence (James, 2018), coincides with increasing concerns about reducing inequality (Balsa-Barreiro et al., 2020; Cosme, Santos, & O'Neill, 2017). These trends are notably influenced by technological developments. Specifically, (1) deglobalization is partly driven by technological advancements that are shortening global value chains (James, 2018), and (2) the push for degrowth is fueled by technology aiding in reducing resource and energy throughput (Samerski, 2018). In contrast, as previously discussed, it is technology, rather than globalization, that plays a more prominent role in exacerbating inequality and social polarization. Yet, this perspective is not universally accepted, particularly in socio-political circles (Kristal & Cohen, 2017; DiPrete, 2007; Lee & Rodríguez-Pose, 2013). Recent research indicates that technology's role in driving inequality is not standalone but interacts significantly with institutional factors, including labor market policies and welfare systems. These dynamics present complex challenges for policy researchers focused on achieving inclusive growth, as highlighted by Cerra et al. (2021).

This study endeavors to explore the drivers of inclusive growth in the context of 'globalization 4.0', aiming to provide valuable insights for policymakers. A central aspect of our research is the development of a new metric, termed 'Inequality-Stabilizing Growth' (ISG). This indicator is designed

to measure economic growth while minimizing the increase in inequality. To address the challenges of estimation, we employ several methodological strategies: mean-centering for micro-multicollinearity, cluster-robust standard errors to account for heteroscedasticity, simultaneous estimation to tackle endogeneity, and fixed effects and autoregression for analyzing cross-time and cross-country data. Our findings reveal that technology and globalization alone are not sufficient to promote ISG. Instead, the study highlights the significance of socio-political factors like domestic credit and education in driving inclusive growth. Interestingly, we observe shifting influences of domestic credit and education at varying stages of development.

The literature review section delves into the existing research on inequality and growth, particularly in the era of industry 4.0. Building on this foundation, we formulate specific research questions and address them in the 'Data and Methodology' section. The 'Results and Discussion' section presents our new findings, situating them within the context of prior research. In the 'Conclusions,' we succinctly summarize our main findings, linking them back to our research questions, and propose potential policy implications based on our analysis.

2. Literature review

2.1. The growth-inequality relationship: a tricky problem

A foundational concept in understanding the relationship between economic growth and inequality is the Kuznets Curve, proposed by Kuznets in 1955. This curve illustrates the rise and fall of income inequality alongside economic development as an inverted U-shape. It links the dynamics of industrialization and democratization with labor mobility shifts, from agriculture to industry and rural to urban areas. Initially, during the early stages of industrialization, a trade-off is observed between economic growth and social equality. However, with the progression of democratization in later stages, it's theorized that economies can achieve both growth and a reduction in inequality (Galbraith, 2007; Kuznets, 1955).

Despite its prominence in the economic discourse of the 1950s and 1960s, Kuznets' theory has faced criticism, both for its conclusions and its methodological underpinnings. Empirical research, notably by Deininger and Squire (1998) and Fields (2001), challenged the proposed relationship between economic growth and inequality. Fogel (1987) raised specific concerns about the reliability of the data used in Kuznets' research. While acknowledging these criticisms, it's important to note that Kuznets' work captures only a snapshot of global economic development.

Nonetheless, the interplay between growth and inequality remains a topic of academic interest. Bourguignon (2003), in his Poverty-Growth-Inequality Triangle, suggests a two-way causal relationship between growth and inequality, emphasizing the role of 'development strategy' in this interconnection. Similarly, Molero-Simarro (2016) found evidence of bidirectional causality between growth and inequality, underscoring the need for economic growth policies to be balanced with measures ensuring social stability.

In expanding upon the Kuznets Curve theory, subsequent research has delved deeper into the intricate relationship between economic growth and social inequality. A key aspect of this exploration is the heterogeneity of this relationship across different income levels within a country. Deininger and Squire (1998) observed that while inequality impedes growth for the lower-income groups, it doesn't have the same negative effect on the wealthy. This finding is echoed in studies by van der Weide and Milanovic (2018) in the context of the United States and Voitchovsky (2005) in Luxembourg, both of which concluded that inequality harms the poor but benefits the rich. Palma (2011) offered an explanation for this disparity, suggesting that income distribution tends to polarize over time, with the poor becoming poorer, the rich getting richer, and the middle-income groups remaining relatively stable.

The heterogeneity in the growth-inequality nexus is also evident when comparing different countries. Studies have shown that while inequality hampers growth in developing countries, it appears to facilitate growth in developed countries (Barro, 2000; Castelló-Climent, 2010). Furthermore, the relationship between growth and inequality is not static over time. Forbes (2000) and Halter, Oechslin, and Zweimüller (2014) found that inequality might spur economic growth in the short term but can have detrimental effects in the long run.

The exploration of the complex relationship between income inequality and economic growth reveals a diverse range of findings. Banerjee and Duflo (2003) identified economic growth as an inverted U-shaped function relative to changes in inequality, adding another dimension to the discourse. This perspective is further enriched by the introduction of the concept of the inequality of opportunity. Notably, Ferreira et al. (2018) illustrated that both the inequality of opportunity and income inequality tend to have a marginally negative impact on growth. Aiyar and Ebeke (2020) took this analysis a step further, arguing that inequality of income only hinders growth in the presence of inequality of opportunity.

Perhaps most intriguing is the work of Marrero and Rodríguez (2013), who dissected the impact of income inequality on growth into two distinct elements. Their study reveals a dichotomy within

income inequality itself: the inequality of opportunity, which negatively affects growth, and the inequality of effort, which, conversely, can be conducive to growth. This nuanced understanding underscores the complexity of the inequality-growth relationship, highlighting the need to consider both facets of inequality in economic analyses.

Growth and inequality interact not just directly, but also through various socioeconomic channels. Education stands out as a key factor in this dynamic. It not only fosters economic growth but also helps to control inequality (Berg et al., 2018; Perotti, 1996; Piketty, 2014). Sylwester (2000) argues that while investment in education may initially slow growth, it yields positive outcomes in the long run. Easterly (2007) and Benjamin, Brandt, and Giles (2011) have identified education as a mediator in the negative impact of inequality on growth, though Benjamin, Brandt, and Giles note the absence of a direct causal link between them.

Another critical element is the agricultural endowment or the sectoral share of agriculture in the total economy. This factor is particularly relevant in the context of industrialization, where economies transition from agriculture to industry (Easterly, 2007; Benjamin, Brandt, and Giles, 2011). Moreover, a host of macro factors have been identified as influencing the growth-inequality relationship. These include taxation and redistribution (Alesina and Rodrik, 1994; Berg et al., 2018; Biswas, Chakraborty, and Hai, 2017; Piketty, 2014), fertility rates (Berg et al., 2018; Perotti, 1996), institutional frameworks (Easterly, 2007), investment (Alesina and Perotti, 1996), and poverty (Marrero and Servén, 2021).

The initial level of income (Brueckner and Lederman, 2018) and the timing of economic transitions (Scholl and Klasen, 2019) also play significant roles. Furthermore, Erman and te Kaat (2019) have shown that the industry type matters: income inequality positively impacts growth in industries reliant on physical capital, but has the opposite effect in industries dependent on human capital. Lastly, the advent of globalization 4.0, or the fourth industrial revolution, introduces additional complexities into the growth-inequality equation (Furceri and Ostry, 2019; Jaumotte, Lall, and Papageorgiou, 2013).

2.2. The growth-inequality relationship in globalisation 4.0

In the era of globalization 4.0, many emerging countries have leveraged increasing global interconnectedness and technological advancements to spur economic growth. However, these growth strategies have often resulted in social polarization, particularly in the form of escalating income inequality. This study thus focuses on analyzing the impact of three primary drivers in the inequality-growth dynamic: trade openness, Foreign Direct Investment (FDI), and technological changes.

Trade-led growth, especially prominent between 1965 and 1990, played a crucial role in the economic surge of emerging Asian countries, famously termed the 'East Asia Miracle' (Stiglitz, 1996). Generally, trade globalization is not seen as detrimental to social equality (Beaton, Cebotari, and Komaromi, 2017) and is even considered beneficial in some contexts (Jaumotte, Lall, and Papageorgiou, 2013). In contrast, FDI-led growth, according to Carkovic and Levine (2005) and the World Bank (2006), has more complex implications for income distribution. For instance, FDI inflows into sectors that require high skill levels can amplify skill premiums and widen the wage gap (Cragg and Epelbaum, 1996).

Beyond strategies centered on globalization, those driven by technological advancements seek to boost productivity and resource efficiency. However, such advancements can sometimes disrupt social stability (Korinek, Schindler, and Stiglitz, 2021). It's important to note that not all technological progress leads to adverse social consequences. The primary concerns relate to labor-saving and skills-biased technologies. Labor-saving technologies have been linked to reduced employment opportunities, contributing to higher unemployment rates (Acemoglu and Restrepo, 2019; Autor, Levy, and Murnane, 2003). Skills-biased technologies, on the other hand, have been associated with job polarization, particularly affecting middle-skilled jobs (OECD, 2019).

Globalization has often been criticized for contributing to increased global inequality. Research focusing on Latin American countries, such as the work of Dobson and Ramlogan (2009), identified an inverted U-shaped relationship between trade liberalization and economic growth, termed 'the Openness Kuznets Curve.' This curve illustrates that while initial levels of trade integration exacerbate inequality, beyond a certain threshold, inequality begins to diminish. Consequently, they recommended that these countries continue their open-trade policies, complemented by effective redistribution strategies. Another significant contribution is the 'Elephant Curve' by Lakner and Milanovic (2013), which highlighted the uneven distribution of globalization benefits. Their analysis showed that the primary beneficiaries of globalization are middle-income groups in emerging Asian countries, like China and India, and the global super-rich. In contrast, the poorest populations, especially in Sub-Saharan Africa (Alvaredo et al., 2018), and middle-income groups in developed countries saw little to no benefit from increased globalization.

In the discourse on global inequality, two influential works stand out: Bourguignon (2015) and Milanovic (2016). Both authors concur that globalization has the potential to reduce international inequality by improving living standards in countries like China and India. However, they also highlight that globalization can simultaneously exacerbate domestic inequality within countries, widening the gap between different social classes.

Contrasting with views that heavily attribute global inequality to globalization, Ravallion (2018) contends that the role of globalization, particularly trade liberalization, in exacerbating inequality is often overstated and not conclusively the primary cause. He points instead to the unequal distribution of scientific and technological progress as a more significant factor. This perspective is supported by research from Jaumotte, Lall, and Papageorgiou (2013) and Furceri and Ostry (2019), which suggests that technological innovation, rather than globalization, plays a central role in widening the income gap. These studies, along with the work of Asteriou, Dimelis, and Moudatsou (2014), demonstrate that globalization impacts income inequality in two divergent ways: trade globalization tends to reduce inequality, while financial globalization appears to increase it.

Disentangling the effects of technological changes from globalization presents a significant challenge. Davis and O'Halloran (2018) argue that technological advancement is a key driver of globalization, while others like Mazumdar (2001), Saggi (2002), Spulber (2008), and Thoenig and Verdier (2003) highlight the evident interconnection between the two, especially in the era of global value chains. These value chains, integrated by global trade, capital mobility, and technological changes, have been central to discussions on globalization (Hummels, Ishii, and Yi, 2001; Rodrik, 2018).

The impacts of this trend, encompassing the rise of globalization and advancements in science and technology, are uneven across different regions and sectors. Geographic concentration of economic activities (Dix-Carneiro and Kovak, 2017; Topalova, 2010), bias towards trade-competing sectors (Helpman et al., 2017; Helpman, Itskhoki, and Redding, 2010), and skill-biased technological changes (Cerra, 2021; Goldberg and Pavcnik, 2007; Meschi and Vivarelli, 2009; Pavcnik, 2017) all contribute to varying socioeconomic outcomes in the context of globalization.

The diverse and often contradictory findings in previous studies highlight the complexity and inconclusiveness of the inequality-growth relationship. In the context of the United Nations' emphasis on sustainable development, and amidst the rapid expansion of globalization and technological advancement, determining the optimal path to inclusive and sustainable growth is a critical challenge for policymakers. This study is designed to shed light on this challenge by addressing two key questions: (Q1) What factors - technology, globalization, or human capital - influence the inequality-growth relationship, and in what ways? (Q2) What factors contribute to promoting inequality-stabilizing growth?

To answer the first question, our approach involves constructing a system of two simultaneous equations focusing on inequality and growth as interdependent variables. This method allows us to

examine the effects of various factors on economic outcomes. These factors include technological and globalization aspects (economic factors), financial development, human capital, and fertility (social factors), and unemployment and inflation (socioeconomic stability indicators).

To address the second question, we introduce a novel metric, 'Inequality-Stabilizing Growth' (ISG), which is designed to measure economic growth while minimizing increases in inequality. This indicator is calculated by adding inequality-reducing elements and subtracting inequality-increasing factors from the overall growth figure. Our analysis then extends to examining the influences on ISG, contrasting 'normal' growth with inequality-stabilizing growth. This comparison is conducted using two datasets: a global dataset and one specifically focused on developing countries.

3. Data and methodology

3.1. The analytical framework

After the literature review, we propose an analytical framework for the relationship between growth and inequality in globalisation 4.0 (as depicted in Figure 1). The relationship between growth and inequality is not simply linear one-way but nonlinear causality, conditioned through various channels (described in detail in the literature review). The interdependence between growth and inequality is further complicated by the autocorrelation of each; thus, the past values of these two variables have also been modelled by several studies, typically, Sukiassyan (2007), Basu and Guariglia (2007), and Castelló-Climent (2010) for growth; and Dreher and Gaston (2008), Bergh and Nilsson (2010), and Gravina and Lanzafame (2021) for inequality. Regarding modelled regressors, in this study, we categorised three groups of factors close to the research relationship, including 'ECON' (trade, FDI, and technology) to stimulate economic growth, 'SOCI' (domestic credit, human capital, and fertility) to impact on social equality, and 'STAB' (unemployment and inflation) to maintain socioeconomic stability. Their impact mechanism on inequality and growth is presented in Figure 1.

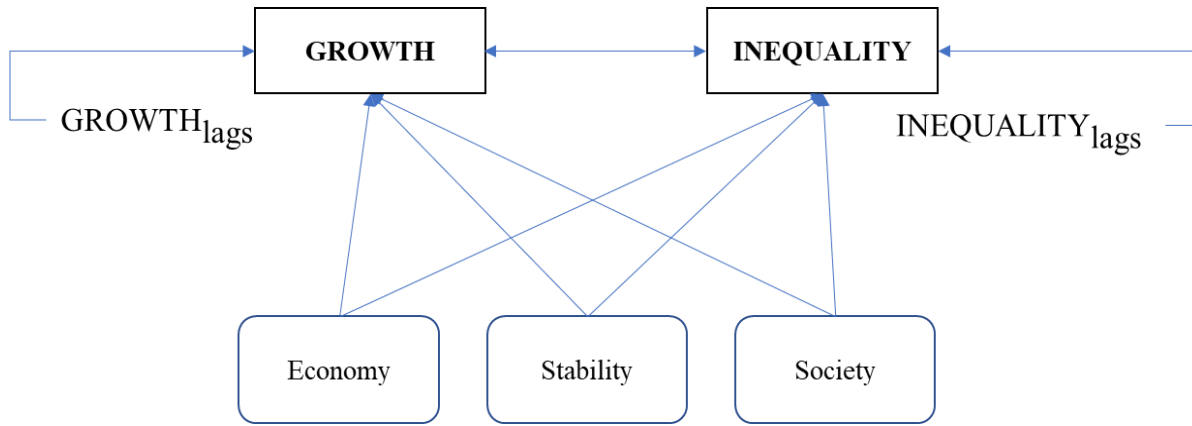


Figure 1. The analytical framework

ECON = trade, FDI, and technology; *SOCI* = domestic credit, human capital, and fertility; *STAB* = unemployment and inflation; *lags* = the past values.

The variables in this study were defined and taken from World Bank and Penn World Table, as shown in Table 1. The ‘ECON’ group is inspired by studies on the trade-offs between growth and equality (Jaumotte, Lall, and Papageorgiou 2013; Furceri and Ostry 2019; Asteriou, Dimelis, and Moudatsou 2014). According to Davis and O’Halloran (2018), technological change is an integral part of globalisation in the era of the Fourth Industrial Revolution 4.0, driving a ‘new phase of globalisation – globalisation 4.0.’ Therefore, in this study, we use two-way interactive terms between trade, FDI, and technology to represent the interplay between globalisation and technology. The ‘SOCI’ group is drawn from transmissive channels that convey the impact of inequality on growth, including *domestic credit* (Furceri and Ostry 2019; Jaumotte, Lall, and Papageorgiou 2013), *human capital* or education (Berg et al. 2018; Brueckner, Dabla Norris, and Gradstein 2015; Perotti 1996; Piketty 2014), and *fertility* (Berg et al. 2018; Perotti 1996). In addition, the relationships between market credit imperfection and human capital (Chambers and Krause 2010; Ranjan 2001) and between parental fertility and children’s education (Ahituv 2001; Moav 2004) are also included in this study. Finally, the ‘STAB’ group (not the focus of this study) consists of two variables: *unemployment* (Furceri and Ostry 2019; Heimberger 2020) and *inflation* (Castelló-Climent 2010; Furceri and Ostry 2019; Gravina and Lanzafame 2021), and their interactive term in line with the Phillips curve (Phillips 1958).

Table 1. Variable definitions and data source

Variable	Measure	Source
Dependent Variables		
Inequality	Gini index (World Bank estimate)	World Development Indicator
GDPPC	GDP per capita (constant 2015 US\$)	World Development Indicator
‘ECON’ Group		
Trade	Trade, the sum of exports and imports (% of GDP)	World Development Indicator
FDI	Foreign direct investment, net inflows (% of GDP)	World Development Indicator
Technology	Total factor productivity level at current PPPs	Penn World Table version 10.0
‘SOCI’ Group		
Domestic credit	Domestic credit to the private sector (% of GDP)	World Development Indicator
Human capital	Years of schooling and returns to education	Penn World Table version 10.0
Fertility	Calculated based on the total population growth	World Development Indicator
‘STAB’ Group - not the focus of this study		
Unemployment	Unemployment rate (modelled ILO estimate)	World Development Indicator
Inflation	Inflation, consumer prices (annual %)	World Development Indicator

Notes: All variables are log-transformed; GDP = gross domestic product; FDI = foreign direct investment; ILO = international labour organisation; PPP = Purchasing power parities

Notably, despite the fact that institutional factors are the primary determinants of the relationship between economic growth and social inequality, they are not included in the estimation model of this study. First, institutional factors are endogenous between inequality and growth (Davis and Hopkins 2011), as well as between physical capital and human capital (Galor, Moav, and Vollrath 2009; Wigton-Jones 2020). This is the primary reason for developing a system of two parallel equations for the inequality-growth relationship (as illustrated below), which reduces the risk of omitting socio-political factors (such as institutions) that moderate the interaction between inequality and growth. Second, institutions establish sociopolitical stability (Chong and Gradstein 2007; Hoff and Stiglitz 2004; Sonin 2003) by fostering interaction between socioeconomic variables in the model. As a result, the addition of institutional variables to the model exacerbates the issue of multicollinearity, as they likely correlate with all other variables. In addition, different institutional characteristics across countries may be included in the country-specific effects, which are already accounted for in the estimation model. Finally, the lack of long-term data prevents the inclusion of institutional variables in cross-country cross-time studies (Adrián Risso and Sánchez Carrera 2019).

In terms of measuring technology, while most recent studies use R&D expenditures, the number of patents, or internet subscriptions as indicators of technological change, we use TFP in accordance with classical economic theories because those measures are insufficient to include all types of technological changes. TFP measures the proportion of aggregate output that cannot be

explained by economic inputs such as labour and capital. Despite the fact that TFP is not a perfect indicator of technological change (Lipsey and Carlaw 2004), it is a good indicator of innovation. Innovation and technological progress are frequently equated, but there is a distinction that must be acknowledged. Schumpeter (2013) defines innovation as the continuous transformation of production, the creation of the new and the destruction of the old, thereby altering the national economic structure. A technological change is only considered innovative if it generates micro- or macro-economic growth, and innovation does not necessarily involve technological change. According to Mairesse and Mohnen (2001), innovation is a ‘parallel’ concept to TFP. Therefore, ‘technology’ in this study is close to ‘innovation’. Because the term ‘technology’ is more prevalent and understandable, we continue to employ it throughout the remainder of the paper.

3.2. How to answer all research questions

$$GDPPC_{it} = \beta_0 + \beta_1 ECON_{it} + \beta_2 SOCI_{it} + \beta_3 STAB_{it} + \mu_i + \epsilon_{it} \quad (1a)$$

$$Inequality_{it} = \beta_0 + \beta_1 ECON_{it} + \beta_2 SOCI_{it} + \beta_3 STAB_{it} + \mu_i + \epsilon_{it} \quad (1b)$$

The research question Q1 can be answered by establishing a two-equation system #1, consisting of endogenous variables whose residuals are assumed to be intercorrelated. This system of equations includes dependent variables (growth and inequality), explanatory variables (groups of variables mentioned above), fixed effects μ_i , and error terms ϵ_{it} . Accordingly, Seeming Unrelated Regression (SUR), combined with country-specific terms, is the most appropriate method for this research model. To robust the estimate, we perform the Breusch-Pagan test of independence to test the hypothesis of the correlation between the residuals of two equations and the Wald test for the validity of fixed effects in the model. However, SUR treats all explanatory variables as exogenous variables in the system of equations, which would no longer be appropriate if including inequality in the GDPPC equation or vice versa as per the PVAR results. Therefore, the SUR model should be replaced by Conditional Mixed-Process (CMP), which also fits SUR for simultaneous equation systems but can address endogeneity and heteroskedasticity (Roodman 2011). To integrate with my cross-time cross-country study, we add two-way fixed effects into the equation systems and obtain robust standard errors clustered by country.

$$ISG = \frac{Growth * Inequality_{lagged}}{Inequality} = Growth \left(1 - \frac{\Delta Inequality}{Inequality} \right) \quad (2)$$

$$ISG_{it} = \beta_0 + \beta_1 ECON_{it} + \beta_2 SOCI_{it} + \beta_3 STAB_{it} + \mu_i + \eta_{it} \quad (3)$$

To answer the research question Q2, we define a new indicator called ‘inequality-stabilising growth’ (ISG) in comparison with ‘normal’ growth to see the trade-off between economic growth and

social equality. The ISG represents the association between inequality changes in proportion and economic growth (the middle part of equation #2) or the trade-off of partial growth for increased inequality (the right-hand part of equation #2). To calculate ISG, inequality-increasing growth is subtracted from the overall growth while inequality-reducing growth is added. To compare the impact of explanatory variables on these two kinds of growth, we build the estimate equation #3 for the cross-country cross-time estimation, including fixed-effects μ_i and error term η_{it} . Due to the short panel regression ($T < N$), it is advisable to run a test for cross-sectional dependence (De Hoyos and Sarafidis 2006). Pesaran (2021) states that only a strong correlation between panels causes serious estimation errors. In addition, Sarafidis and Robertson (2009) demonstrated that short dynamic panel estimators with ‘instrumental variables’ or ‘generalised method of moments’ would suffer in case of spatial dependence in disturbance because of invalid instruments. Thus, after performing the test and detecting cross-sectional dependence, we consider employing the fixed-effects Driscoll–Kraay estimator for my short panel data, which allows temporally spatially dependent and heteroskedastic residuals (Hoechle 2007).

3.3. How to address estimation problems

As shown in the ‘Literature review,’ there is expectedly interdependence among regressors; thus, multicollinearity is unavoidable. In order to mitigate strong multicollinearity and achieve the ‘clarified’ coefficients, we use the mean-centring technique for all explanatory variables according to the study by (Iacobucci et al. 2017; Iacobucci et al. 2016). Accordingly, this technique is not intended to reduce the multicollinearity between original variables or to modify the overall parameters of the whole estimation model but to help clarify the impact coefficients of single variables in the presence of their interaction terms. Therefore, we need to perform tests for collinearity before estimating (see Table 2) and attempt to limit pairwise correlation coefficients between regressors less than 0.4 or weak correlation, according to Dancey and Reidy (2004) (see Table 3). Because of the strong collinearity between Trade and FDI, we cannot separate their impacts but lump them together to consider the impact of globalisation in general. To demonstrate the interaction between globalisation and technology, we add interactive terms between technology and trade and between technology and FDI to the models. Accordingly, the total coefficient of these two terms is considered the conjugate effect between globalisation and technology. Similarly, the interaction between the three social variables (domestic credit, human capital, and fertility) leads to bias problems if including their original values in the model; thus, we aim to retain ‘domestic credit’ (representing the relationship between finance and physical capital), ‘domestic credit’ x ‘human capital’ (the transmissive channel of financial development to education), and ‘human capital’ x ‘fertility’ (the trade-off between parental fertility

and children education). In addition, we add the unemployment–inflation interaction to represent their relationship in the Phillips curve. One should be noted that explanatory variables in this study are mean-centred, and their interaction terms would be formed after this process. Furthermore, to compare the magnitude of the impacts, all research variables (including dependent variables) are log-transformed prior to mean-centring; the standard errors of the estimation coefficient are also cluster-robust to address the problem of heteroskedasticity.

Table 2. The correlation matrix with original values

		A	B	C	D	E	F	G	H
Trade	A	1.00	0.44	0.14	0.34	0.36	-0.14	-0.17	0.04
FDI	B	0.44	1.00		0.26	0.34	-0.13	-0.14	0.08
Technology	C	0.14		1.00	0.39	0.23	-0.20	-0.12	0.16
Domestic credit	D	0.34	0.26	0.39	1.00	0.68	-0.42	-0.21	0.07
Human	E	0.36	0.34	0.23	0.68	1.00	-0.56	-0.08	0.25
Fertility	F	-0.14	-0.13	-0.20	-0.42	-0.56	1.00	0.05	-0.23
Inflation	G	-0.17	-0.14	-0.12	-0.21	-0.08	0.05	1.00	
Unemployment	H	0.04	0.08	0.16	0.07	0.25	-0.23		1.00

Notes: display only with p -value < 0.05 ; the correlation sizes above 0.4 are highlighted; all variables in log-transformed.

Table 3. Correlation matrix after mean-centring

		A'	B'	C'	D'	E'	F'	G'	H'	I'	J'
Technology	A'	1.00		-0.12	-0.09	0.39	0.10	-0.07	-0.12	0.16	
Trade x FDI	B'		1.00	0.28	0.15	0.06	0.20			-0.04	
FDI x Technology	C'	-0.12	0.28	1.00	0.38		0.12		-0.04	-0.14	
Trade x Technology	D'	-0.09	0.15	0.38	1.00	-0.11	0.09		-0.03	-0.26	0.12
Domestic credit	E'	0.39	0.06		-0.11	1.00	-0.03	-0.07	-0.21	0.07	0.05
Human x Credit	F'	0.10	0.20	0.12	0.09	-0.03	1.00	-0.30	-0.05	-0.11	-0.05
Human x Fertility	G'	-0.07				-0.07	-0.30	1.00	0.03	-0.08	0.07
Inflation	H'	-0.12		-0.04	-0.03	-0.21	-0.05	0.03	1.00		-0.23
Unemployment	I'	0.16	-0.04	-0.14	-0.26	0.07	-0.11	-0.08		1.00	-0.12
Inflation x Unemp.	J'				0.12	0.05	-0.05	0.07	-0.23	-0.12	1.00

Notes: display only with p -value < 0.05 ; correlation sizes above 0.4 are highlighted; log-transformation, then mean-centring, and finally cross-product.

4. Results and discussions

4.1. The growth-inequality nexus: what matter?

As shown in Table 4, the singular technology (deemed as domestic technology) is beneficial to the economy and society, with growth-stimulating effects (with a magnitude of 0.335 ± 0.068 at the 1% significance level) and inequality-reducing effects (with a magnitude of 0.062 ± 0.032 at 10% significance level), and this statement still holds for CMP2 and CMP3 (which are both variable-

modified) with negligible difference compared to CMP1 though. Unsurprisingly, the outcomes show that technology is the engine of growth; however, its negative relationship with inequality deserves more attention. Recent research by Biurrun (2020) in EU countries demonstrates the negative association between innovation and income inequality. Supporting the Schumpeterian hypothesis that technological change is significantly negative to income inequality, Antonelli and Gehringer (2017) argued that the higher inequality, the stronger the inequality-alleviating effect is. Another cross-time cross-country research in 74 countries over the period 1996-2014 also found the beneficial effects of innovation on narrowing the income gap only if the level of innovation is large enough (Adrián Risso and Sánchez Carrera 2019). In short, domestic technological development is good for growth but not detrimental to equality and even may lead to reduced inequality despite little evidence for this socially beneficial effect.

Table 4. Which factors impact the growth-inequality link?

	CMP1		CMP2		CMP3	
	GDPPC	Inequality	GDPPC	Inequality	GDPPC	Inequality
Modelling						
Inequality			-0.086 (0.171)		-0.101 (0.181)	
Technology	0.335*** (0.068)	-0.062* (0.032)	0.357*** (0.073)	-0.061* (0.032)	0.355*** (0.072)	
Trade x FDI	0.007 (0.007)	0.001 (0.005)	-0.000 (0.009)	0.002 (0.004)	-0.000 (0.009)	
Technology x FDI	0.009 (0.012)	-0.014*** (0.004)	0.016 (0.010)	-0.014*** (0.004)	0.015 (0.011)	
Technology x trade	-0.283*** (0.098)	-0.029 (0.052)	-0.184** (0.079)	-0.030 (0.052)	-0.184** (0.079)	
Domestic credit	0.016 (0.032)	-0.020 (0.015)		-0.020 (0.015)		-0.021 (0.014)
Human x Credit	0.170** (0.069)	0.057 (0.039)		0.063* (0.037)		0.077** (0.034)
Human x Fertility	-0.056* (0.029)	0.002 (0.015)		0.000 (0.014)		0.001 (0.015)
Inflation	-0.039 (0.041)	0.048*** (0.013)	-0.024 (0.028)	0.048*** (0.012)	-0.023 (0.028)	0.044*** (0.015)
Unemployment	-0.084** (0.041)	0.000 (0.014)	-0.099*** (0.027)	0.001 (0.014)	-0.099*** (0.027)	0.012 (0.013)
Inflation x Unemployment	-0.126 (0.140)	-0.413*** (0.082)	-0.108 (0.141)	-0.413*** (0.082)	-0.113 (0.138)	-0.297*** (0.095)
Combined effects						
Technology	0.061 (0.078)	-0.104** (0.053)	0.188** (0.085)	-0.105** (0.053)	0.186** (0.081)	
Globalisation	-0.267*** (0.095)	-0.041 (0.049)	-0.169** (0.078)	-0.042 (0.049)	-0.169** (0.077)	
Domestic credit	0.186*** (0.072)	0.036 (0.027)		0.042* (0.025)		0.056** (0.025)
Education	0.114* (0.068)	0.059 (0.040)		0.063 (0.039)		0.078** (0.038)
Observations	2066		1215		1363	

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Two-way fixed effects and constants are not reported; Cluster-robust standard errors; estimation method = Conditional Mixed-Process.

Technology spillover through globalisation on the studied relationship may be respectively uncondusive to growth (via international trade with a size of -0.283 ± 0.098 at the 1% significance level) and curbing inequality (via foreign investment with a size of -0.014 ± 0.004 at the 1% significance level). The negative effect of trade openness on growth is initially documented by Ramzan et al. (2019) and Kim, Lin, and Suen (2011), and Madsen (2009), who all ultimately report a nonlinear pattern that openness is harmful to less-developed countries yet positive to well-developed ones, and TFP moderates this heterogeneous effect. To support this phenomenon, we plot the correlation between trade openness, TFP, and Trade x TFP with GDP per capita. As illustrated in Figure 2, the nonlinearity of the openness-growth relationship and trade openness x TFP is proven. The cause behind this phenomenon, as hypothesised by Kim (2011) and Ramzan et al. (2019), is the weak absorptive capacity (formed by human capital and R&D) which prevents the benefits from foreign technology and thus harms growth. These findings raise the importance of absorptive capacity development as previously documented (Danquah 2018; Lin, Qin, and Xie 2021; Mowery and Oxley 1995).

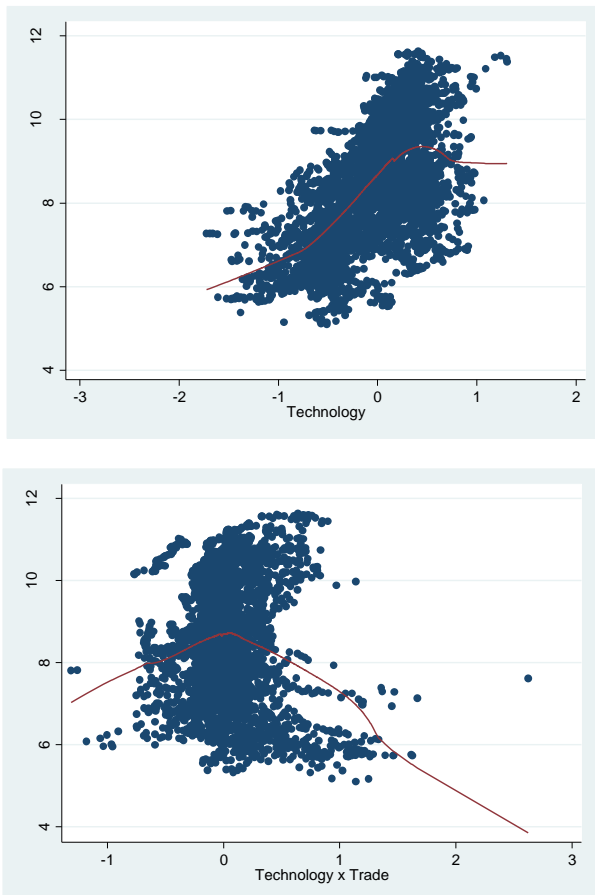


Figure 2. The relationship between trade and TFP with GDP per capita

Data source: World Bank and Penn World Table

In addition to the non-harmful effect of domestic technology, technology generally does not lead to increased inequality; furthermore, some evidence of a negative relationship between FDI and inequality in Turkey (Ucal, Haug, and Bilgin 2016) and the US (Chintrakarn, Herzer, and Nunnenkamp 2012) can be attributed to TFP spillovers. Investigating inward FDI and wage inequality in over 100 countries over 22 years, Figini and Görg (2011) presented a nonlinear effect in non-OECD countries, the positive relationship at an early stage, and then becomes negative as FDI increases. In conclusion, technology does not harm social equality; despite that, this finding should be interpreted with caution because ‘technology’ under this study is measured by TFP, which is close to ‘innovation.’ The outcome difference due to measurement is attested previously by Richmond and Triplett (2018), who pointed out that the opposite direction of technology on inequality is attributed to two different measures: fixed broadband subscriptions (positive effect) and mobile subscriptions (negative effect).

When including inequality in CMP2 and CMP3, we interestingly found that the aggregate effect of technology on growth becomes considerable and significant (with a size of 0.188 ± 0.085 in CMP2 and 0.186 ± 0.081 in CMP3). This finding, along with the insignificance of the combined effects of technology in CMP1, motivates us to investigate its importance to the studied relationship. The model with the constraint of no technology (as illustrated in Table 5) shows considerable volatility in terms of the magnitude and significance of estimated coefficients. All coefficients of the GDPPC equation become insignificant (yet their signs are primarily unchanged), while the inequality equation remains somewhat stable. This evidence confirms that technology does have spillover effects on growth not only via globalisation but also via social channels, and these effects support but do not resist such social policies (due to the unchanged effect directions). Indeed, Miller and Upadhyay (2000) showed that human capital is positively associated with TFP generally in less-well-off economies in the case of accompanying openness. In addition, domestic credit is also related to technology in two cases: (1) for individuals, a shortage of loans for human capital development can hinder interclass mobility for the poor and can ‘quell’ ground-breaking ideas (or innovation) for economic development (Foellmi and Oechslin 2010, 2020); (2) for enterprises, the limitation on borrowing capital hinders the innovation process in production and business, which in turn may hinder economic growth later (Banerjee and Newman 1993).

Table 5. How important are technology and globalisation for the studied relationship?

	CMP1		Technology		Globalisation	
	GDPPC	Inequality	GDPPC	Inequality	GDPPC	Inequality
Technology	0.335*** (0.068)	-0.062* (0.032)			0.318*** (0.059)	-0.062* (0.034)
Trade x FDI	0.007 (0.007)	0.001 (0.005)	0.007 (0.010)	-0.002 (0.005)		
Technology x FDI	0.009 (0.012)	-0.014*** (0.004)				
Technology x trade	-0.283*** (0.098)	-0.029 (0.052)				
Domestic credit	0.016 (0.032)	-0.020 (0.015)	0.043 (0.030)	-0.017 (0.014)	0.035 (0.031)	-0.013 (0.014)
Human x Credit	0.170** (0.069)	0.057 (0.039)	0.098 (0.075)	0.044 (0.037)	0.130* (0.071)	0.038 (0.036)
Human x Fertility	-0.056* (0.029)	0.002 (0.015)	-0.036 (0.035)	0.002 (0.015)	-0.067** (0.033)	0.005 (0.015)
Inflation	-0.039 (0.041)	0.048*** (0.013)	-0.038 (0.041)	0.048*** (0.014)	-0.026 (0.035)	0.046*** (0.013)
Unemployment	-0.084** (0.041)	0.000 (0.014)	-0.070 (0.047)	0.004 (0.015)	-0.083** (0.042)	0.003 (0.014)
Inflation x Unemp.	-0.126 (0.140)	-0.413*** (0.082)	0.022 (0.145)	-0.414*** (0.088)	-0.049 (0.130)	-0.393*** (0.088)
Observations	2066		2066		2066	

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$; Two-way fixed effects and constants are not reported; Cluster-robust standard errors; estimation method = Conditional Mixed-Process; the first row (CMP1, Technology, Globalisation) respectively indicates the original model without constraint; that with the constraint of no technology; and that with the constraint of no globalisation.

Meanwhile, the direct impact of globalisation (Trade and FDI) is minimal and insignificant to the growth-inequality link despite its indirect effect via technology channel, as discussed above. Like that of technology, the overall effect of globalisation shrinks in size when including inequality in the model (from -0.267 ± 0.095 in CMP1 to -0.169 ± 0.078 in CMP2). we found that trade negatively damages growth (-0.283 ± 0.098 at the 1% significance level in CMP1) while FDI indirectly reduces inequality (-0.014 ± 0.004 at the 1% significance level in CMP1). Comparing the indirect impact size of trade and FDI, international trade has a more pronounced impact than FDI in conveying the impact of technology. Indeed, trade is considered a vital channel (Coe, Helpman, and Hoffmaister 1997; Coe and Helpman 1995) or the primary determinant (Danquah, Moral-Benito, and Ouattara 2014) of technology spillovers. Recent research by Pietrucha and Żelazny (2020) also corroborated this claim with an empirical study in 41 OECD countries during the period 1995-2014; it showed that both FDI and Trade (Import and Export) are the main channels of TFP spillovers, but the export channel is the dominant one. Furthermore, the role of technology trade was also previously emphasised in the innovation process of the economy (Spulber 2008).

When inequality and growth are intercorrelated in CMP1, domestic credit and education both affect growth (with a magnitude of 0.186 ± 0.072 at the 1% significance level and of 0.114 ± 0.068 at

10%, respectively) more considerably and significantly than inequality (with a magnitude of 0.036 ± 0.027 and 0.059 ± 0.040 , respectively). Education mainly contributes to the positive effect of the ‘SOCI’ group on growth, while fertility is responsible for the negative impact. Indeed, studying inclusive growth in the case of Zambia, Ianchovichina and Lundström (2009) suggests that raising the level of education for the poor plays an essential role in future growth. Education is a ‘key lever of sustainable development’ (Piece 2012) or promoting inclusive growth (Busemeyer 2017). Research by Rehme (2007) shows that the simultaneous impact of education on growth and inequality is nonlinear, i.e., the increase in education may initially have a positive impact but then become negative. The negative effect of fertility is further discussed below.

In case inequality is presented in lieu of the effects of the ‘SOCI’ group on GDPPC in CMP2 and CMP3, the channelling-via-inequality role of domestic credit and education begin to be more obviously adverse to social equality in term of size and significance (domestic credit with a magnitude of 0.042 ± 0.025 at the 10% significance level in CMP2), significantly when restraining the impact of ‘ECON’ group on inequality (domestic credit with a magnitude of 0.056 ± 0.025 and education with a magnitude of 0.078 ± 0.038 both at 5% significance level in CMP3). The leading cause of this effect is education, which implies that if schooling is not an engine of growth, it threatens social balance. This finding sounds paradoxical, yet having been proven to be accurate by Martins and Pereira (2004) and Sequeira, Santos, and Ferreira-Lopes (2017), who both pointed out that human capital (or education) causes increased inequality. To robust their findings, Martins and Pereira (2004) provided possible explanations, including over-education, schooling-ability interdependence, and differences in educational quality or fields of study, while Sequeira, Santos, and Ferreira-Lopes (2017) adopted rigorous econometric techniques addressing heterogeneity and cross-country dependence, as well as many specification adjustments. Another point should be noted that the magnitude of the negative impact of inequality (-0.101 ± 0.181 in CMP3) is correspondingly magnified though still insignificant. In short, if growth alone is concerned, or growth does not go along with social-inclusive policies, inequality may hinder future growth. According to Cook (2006), growth alone can threaten social inclusion and thus undermine future growth; government policies on public spending, social stability, and institution improvement play a vital role in sustaining growth.

4.2. What promotes inclusive growth?

As presented above, the ‘ECON’ group plays a crucial role in economic development, though their aggregate effects are significantly deductible due to the component offsetting. Notwithstanding, this group (and all its component effects) does not lead to inclusive growth (with insignificant coefficients in the estimate of ISG worldwide), as shown in Table 6 below, because of the negative

effect of technology transfer on the growth of developing countries as discussed in the previous section. As a result, the detrimental impact of globalisation on ISG (-0.278 ± 0.128 at the 5% significance level) is found only in developing countries. Meanwhile, the ‘SOCI’ group is not considered a key factor for ‘normal’ growth yet contributes largely to inequality-stabilising growth (the more considerable magnitude in the ISG-worldwide model compared with CMP1).

Table 6. Which promotes ISG?

	Growth-Inequality Link (CMP1)				Inequality-Stabilising growth (ISG)			
	GDPPC		Inequality		Worldwide		Developing	
Modelling								
Technology	0.335***	(0.068)	-0.062*	(0.032)	0.123	(0.087)	0.014	(0.085)
Trade x FDI	0.007	(0.007)	0.001	(0.005)	-0.004	(0.011)	-0.036	(0.023)
Technology x FDI	0.009	(0.012)	-0.014***	(0.004)	-0.009	(0.013)	0.079***	(0.026)
Technology x trade	-0.283***	(0.098)	-0.029	(0.052)	0.012	(0.123)	-0.320**	(0.148)
Domestic credit	0.016	(0.032)	-0.020	(0.015)	0.062	(0.075)	0.334***	(0.054)
Human x Credit	0.170**	(0.069)	0.057	(0.039)	0.399**	(0.188)	0.287	(0.185)
Human x Fertility	-0.056*	(0.029)	0.002	(0.015)	-0.039	(0.024)	-0.241***	(0.083)
Inflation	-0.039	(0.041)	0.048***	(0.013)	-0.171**	(0.071)	-0.207***	(0.050)
Unemployment	-0.084**	(0.041)	0.000	(0.014)	-0.176**	(0.073)	-0.047	(0.042)
Inflation x Unemp.	-0.126	(0.140)	-0.413***	(0.082)	-0.298	(0.607)	0.327	(0.536)
Combined effects								
Technology	0.061	(0.078)	-0.104**	(0.053)	0.126	(0.113)	-0.227	(0.185)
Globalisation	-0.267***	(0.095)	-0.041	(0.049)	-0.001	(0.118)	-0.278**	(0.128)
Domestic credit	0.186***	(0.072)	0.036	(0.027)	0.461***	(0.120)	0.620***	(0.141)
Education	0.114*	(0.068)	0.059	(0.040)	0.360*	(0.179)	0.045	(0.156)
Observations	2066		2066		575		252	
R-squared	N/A		N/A		0.325		0.676	

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Developing = low- and middle-income nations under World Bank classification; Two-way fixed effects and constants are not reported; Cluster-robust standard errors; estimation method of CMP1 = Conditional Mixed-Process and that of ISG = the fixed-effects Driscoll–Kraay estimator for short panel data.

We found some markable disparities when comparing worldwide and developing nation datasets for ISG estimates. Firstly, the opposite direction of foreign technology is presented via international trade and foreign investment, though altogether (in addition to trade x FDI) reporting the negative indirect impact of globalisation on inequality-stabilising growth (-0.001 ± 0.118 without insignificance for worldwide), especially in poor nations (-0.278 ± 0.128 at 5% significance level for developing countries), suggesting technology transfer from well-developed nations to less well-off nations, which harms ISG of the poor countries. This finding is in line with the nonlinear relationship between trade openness and economic growth, moderated by the level of domestic TFP (Ramzan et al. 2019; Kim, Lin, and Suen 2011; Madsen 2009). Whether globalisation 4.0 is detrimental to socioeconomic development depends on the national absorptive capacity, as discussed in the previous section. This outcome challenges the notion that technology and globalisation are mainly responsible for inequality-inducing growth.

Secondly, domestic credit and education alternately promote ISG at different stages of development; specifically, domestic credit ('singular' domestic credit: 0.334 ± 0.054 at 1% significance level at developing country dataset) at the early stages and education (human x credit: 0.399 ± 0.188 at 5% significance level at worldwide dataset) at higher levels of development. The 'combined effects' also demonstrate the reallocation of the contribution of domestic credit to ISG (from 0.620 ± 0.141 to 0.461 ± 0.120 at the 1% significance level), which is partially transferred to education (0.360 ± 0.179 at 10% significance level). This argument is related to the theory of the driving roles of capital factors at different stages of development (Galor and Moav 2004). At an early stage (or in developing countries), physical rather than human plays a crucial role in stimulating growth – and in this study, domestic credit somewhat represents physical capital, separated from human capital in the model. At a higher stage of development, human capital plays a more critical role in economic development, primarily reflected in the positive impact of investment in education through domestic credit under this study.

Finally, fertility is reportedly negative to ISG for poor countries rather than worldwide. As a result, fertility (coupled with education) stunts growth (-0.056 ± 0.029 at the 10% significance level in CMP1) and increases inequality (0.002 ± 0.015 without insignificance in CMP1), and thus to the detriment of ISG for developing countries (-0.207 ± 0.050 at 1% significance level). The negative impact of the interactive term between education and fertility on two types of economic growth (as well as its offset effects on the education–domestic credit intercorrelation) demonstrates the trade-offs between fertility and education (Ahituv 2001; Moav 2004). A recent study by Bucci and Prettnner (2020) provides evidence that higher productivity growth is associated with higher human capital and lower fertility rates.

5. Conclusions

Globalization has long been recognized as a strategy that leads to uneven global growth (Stiglitz, 1996), often resulting in increased social polarization and income inequality (Bourguignon, 2015; Lakner & Milanovic, 2013; Milanovic, 2016). In light of the growing discussions on degrowth and deglobalization, particularly in the context of climate change (James, 2018; Samerski, 2018), there is a heightened need for policy scholars to explore pathways to inclusive growth (Cerra et al., 2021). This study has therefore sought to identify drivers of inclusive growth in the context of globalization 4.0, aiming to provide actionable insights for policymakers. A key outcome of our research is the development of the 'Inequality-Stabilizing Growth' indicator, which effectively measures economic growth while controlling for increases in inequality. To address critical estimation challenges, our methodology included the use of mean-centering to manage micro-multicollinearity, cluster-robust

standard errors for heteroscedasticity, simultaneous-equation models for endogeneity, and fixed-effects models for temporal-spatial dependencies in our time-series cross-sectional analysis.

Our findings reveal a complex picture of technology's impact on social equality. Contrary to common assumptions, technology, as measured by Total Factor Productivity (TFP), does not inherently undermine social equality and may even contribute to reducing inequality, although the evidence for its positive social impact remains limited (Biurrun, 2020; Antonelli & Gehringer, 2017). However, caution is necessary in interpreting these results, as the influence of technology varies based on the indicators used to measure technological changes and the levels of innovation. For instance, Richmond and Triplett (2018) found that while both fixed broadband and mobile subscriptions are indicators of technological progress, they have opposing effects on income inequality; increased fixed broadband subscriptions are linked to greater income inequality, whereas more extensive mobile subscriptions correlate with reduced income inequality.

Furthermore, our study highlights threshold effects where the benefits of innovation in reducing inequality only materialize beyond a certain level of innovation intensity (Adrián Risso & Sánchez Carrera, 2019). Additionally, we found that technology influences growth not only via globalization but also through social channels, particularly through factors such as domestic credit (Foellmi & Oechslin, 2010, 2020; Banerjee & Newman, 1993) and human capital (Miller & Upadhyay, 2000). These insights underscore the complexity of the technology-inequality-growth nexus and the importance of considering various dimensions and thresholds of technological progress.

Although globalization, in the forms of international trade and Foreign Direct Investment (FDI), exerts a considerable indirect effect through technology channels, our study finds that its direct impact on the growth-inequality relationship is relatively minor and not statistically significant. When comparing the indirect effects of trade and FDI, international trade emerges as having a more substantial role than FDI in mediating technology's impact, as indicated by the findings of Pietrucha and Żelazny (2020) and Spulber (2008). Moreover, our research reveals that while technology transfer benefits inclusive growth in highly developed countries, this benefit is not consistently observed in less-developed countries. The positive effects of globalization 4.0, such as technology absorption, are contingent upon a country's Total Factor Productivity (TFP) being sufficiently high. This highlights the critical role of human capital and research and development investments in enhancing a nation's capacity to effectively assimilate foreign technology, as suggested by Kim (2011) and Ramzan et al. (2019). Saggi (2002) further underscores the importance of these factors in building national absorptive capacity.

Consistent with previous research (Ianchovichina and Lundström, 2009; Pierce, 2012; Busemeyer, 2017), our findings affirm that education generally has a positive impact on growth. However, this does not automatically imply that education always contributes to inclusive growth. Echoing Rehme (2007), our study observes that increases in education can initially drive both growth and income inequality upwards, followed by a subsequent decrease in these factors. Intriguingly, we also note that in scenarios where education does not function as a growth catalyst, it can potentially disrupt social equilibrium. This seemingly paradoxical outcome is supported by empirical evidence from Martins and Pereira (2004) and Sequeira, Santos, and Ferreira-Lopes (2017).

A possible explanation for this phenomenon could be the issue of ‘over-education,’ where the level of education exceeds the requirements of the job market. This situation, potentially coupled with disparities in educational quality, fields of study, or the interplay between schooling and ability, can lead to unintended consequences in the growth-inequality dynamic (Martins and Pereira, 2004). These findings underscore the need for a nuanced understanding of the role of education in promoting both economic growth and social inclusivity.

In line with the theoretical framework proposed by Galor and Moav (2004), our findings indicate that domestic credit and education play alternating roles in fostering inclusive growth at different stages of development, akin to the expansion of ‘physical capital’ and ‘human capital,’ respectively. In the early stages of development, typically observed in developing countries, it is physical capital, often facilitated by domestic credit, that is more crucial for spurring growth. Conversely, in more advanced stages of development, human capital, augmented through education, becomes increasingly vital for economic progress. This transition underscores the evolving significance of different types of capital across development stages.

Additionally, our study reveals that fertility has a distinctly negative impact on inclusive growth in less affluent countries. This finding highlights the complex trade-offs between fertility and education, as evidenced by research from Ahituv (2001), Moav (2004), and Bucci and Prettnner (2020). It suggests that higher fertility rates can impede the potential benefits of education and economic development in these regions, thereby posing challenges to achieving inclusive growth.

In summary, our study underscores that focusing solely on economic growth, without integrating social-inclusive policies, may lead to increased inequality that can, in turn, impede future growth. Echoing Cook (2006), we advocate for the incorporation of socially inclusive policies — such as increased public spending, enhanced social stability, and institutional improvements — alongside

growth strategies to achieve sustainable and equitable development. Technology emerges from our study as a potent catalyst for growth. While it does not directly ensure inclusive growth, it exerts significant spillover effects through various social channels.

Our findings highlight that domestic credit and human capital are instrumental in fostering inequality-stabilizing growth, though their roles vary across different stages of national development. In poorer countries, strategies for inclusive growth should be carefully designed, potentially including fertility control measures to mitigate any regressive impacts. Promoting social mobility, which is pivotal in reducing inequality (Wienk, Buttrick, & Oishi, 2022), should be a central aim of these strategies. Ultimately, this study contributes to a deeper understanding of how various factors — technological, economic, and social — interplay in the pursuit of inclusive growth.

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