Zoaka and Güngör *Financial Innovation* (2023) 9:1
https://doi.org/10.1186/s40854-022-00397-8

Financial Innovation

REVIEW

Open Access

Effects of financial development and capital accumulation on labor productivity in sub-Saharan Africa: new insight from cross sectional autoregressive lag approach

Joshua Dzankar Zoaka* and Hasan Güngör

*Correspondence: jozoks69@gmail.com

Department of Economics, Faculty of Business and Economics, Eastern Mediterranean University, Famagusta, North Cyprus

Abstract

This study aims to shed light on the effects of financial development and accumulation of capital on the productivity of labor in the sub-Sahara African region within the period of 1990–2018. In this work, we used the (dynamic) common correlated effects estimator-mean group and additional techniques such as cross-section autoregressive distributed lag to calibrate the sample into the African subregion to ensure robustness. The findings reveal that financial progress in the region over time leads to an increase in productivity of labor and also the accumulation of capital. Furthermore, financial markets have a progressive impact on the productivity of labor within sub-Saharan African regions. We extend the very limited literature on the nexus between financial development and labor productivity by incorporating capital accumulation into our model which has not been previously studied.

Keywords: Productivity of labor, Financial development, CS-ARDL, Capital accumulation, Sub-Saharan Africa

Introduction

Without a well-operating financial system, economic activities cannot be conducted effectively. Consequently, theoretical literature asserts that the financial sector precedes economic progress (Hirono 2021; Asongu 2020; Bernier and Plouffe 2019). This study is novel and contributes to literature, as it is among the few or even the first that has endeavored to examine the connection between capital accumulation (CAPTA) and financial development (FD) and labor market outcomes with an emphasis on Sub-Saharan Africa (SSA). FD refers to the improvement in the number, value, and effectiveness of financial intermediate services. Based on this definition, some theoretical opinions have been established connecting FD to labor market outcomes in an economy and vice versa. Generally, the connecting channels are anticipated to be the means of investment and savings. Nevertheless, no specific theoretical framework has been established to forecast the nature of employment in relation to financial institution (FI) and FD.

Our research also contributes to the growing understanding of the diversity of the labor market and the importance of FD and FI toward a reduction in the rate of unemployment. In deliberation of the next segment, the development, employment, and unemployment levels are expected to function from diverse frequencies, and the net effect is likely to be uncertain. Although our study originally aims to conduct estimations beyond the 1990–2018 study period, it is impossible due to incomplete data for some of the variables in some countries.

Some researchers have drawn alternative conclusions from some well-established findings, implying that market credit failures may play an important role in the collective concepts of dynamic operations involving labor and divergent investment flows. Our research is unique in that it uses conventional theory to investigate the relationships between FD, CAPTA, and labor productivity (Fontaine et al. 2020; Iheonu et al. 2020; Ssozi and Asongu 2016).

Our study has two further interesting elements: first, a large sample of SSA countries is utilized, as estimations are performed for all 39 SSA countries and each subregion (South Africa, West Africa, East Africa, and Central Africa). Doing so ensures the robustness of our findings. Second, to obtain the empirical output, our study employs the (dynamic) common correlated effect estimator–mean group (CCEE-MG) through cross-section autoregressive distributed lag (CS-ARDL), second-generation unit root test, panel dynamic ordinary least square (PDOLS), and fully modified ordinary least square (FMOLS) estimation techniques. This method allows the heteroscedasticity and endogeneity problems to be solved, which are common issues associated with micro panel data. To the best of our knowledge, this method has not been utilized by previous studies in the context of SSA. Additionally, FI and other institutions are largely underdeveloped within the SSA region.

The remainder of the paper is structured as follows: Sect. 2 gives an overview of the reviewed literature. Section 3 contains the data description and methodology. Section 4 presents and discusses the observed results. Section 5 provides the conclusion and policy inferences.

Literature review

Empirical review

Impacts of FD and FI on labor productivity

Insignificant attention has been paid in recent literature to FD impression, labor productivity, and its impact on employment. Nonetheless, existing empirical studies have thoroughly examined the impending breaks mediating the nexus between FD and labor productivity. Ibrahim and Alagidedeb (2018), Atiase et al. (2019), and Chao et al. (2021) examined the influence of finance on job creation, which explains the preliminary level of percapita income, human capital in nations, and FD for 29 African nations within the SSA region over the 1980–2014 period by applying the verge estimation and sample splitting technique. Their results indicated that FD is positively and significantly connected with economic development. However, the findings and policy implications drawn from the conclusion revealed that an increase in the FD level is essential in the long run besides the general levels of human capital and income, which is extremely important.

Other previous studies carried out on FI applied the variance decomposition VAR method and another causality test, which assumes that the existence of FI aids in promoting trade and commercial activities within the economy where linear correlation exists and activities are normally distributed. However, such an assumption is contrary to others because of the weakness in their financial system, whereby the reappearance of FI does not observe the normal distribution aspect. Therefore, a nonlinear connection tends to appear among FI (Hong et al. 2021; Li et al. 2018). Bernier and Plouffe (2019) studied the development spending in the financial sector and financial innovation research using a panel of 23 countries during the 1996–2014 period. The results validated a net positive correlation between gross capital formation (GCF) and financial innovation.

According to Sarwar et al. (2020), the relationship between FD and human capital development is significant and positive in developing economies. Barucca et al. (2021) and Shahbaz et al. (2011) examined the relationship between FI, output, and the unindustrialized sector in Pakistan using the Cobb–Douglas production function, which incorporates FD as the central production factor, for the period from 1971 to 2011. To examine the long-run relationships among the variables, the ARDL bounds test technique for cointegration was used. Based on their study outcomes, the researchers suggested that the government must encourage output development, particularly in the agricultural sector, to increase the effectiveness in the financial sector.

Influence of financial market (FM) and CAPTA on labor productivity

Other studies have examined associations between FM and various productivity factors, such as capital formation, productivity, and investment where the outcomes have shown that an improvement in finance and capital availability leads to an increase in investment (Joyce et al. 2020; Arcand et al. 2015). Iheonu et al. (2020) explored the influence of financial sector development on domestic investment in several ECOWAS countries. The Granger noncausality test was performed to examine for causality in the presence of cross-sectional dependence (CD), and the augmented mean group technique was used to account for country-specific heterogeneity and CD. The findings revealed that (1) the impact of financial sector development on domestic investment varies depending on the measure of the financial sector development used; (2) domestic credit to a private sector has a positive but insignificant impact on domestic investment in ECOWAS countries, whereas banking intermediation efficiency (i.e., banks' ability to convert deposits into credits) and broad money supply have negative and significant impacts on domestic investment. Our study suggests that the measure of FD used as a policy tool to encourage domestic investment should be carefully considered. We also stress the need to use country-specific domestic investment strategies rather than broad-brush initiatives. When anticipating future domestic investment, domestic lending to the private sector should take precedence.

Consequently, some recent studies on FM development with an emphasis on European countries propose that FM development can hinder inequality if further consideration is given to its development; hence, countries with FMs that are developed are considered to have better social equality than countries that have less developed financial systems (Baiardi et al. 2019). In their recent empirical studies, which propose that finance has a declining and ultimately negatively market improvement, Kou et al. (2022) and Bukhari et al. (2020) suggested that emphasis must also be placed on the positive effects of financial complexity and growth within the FMs of developing economies. Based on this evidence, questions have been raised regarding whether financial freedom may obstruct rather than guarantee a viable increase in the gross domestic product through finance, entrepreneurial process, FM, and innovation (Fonseca and Doornik 2022). Using a large sample of listed Chinese firms from 2007 to 2017, evidence shows that firms with high retail investor attention tend to have a low future stock price crash risk. Moreover, high-quality auditing can mitigate the impact of retail investor attention on the future crash risk of firms (Wen et al. 2019).

A theoretical debate has been continuing regarding the relationship between FD and human capital, technology, and labor productivity. Thus, Bosworth and Collins (2003) explained total factor productivity (TFP) and educational attainment and applied an extended structure, which includes human capital incorporation. That is, the role played by education in the Cobb–Douglas model is shown in the equation below:

$$Y_t = A_t K_t^{\alpha} \left\{ h_t L_t \right\}^{1-\alpha} \tag{1}$$

Note: $0 < \alpha < 1$,

where Y_t is the output, A_t is the TFP, K $[H_t = h_t, L_t]$, α is the share of K, h_t refers to educational attainment (human capital), and L_t means labor. Therefore, the following model is considered:

$$PL_{it} = \beta + \theta Y_{it} + \delta K_{it} + \varepsilon_{it}. \tag{2}$$

Finally, for improved economic development and performance, CAPTA and labor productivity are considered prerequisites. Other basics include growth in FI development, FM development, which transforms into an improved labor force, and technical progress along with the monetary impact (Hong et al. 2021; Asongu and Acha-Anyi 2020).

However, according to data sourced from the International Labour Organization (ILO) and the World Bank's World Development Indicators, the increase in labor productivity in Africa shows a similar pattern to the regions' FD, CAPTA proxies by GCF, FI, and FM development index. This graph is established to view the movements and trends among the variables under study. As observed, FD and CAPTA (proxied by GCF) exhibit similar movements to FI and FM, indicating that the variables have cluster relationships, which are displayed in Fig. 1.

Data modeling and empirical specification

Data description

Data from 39 SSA nations, which comprised countries from different regions as indicated in Table 1, were extracted and analyzed for the period from 1990 to 2018.

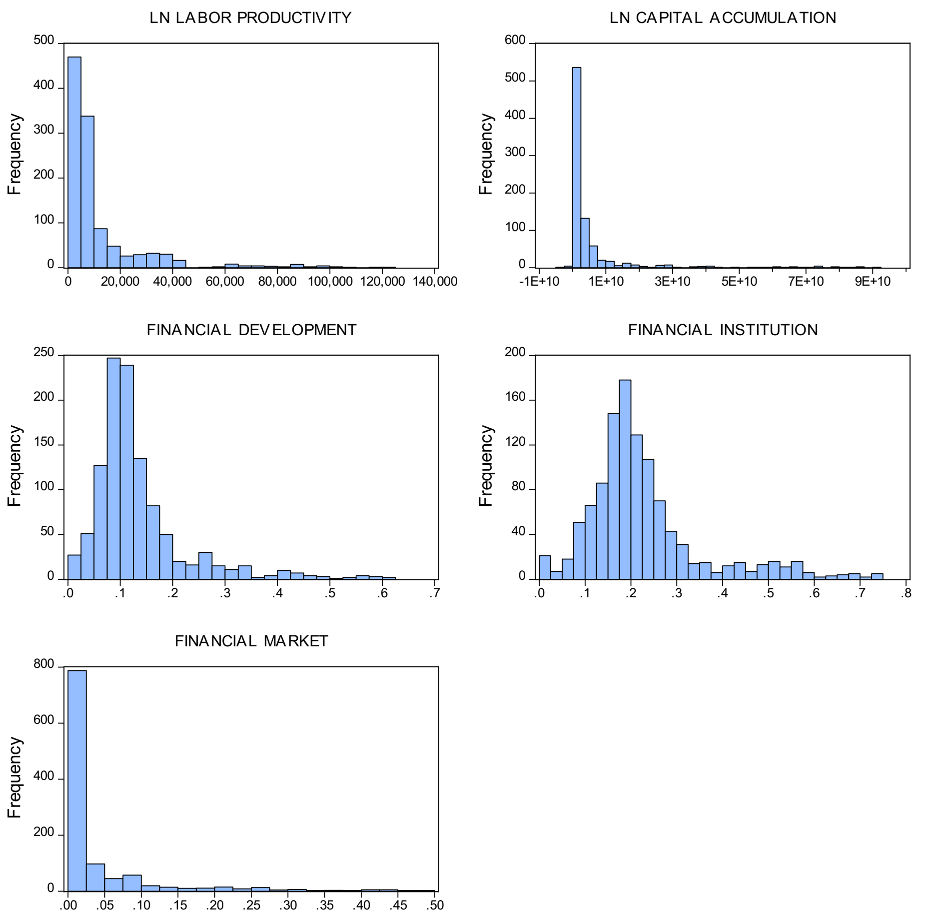

Fig. 1 Data from selected African Countries on productivity, financial development (FD), financial institutions (FI) financial markets development index (FM), and capital accumulation (LNCAPTA) from 1990 to 2018

Table 1 Description of sub-Saharan region

Central African Region	East African Region	South African Region"	West African Region
Angola	Mozambique	Angola	Benin
Cameroon	Madagascar	Botswana	Burkina Faso
Central African Republic	Malawi	Lesotho	Cabo Verde
Chad	Zambia	Malawi	Côte D'ivoire
Congo	Zimbabwe	Mozambique	The Gambia
Democratic Republic of the	Comoros	Namibia	Ghana
Equatorial Guinea	Mauritius	South Africa	Guinea
Gabon	Seychelles	Swaziland	Guinea Bissau
Republic of the Congo		Zambia	Liberia
São Tomé and Príncipe		Zimbabwe	Mali
			Niger
			Nigeria
			Senegal
			Sierra Leone
			Togo

Source: Africana collections

However, because of inadequate data for some countries concerning the required variables, the initial plans of obtaining observations and exploring all SSA countries were disregarded.

Countries from various regions with the most available data for the required period under study were chosen. The panel method and model-based analysis were applied to resolve or adjust for heterogeneity changes and differences in various countries. Data were collected from different sources, which comprised data on labor productivity (LNPROD), which was proxied by output per worker sourced from ILO, CAPTA (LNCAPTA) proxied by GCF obtained from the recent 2019 form of the World Development Indicators, and a comprehensive financial index.

Descriptive statistics

To analyze the characteristics of the variables and the existing relationships among FI development, CAPTA, and labor productivity, a preliminary analysis was performed (Fig. 2). The results are presented as follows.

Table 2 presents a summary of the dependent and explanatory variables used in this study. It enables a cursory examination of the statistical properties of the variables. Table 2 also shows descriptive statistics where the results revealed that for the sample of 39 countries across the period studied, the average overall FD of SSA countries is approximately 0.134% and the average value of PROD is 10,502. The overall FD ranges

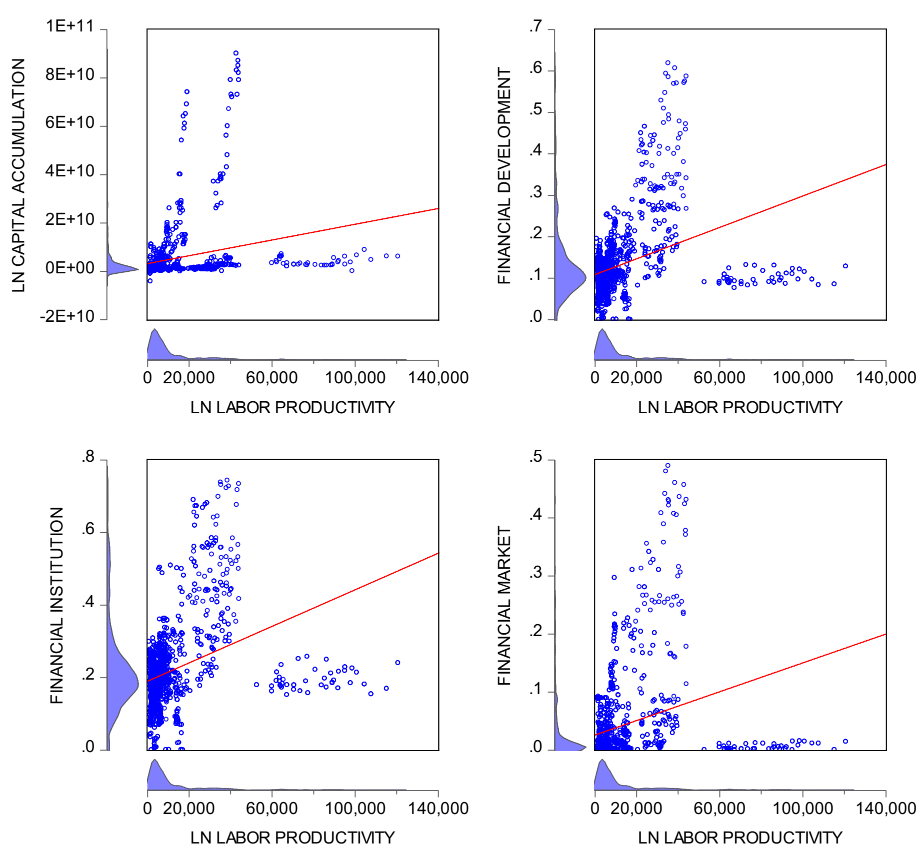

Fig. 2 Scatter Dot Diagram

Table 2 Summary of variables

Variables	Proxy	Symbols
Labour productivity	The value of productivity, output per worker (opw)	LNPROD
Financial development	Overall Financial development index	FD
Financial institution	Financial institution development index	FI
Financial market	Financial markets development index	FM
Capital accumulation	Gross capital formation	LNCAPTA

Table 3 Descriptive statistics

Stat	LNPROD	FD	FI	FM	LNCAPTA
Mean	10.502	0.134	0.226	0.0398	21.19
Standard deviation	13.687	0.0923	0.127	0.0779	1.510
Minimum	411.8	0.000	0.000	0.000	17.31
Maximum	107.751	0.618	0.743	0.489	25.22

Source: Author's computation

from a minimum of 0 to a maximum of 0.618. Thus, on average, SSA countries record positive overall FD over the selected period. However, the minimum and maximum productivity rates (PROD) are 411.8 and 107.51, respectively. The average FI index is approximately 2%, whereas the maximum value is 0.743 and the minimum is 0. The FM development index average value is 0.3% with minimum and maximum values of 0 and 0.489, respectively. The standard deviation, including the minimum and maximum values, shows significant variations in the variables over the period, which is worthy of further evaluation; therefore, this outcome relates to the work of Baiardi et al. (2019).

The scatter graph presents a visualization of the relationships between labor productivity and other variables under study, which denotes a positive connection between CAPTA, FD, and FM and labor productivity. The variables are correlated, in accordance with the findings of Nakamura et al. (2019); thus, an improvement in capital, finance, and technology encourages productivity. Table 3 presents the correlation outcomes.

Correlation coefficients were applied to test for multicollinearity, and all variables were positively correlated. However, the results indicated a strong correlation between FD and its subcomponents, namely, FI and FM. Thus, FD, FI, and FM were included in the regression separately to control for the multicollinearity problem.

Model specification

Our model was construed based on the adjustment and extension of the model adopted by Hirono (2021), which is written below:

$$LnX_{it} = \beta_{0i} + \beta_{1i}LnY_{it} + \mu_{it} \tag{3}$$

where X_{it} is the output per worker proxied by LNPROD in SSA country i at time t. Y_{it} refers to the independent variables (LNCAPTA, FD, FI, and FM of country i at time t). Two of the variables are expressed in logarithmic form.

Methodology and results

Before proceeding with our estimates, verifying the existence of long-run associations among all variables is necessary. In this regard, we first check for the existence of CD within the panel data, that is, to verify whether the cross-sectional units are independent of one another. One of the reasons for the presence of CD is the absence of unnoticed common shocks across countries.

Panel CD

We employ the test proposed by Pesaran (2015) to detect the existence of CD among variables. The correlation coefficient for each association between the variable's series of country i with country j is estimated through this test. The higher the correlation coefficient, the stronger the CD among the residuals. If the null hypothesis is rejected, then the panel is cross-sectionally dependent or correlated.

A simple panel model is considered in this study.

$$x_{it} = \beta_i + \alpha' y_{it} + \mu_{it} \tag{4}$$

where α_i refers to the parameters to be estimated and β_{i} represents time-invariant individual nuisance parameters. In testing for the existence of CD, the CD statistics tests proposed by Pesaran (2015) is as follows:

$$CD = \sqrt{\frac{2L}{M(M-1)}\left(\sum_{t=1}^{M-1}\sum_{i=t+1}^{M}\hat{p}ti\right)},$$

where pti represents the sample evaluation of the correlation. Table 4 presents the outcomes of the Pesaran (2015) test. The null hypothesis of no CD is rejected by all tests in Table 4. Thus, CD exists within the sample".

Second-generation unit root tests

Considering the existence of CD in our variables, we cannot proceed with the first-generation unit root test, which is the conventional one, because it rejects the null hypothesis of nonstationarity in the presence of CD. To resolve this problem, we utilize second-generation unit root tests. The cross-sectionally augmented Dickey Fuller (CADF) test proposed by Pesaran (2015), which examines a unit root in the presence of one common factor, is applied in this study. This test is advantageous, as factor estimation is no longer needed. The common factor can be proxied by the

Table 4 Correlation matrix test

Variables	LNPROD	LNCAPTA	FI	FM	FD
PROD	1.000				
CAPTA	0.226	1.000			
FI	0.473	0.357	1.000		
FM	0.298	0.630	0.569	1.000	
FD	0.455	0.509	0.937	0.820	1.000

Source: Author's computation

Table 5 Panel cross-sectional dependence tests

Variables	P-CD test	P value
LNPROD	146.642[a]	0.000
LNCAPTA	98.964[a]	0.000
FI	130.299[a]	0.000
FD	130.311[a]	0.000
FM	130.388[a]	0.000

"P-CD represents Pesaran cross-sectional dependence, a stands for the rejection of the null hypothesis of cross-sectional independence at 1%" correspondingly

Table 6 Pesaran CADF panel unit root test (2nd generation unit root test)

Variables	LEVELS		FIRST DIFFERENCES		Conclusion
	t-bar	Z(t-bar)	t-bar	Z(t-bar)	
LNPROD	− 3.086	− 5.531	− 4.666	− 16.807[c]	I(1)
LNCAPTA	− 3.357	− 7.466	− 4.828	− 17.962[c]	I(1)
FI	− 3.613	− 9.297	− 4.874	− 18.291[c]	I(1)
FD	− 3.644	− 9.517	− 4.900	− 18.473[c]	I(1)
FM	− 2.544	− 1.730	− 3.671	− 9.706[c]	I(1)

"c, b, and a denotes statistically significant at 0.01%, 0.05%, and 0.10%. Correspondingly. Z(t-bar) is the average of the individual t-ratios of the OLS estimate of"∝ i

cross-section means of the lagged levels and the first difference of the variable. The test is based on the unit root hypothesis on the t-ratio of the ordinary least square estimate of α_i in the following CADF regression:

$$\Delta x_{it} = \beta_i + \alpha_i x_{i,t-1} + g_i\overline{x_{t-1}} + b_i\Delta\overline{x_t} + \varepsilon_{it} \tag{5}$$

where $\Delta\overline{x_t}$ represents the cross-section mean of the first differences of x_{it} and the cross-section mean of the lagged values of x_{it} is represented by" $\overline{x_{t-1}}$ (Table 5).

The second-generation panel unit root test outcomes are presented in Table 6, as suggested by Pesaran's (2015) findings. The existence of nonstationarity (unit root) is tested for the five variables (LNPROD, LNCAPTA, FI, FD, and FM). The test is conducted at both levels and the first difference for each of the abovementioned variables. At level, that is at 1(0), the variables are nonstationary for the versions with and without trend. Nevertheless, the variables become stationary at the differences in the versions with and without trend. Thus, the variables are 1(1) series. The results also include specific deterministic terms and are thus robust.

Testing for cointegration

We proceed by ascertaining the existence of a cointegrating association among the variables, after establishing that the variables are all 1(1) series. We consider the error correction-based panel cointegration test developed by Westerlund (2007) and the second-generation panel cointegration test for unnoticed factors. Each test allows for heterogeneity and CD.

Westerlund (2007) error correlation model (ECM) panel cointegration test

The Westerlund (2007) ECM ascertains whether cointegration is present using four panel cointegration test statistics (Ga, Gt, Pa, and Pt). The four test statistics are normally distributed. The two tests (Gt and Pt) are computed with the standard errors of $\lambda_i^{\log K}$ estimated in a standard way, whereas the other statistics (Ga and Pa) are based on Newey and West (1994) standard errors, adjusted for heteroscedasticity and autocorrelations. We utilize this Westerlund (2007) cointegration test based on the following reasons: it has been developed to cope with cross-sectionally dependent data, and it allows for large heterogeneity in short-run dynamics and in long-run cointegration relationships.

The equation below represents the existence of cointegration in our study:

$$\Delta LnPROD_{it} = \beta_i^{PROD} + \lambda_i^{PROD} \sum_{j=i}^{n} \phi^{PROD} \Delta LnCAPTA_{it-j} + \sum_{j=1}^{n} \vartheta_{ij}^{PROD} \Delta FD_{it-j} + \sum_{j=1}^{n} \delta_{ij}^{PROD} \Delta FI_{it-j} + \sum_{j=1}^{n} \pi_{ij}^{PROD} \Delta FM_{it-j} + \varepsilon_{i,j}, \tag{6}$$

where λ_i^k K ∈ (PROD) stands for the parameters of the error correction term, *i* represents the estimate of the speed of error correction, and $\mathcal{E}_{i,t}$ is the white noise random disturbance term.

Exploring the long-term equilibrium through the panel cointegration test is important (Table 7). The cointegration assessment from the Westerlund results depicts strong evidence to reject the null hypothesis of no cointegration because most group and panel statistics with their respective robust *p*-values are statistically significant. Based on the statistics with their respective *p*-values, although Model 3 is fully significant, which shows that some errors can be adjusted in the long run, the presence of long-run equilibrium relationships among variables is still confirmed for the panels that the model 3 is highly significant in the long run.. Therefore, the variables being analyzed are characterized by long-term links, which must be simulated, concurring with the studies of Coffie et al. (2020) and Matsuoka et al. (2019).

(Dynamic) CCEE-MG (CS-ARDL)

(Dynamic) CCEE-MG (CS-ARDL) is also conducted to observe the association among LNPROD, FD, LNCAPTA, FI, and FM for SSA countries for comparative purposes. CS-ARDL is deemed effective as an alternative model to the generalized methods of moments because it utilizes the cointegration form of the standard (ordinary) ARDL model

Table 7 Westerlund cointegration test

Models	G_t		G_a		P_t		P_a	
	Z-value	P-value	Z-value	P-value	Z-value	P-value	Z-value	P-value
Model (1)	− 16.932[a]	0.000	− 5.177[a]	0.000	− 7.540[a]	0.000	− 8.839[a]	0.000
Model (2)	− 17.528[a]	0.000	− 6.966[a]	0.000	− 7.858[a]	0.000	− 9.109[a]	0.000
Model (3)	− 11.946[a]	0.000	− 0.747	0.228	− 1.799[b]	0.036	− 0.670	− 0.252

a, and b represents the null hypothesis at 1% and 5% correspondingly developed by Pesaran, Shin, and Smith (1999)."The main features of the (Dynamic) CCEE-MG (CS-ARDL) are that it permits short-run coefficients (with error variances, speed of adjustment to long-run equilibrium values and intercepts) to be heterogeneous across countries, whereas long-run slope coefficients are restricted to be homogeneous across countries. According to Blackburne and Frank (2007), CCEE-MG is useful when reasons exist to believe that equilibrium relationships among variables appear within areas. ECM is the result of these properties, as illustrated in Eq. (7) in which divergence from the equilibrium influences the short-run dynamics of the variables in the system.

$$\Delta X_{it} = \emptyset_i(x_{i,t-1} - \theta_i' Y_{it}) + \sum_{j=1}^{F-1} \psi_{ij}^* \Delta X_{i,t-1} + \sum_{j=0}^{q-1} \vartheta_{ij}^* \Delta Y_{i,t-j} + \mu_i + \ell_{it} \tag{7}$$

where

$$\emptyset_i = \left(-1 - \sum_{j=1}^{F} \psi_{ij}\right), \quad \theta_i = \sum_{j=0}^{q} \vartheta_{ij} \Bigg/ \left(1 - \sum_{k} \psi_{ij}\right), \quad \psi_{ij}^* = -\sum_{n=j+1}^{p} \psi_{in},$$

$$j\,equals\,1, 2, \ldots, (f-1), \quad \& \quad \vartheta_{ij}^* = -\sum_{n=j+1}^{q} \vartheta_{in} \quad j\,equals\,1, 2, \ldots\ldots., (q-1),$$

where X_{it} is labor productivity and Y_{it} refers to the independent variables. Parameter $ø_i$ is the error correction speed of the adjustment term. If $ø_i = 0$, then no evidence of a long-run relationship exists. This parameter is expected to be statistically significant. The long-run associations among the variables are shown by vector θi. The outcomes of the CS-ARDL are presented in Table 8.

Due to the existence of CD, the CCEE-MG estimator through the CS-ARDL model is implemented, and the findings of which are displayed in Table 8. The coefficients of the CS-ARDL reveal that FD, FI, and FM have positive significant impacts on the labor productivity of SSA countries in the long run. A positive significant impact on CAPTA is also observed, implying that a 1% increase in FD, FI, CAPTA, and FM leads to 2%, 2%, 5%, and 3% decreases in labor productivity, respectively. Note that CAPTA has an enormous impact on the long-run reduction of labor productivity in SSA. Thus, CAPTA, FD, FI, and FM enhance the labor productivity of the SSA region in the long run.

PDOLS and FMOLS results

Equation (8) is estimated using the PDOLS technique proposed by Pedroni (2001) after detecting the existence of long-run associations among the sampled variables. This method is also used because the output per worker proxied by labor productivity can be endogenous. Furthermore, the exogeneity assumption is not required by PDOLS. Finally, it calculates the mean group estimator and considers heterogeneity across groups. The estimator of PDOLS is derived by taking the average of the conventional time series (DOLS) estimator. In our case, the regression is represented below:

Table 8 Results of (dynamic) common correlated effects estimator-mean group (CS-ARDL)

Variables	Dependent variable labor productivity		
	(1)	**(2)**	**(3)**
	Overall financial development	**Financial institutions development**	**Financial markets development**
Long-run coefficients			
L.lnprod	0.0285 (0.0275)	0.0338 (0.0283)	0.00205 (0.0335)
Lncapta	0.140*** (0.0414)	0.138*** (0.0441)	0.128*** (0.0466)
Fd	0.320 (0.345)		
Fi		−0.176 (0.239)	
Fm			4.269 (2.827)
Constant	5.605*** (0.945)	5.626*** (1.006)	6.098*** (1.167)
Adjustment term	−0.971*** (0.0275)	−0.966*** (0.0283)	−0.998*** (0.0335)
Long-run coefficients			
lr_fd	0.290 (0.331)		
lr_lncapta	0.164*** (0.0516)	0.162*** (0.0544)	0.156*** (0.0511)
lr_fi		−0.167 (0.244)	
lr_fm			4.783 (2.931)
lr__cons	5.384*** (1.084)	5.452*** (1.155)	5.528*** (1.080)
Observations	695	695	695
Number of groups	36	36	36

Standard errors in parentheses

***p < 0.05; **p < 0.1

$$\ln X_{it} = \beta_i + \vartheta_i t + \alpha_{it}\ln(Y_{it}) + \sum_{j=-Fi}^{Fi} \delta_{ij}\Delta L_{it-j} + \varepsilon_{it} \tag{8}$$

where X_{it} refers to productivity, Y_{it} represents the independent variables, and δ_{ij} represents the lag/lead coefficients. The formula for calculating the estimator is as follows:

$$\hat{\alpha} = M^{-1}\sum_{i=1}^{M}\hat{\alpha}_i.$$

FMOLS is also estimated using Eq. (9) below; this test is the upgraded form of the Phillip and Hansen (FMOLS) estimator proposed by Pedroni (2001). This estimation method is selected because it is appropriate for endogenous variable estimation, and the equation is recommended when series are stationary in the same order. FMOLS can also be powerful for any variable that does not appear to be stationary. Hence, the equation below shows the panel of FMOLS:

$$\hat{\alpha}_{fmol} = \left[\sum\nolimits_{i-1}^{R}\sum\nolimits_{t-1}^{G}\left(P_{it}-\hat{P}_i\right)^1\right]^{-1}\left[\sum\nolimits_{i-1}^{R}\sum\nolimits_{t-1}^{G}\left(h_{it}-\hat{h}_i\right)\overline{P}_{it}^{t} + G\hat{\Delta}^t + \varepsilon\ell\right] \tag{9}$$

where $\Delta\varepsilon\ell$ denotes the serial correlation, y_{it}^{+} stands for the correction term, and Y_{it} is the transformed variable, which is used to resolve endogeneity problems.

Table 9 Panel Analysis of FMOLS and PDOLS

Variables	Model
FMOLS	
FD	0.0150**
FI	0.0001***
FM	0.0012***
LNCAPTA	2.6100***
PDOLS	
FD	0.0094
FI	− 0.0002***
FM	0.0001***
LNCAPTA	8.0600***

***; **Means the rejection of null at 5% and 10% significance level respectively

Table 9 shows the estimations of Pedroni's (2001) FMOLS and DOLS off stock and Watson arguments after testing and confirming that the variables are connected in the long run. In FMOLS and DOLS, the model estimations yield identical results. However, according to the outcomes of FMOLS and PDOLS, all variables used in our study are positive and statistically significant except for FI whose coefficients have negative values. Additionally, FI has a negative effect on labor productivity in the SSA region with a coefficient of 0.0002. Thus, a one-unit increase in FI development results in a decrease in labor productivity in SSA of 0.0002 units. It is a result of the developing nature of FI within the region and is in agreement with Dumitrache et al. (2021) and Bakas et al. (2020).

FD outcomes indicate that labor productivity has a positive contribution in the SSA region with coefficients of 0.015 and 0.009. Therefore, FD boosts labor productivity by less than a unit in the region. Another research has been carried out with an emphasis on FD whose outcomes are in line with the study conducted by Mohammed et al. (2019). Nevertheless, FM is also significant with a positive coefficient. Thus, a rise in FM by one unit results in an increase in labor productivity by 0.0012 and 0.0001 units. Therefore, given that FM development improves labor productivity in the long run, the hypothetical impact is presumed to be consistently long- and short-run events for SSA countries.

CAPTA is positive and statistically significant, meaning that labor productivity is fostered by a rise in CAPTA in SSA countries, considering the findings of Bustos et al. (2020) and Ibrahim and Alagidede (2018). Considering that most variables have significant values, no collinearity problem exists among them. Moreover, given that the main estimator, FMOLS, compensates for serial correlation, no serial correlation testing is performed for the models.

Structural stability check

To check the stability of model variables, Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Recursive Residuals Squares (CUSUMSQ) calculations are made. The CUSUM results indicate that the parameters remain constant throughout the research duration because the CUSUM numbers fall inside the threshold region of 5% (Fig. 3).

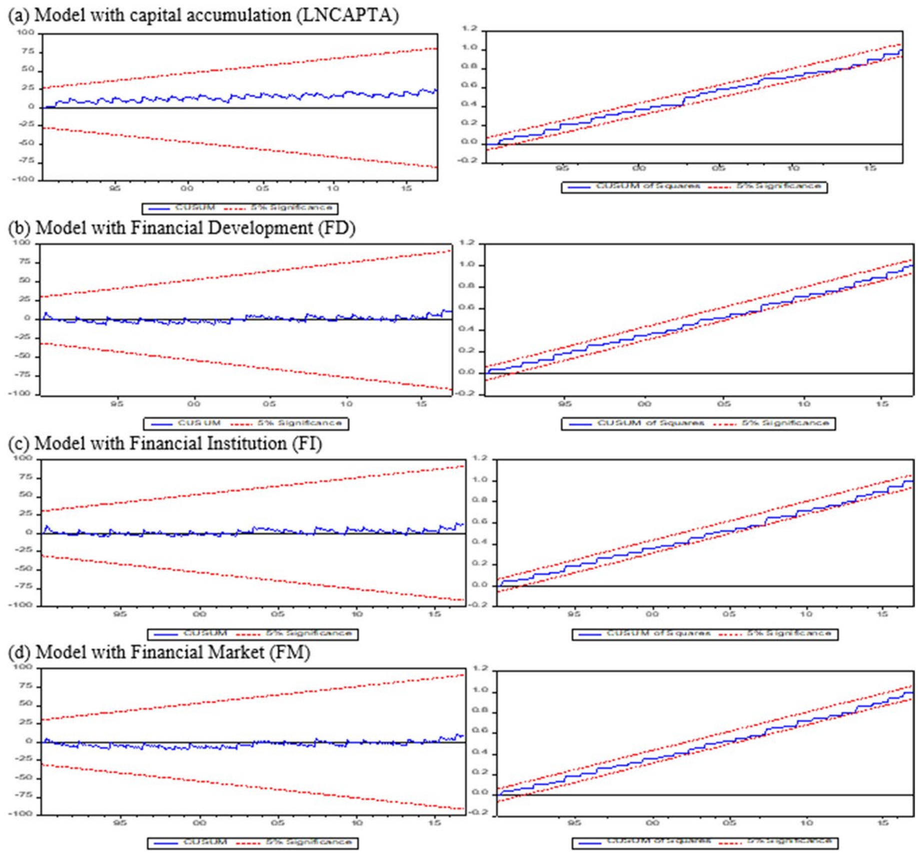

Fig. 3 The CUSUM STABILITY test and the CUSUM-of-squares test with capital accumulation (LNCAPTA), financial development (FD), financial institution (FI), and financial market (FM)

Discussion

In the early stage of the analysis, the Pesaran CD residual CD test rejects the null hypothesis of cross-sectional independence across all variables. This rejection implies the presence of cross-country connectedness between SSA nations among various study panels. Based on the economic, regional, and social experiences of the sampled SSA countries, the intersectoral dependency of these countries is unsurprisingly seen in their respective panels. This evidence is comparatively consistent with the studies of Coffie et al. (2020) for African states in terms of income levels and Mendez and Kataoka (2021) for South Asian countries together with Dumitrache et al. (2021) for industrialized countries but contrary to their findings.

Therefore, the application of CADF stationarity tests reveals that all evaluated variables have homogeneous integration orders at first differences. Accordingly, the variables used are capable of producing prolific results as shown to be stationary. The findings of the stationarity tests confirm the results of Hong et al. (2021) regarding production, FD, and income in South Asian countries. However, the Westerlund ECM panel cointegration result reveals that the presence of long-run equilibrium relationships among variables is still confirmed for the panels from the economic perspective, which implies that the utilized CAPTA and financial indicators have elastic long-term effects on labor productivity. Therefore, this evidence supports the revelation of

Nakamura et al. (2019) concerning states in North America and that of Bernier and Plouffe (2019) regarding 23 states. However, Bernier and Plouffe (2019) had a contrary view from their findings, which state the nonexistence of long-run relationships amid FD.

Empirically considering the long-term simulation outcomes from the CCEE-MG–CS-ARDL approach and with the existence of CD and proliferation concerns, the CCEE-MG estimator through the CS-ARDL model is implemented, and the findings are indicated in Table 8. The effects on LNPROD and LNCAPTA concerning FD, FI, and FM are significant among most panels in the long run. The coefficients of CS-ARDL reveal that FD, FI, and FM have positive significant impacts on the labor productivity of SSA countries in the long run and still have positive significant impacts on CAPTA.

Furthermore, a positive significant impact of LNCAPTA on LNPROD, according to the outcomes of FMOLS and PDOLS within the SSA region, concurs with the findings of Fonseca and Doornik (2022) for Brazil. When LNCAPTA increases, it enhances productivity, thereby boosting the capacity of any ventures be they governmental or non-governmental. Additionally, FI has a negative effect on labor productivity in the SSA region. This finding entails that an increase in FI development results in a decrease in labor productivity in SSA. It is a result of the developing nature of FI within the region and is in agreement with Khraief et al. (2020) and Bakas et al. (2020).

Last, FD outcomes indicate that FD makes a positive contribution to labor productivity in the SSA region. It further portrays how policymakers in SSA countries within this panel are saddled with the duty of promoting FD to improve labor productivity. This result is consistent with Baiardi et al. (2019) for African states. Meanwhile, the relationship between FD and labor productivity generally differs significantly from the report of Mohammed et al. (2019) for Turkey. Nevertheless, FM is also significant with a positive coefficient. Thus, a rise in FM by one unit results in an increase in labor productivity. Therefore, given that FM development improves labor productivity in the long run, the hypothetical impact is presumed to be consistently long- and short-run events for SSA countries. This result is in line with the findings of Ibrahim and Alagidede (2017) for SSA countries and Barucca et al. (2021) for the United Kingdom region.

Conclusions and policy implications

Our study uses effective and robust panel econometric approaches to model the impacts of CAPTA and FD on the validity of labor productivity within the SSA region in the presence of possible issues of heterogeneity and residual cross-sectional connectivity to avoid erroneous findings. Therefore, the key results drawn from the use of newly developed econometric techniques are in the following paragraphs.

The estimates on LNPROD and LNCAPTA concerning FD, FI, and FM suggest significant effects among the panels. The CS-ARDL coefficient reveals that FD, FI, and FM positively impact the labor productivity of SSA countries in the long run. PDOLS and FMOLS among other techniques are also applied, the results of which indicate that FD, CAPTA, and FM have significant positive impacts on productivity in the SSA region; this result is in line with the studies of Mohammed et al. (2019) and Mendez and Kataoka (2021).

Furthermore, our findings reveal that the development of the financial sector of the continent improves labor productivity. FI development also propels further labor productivity on the one hand, and the FM development index has a positive correlation to productivity in the continent on the other hand. This case can be a result of the underdevelopment of FM in Africa. We conclude that FD, LNCAPTA, and FM are positively related to labor productivity in Africa and its subregions. Therefore, policymakers should consider FD and LNCAPTA as indispensable for the enhancement of labor productivity in Africa and its subregions. In conclusion, financial administrators and Apex Bank supervisors in different SSA nations should promote different programs and policies, which can heighten the development of the financial sector toward achieving great productivity in the region.

Abbreviations

ARDL	Autoregressive Distributive Lag
CAPTA	Capital accumulation
CCEE-MG	Common correlated effects estimator-mean group
CS-ARDL	Cross-sectional-Autoregressive Distributive Lag
CD	Cross-sectional dependence
CUSUM	Cumulative Sum
CUSUMSQ	Cumulative Sum of Squares
DF(CADF)	Cross-Sectional Augmented Dickey–Fuller
DOLS	Dynamic ordinary least square
ECM	Error Correction Model
FD	Financial development
FDI	Foreign Direct Investment
FI	Financial institution
FM	Financial market
FMOLS	Fully modified ordinary least square
GCF	Gross capital formation
GDP	Gross domestic product
ILO	International Labor Organization
LNCAPTA	Log Capital Accumulation
LNPROD	Log labor productivity
MPL	Marginal Productivity of Labor
OPW	Output per worker
PDOLS	Panel dynamic ordinary least square
PROD	Labor productivity
TFP	Total factor productivity
WDI	World Development Indicators

Acknowledgements
I sincerely want to express my profound gratitude to the editorial office and the five anonymous referees for their comments and useful suggestions for improving the content of this paper and eliminating errors. Huge acknowledgment also goes to the Southwestern University of Finance and Economics for taking the responsibility of covering all the charges.

Author contributions
JDZ assist in drafting and developing the manuscript, performed the statistical analysis, and participated in the sequence alignment. HG participated in the modification of the title and coordination. All authors read and approved the final manuscript.

Funding
None.

Availability of data and materials
The datasets used in this study were collected from different sources, and they consist of data on labor productivity (PROD), which was proxied by output per worker sourced from the International Labor Organization (ILO), capital accumulation proxied by gross capital formation (GCF) obtained from the latest 2019 version of the World Bank's World Development Indicators and a comprehensive financial development index (FDI). World development indicator (WDI): https://databank.worldbank.org/source/world-development-indicators international labor organization.

Declarations

Competing interests
The authors declare that they have no competing interests.

Received: 17 February 2022 Accepted: 27 September 2022
Published online: 03 January 2023

References

Arcand JL, Berkes E, Panizza U (2015) Too much finance? J Econ Growth 20(2):105–148
Asongu SA (2020) Financial access and productivity dynamics in sub-Saharan Africa. Int J Public Adm 43(12):1029–1110
Asongu SA, Acha-Anyi PN (2020) Enhancing ICT for productivity in sub-Saharan Africa: thresholds for complementary policies. Afr J Sci Technol Innov Dev 12(7):831–845
Atiase VY, Wang Y, Mahmood S (2019) FNGOs and financial inclusion: investigating the impact of microcredit on employment growth in Ghana. Int J Entrep Innov 20(2):90–106
Baiardi D, Profeta P, Puglisi R, Scabrosetti S (2019) Tax policy and economic growth: Does it really matter? Int Tax Public Financ 26(2):282–316
Barucca P, Mahmood T, Silvestri L (2021) Common asset holdings and systemic vulnerability across multiple types of financial institution. J Financ Stabil 52:100810
Bernier M, Plouffe M (2019) Financial innovation, economic growth, and the consequences of macroprudential policies. Res Econ 73(2):162–173
Blackburne EF III, Frank MW (2007) Estimation of nonstationary heterogeneous panels. Stand Genomic Sci 7(2):197–208
Bosworth B, Collins SM (2003) The empirics of growth: an update. Brook Pap Econ Act 2003(2):113–206
Bukhari AH, Raja MAZ, Sulaiman M, Islam S, Shoaib M, Kumam P (2020) Fractional neuro-sequential ARFIMA-LSTM for financial market forecasting. IEEE Access 8:71326–71338
Bustos P, Garber G, Ponticelli J (2020) Capital accumulation and structural transformation. Q J Econ 135(2):1037–1094
Chao X, Kou G, Peng Y, Viedma EH (2021) Large-scale group decision-making with non-cooperative behaviors and heterogeneous preferences: an application in financial inclusion. Eur J Oper Res 288(1):271–293
Coffie CPK, Zhao H, Adjei Mensah I (2020) Panel econometric analysis on mobile payment transactions and traditional banks effort toward financial accessibility in sub-Sahara Africa. Sustainability 12(3):895
Dumitrache VM, Gombos SP, Bran F, Balu PE (2021) The dynamics of human capital accumulation in the ex-communist countries in Europe in the context of globalization. In: SHS web of conferences, vol 92. EDP Sciences
Fonseca J, Van Doornik B (2022) Financial development and labor market outcomes: evidence from Brazil. J Financ Econ 143(1):550–568
Fontaine I, Galvez-Iniesta I, Gomes P, Vila-Martin D (2020) Labour market flows: accounting for the public sector. Labour Econ 62:101770
Hirono M (2021) Demographic change, human capital accumulation, and sectoral employment. J Econ 132(2):165–185
Hong D, Tran NP, Nguyen HM (2021) Does financial development improve human capital accumulation in Southeast Asian countries? Cogent Bus Manag 8(1):1932245
Ibrahim M, Alagidede P (2017) Financial development, growth volatility and information asymmetry in sub-Saharan Africa: Does law matter? S Afr J Econ 85(4):570–588
Ibrahim M, Alagidede P (2018) Nonlinearities in financial development–economic growth nexus: evidence from sub-Saharan Africa. Res Int Bus Financ 46:95–104
Iheonu CO, Asongu SA, Odo KO, Ojiem PK (2020) Financial sector development and Investment in selected countries of the Economic Community of West African States: empirical evidence using heterogeneous panel data method. Financ Innov 6(1):1–15
Joyce MA, Lasaosa A, Stevens I, Tong M (2020) The financial market impact of quantitative easing in the United Kingdom. In: 26th issue (September 2011) of the International Journal of Central Banking
Khraief N, Shahbaz M, Heshmati A, Azam M (2020) Are unemployment rates in OECD countries stationary? Evidence from univariate and panel unit root tests. N Am J Econ Finance 51:100838
Kou G, Yüksel S, Dinçer H (2022) Inventive problem-solving map of innovative carbon emission strategies for solar energy-based transportation investment projects. Appl Energy 311:118680
Matsuoka T, Naito K, Nishida K (2019) The politics of financial development and capital accumulation. Macroecon Dyn 23(1):358–383
Mendez C, Kataoka M (2021) Disparities in regional productivity, capital accumulation, and efficiency across Indonesia: a club convergence approach. Rev Dev Econ 25(2):790–809
Mohammed SMA, Guo P, Haq IU, Pan G, Khan A (2019) Do government expenditure and financial development impede environmental degradation in Venezuela? PLoS ONE 14(1):e0210255. https://doi.org/10.1371/journal.pone.0210255
Nakamura K, Kaihatsu S, Yagi T (2019) Productivity improvement and economic growth: lessons from Japan. Econ Anal Policy 62:57–79
Newey WK, West KD (1994) Automatic lag selection in covariance matrix estimation. Rev Econ Stud 61(4):631–653
Pedroni P (2001) Purchasing power parity tests in cointegrated panels. Rev Econ Stat 83(4):727–731
Pesaran MH (2015) A simple panel unit root test in the presence of cross-section dependence. Time series and panel data econometrics. J Appl Econom 22(2):265–312
Sarwar A, Khan MA, Sarwar Z, Khan W (2020) Financial development, human capital and its impact on economic growth of emerging countries. Asian J Econ Bank 6:66
Shahbaz A, Shabbir S, Butt L (2011) Effect of financial development on agricultural growth. In: Pakistan: new extensions from bounds test to level relationships and granger causality tests. Online at ttps://mpra.ub.unimuenchen.De/34162/MPRA Paper No. 34162. Retrieved on 29/82017
Ssozi J, Asongu SA (2016) The comparative economics of catch-up in output per worker, total factor productivity and technological gain in sub-Saharan Africa. Afr Dev Rev 28(2):215–228
Wen F, Xu L, Ouyang G, Kou G (2019) Retail investor attention and stock price crash risk: evidence from China. Int Rev Financ Anal 65:101376

Westerlund J (2007) Testing for error correction in panel data. Oxf Bull Econ Stat 69(6):709–748

Publisher's Note