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Financial Development and Technical Efficiency in Transitional Economies: Evidence from BLEND Countries

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ABSTRACT

This study investigates the impact of Financial Development components on Technical Efficiency in 11 BLEND countries from 1980 to 2019 using panel data from the Penn World Table and IMF's Financial Development Index. Employing Stochastic Frontier Analysis (SFA) with a Translog production function and time-varying inefficiency effects (Battese & Coelli, 1995), the results reveal that Financial Institution Depth (FID) significantly reduces inefficiency ($\delta = -0.79$, $p < 0.001$), while greater Financial Access (FIA) is associated with increased inefficiency ($\delta = 0.57$, $p < 0.001$). Country-specific analysis reveals notable disparities: Kenya and the Congo Republic demonstrate high average efficiency (97-98%), in contrast to Nigeria (25%), while some island nations experience persistently low efficiency scores (27-37%), underlying institutional differences and structural vulnerabilities. Fixed-effects robustness tests confirm that these findings remain consistent after controlling for country-specific heterogeneity. These findings suggest that the benefits of financial development are conditional on regulatory effectiveness and institutional capacity, with important implications for SDG 8 (Economic Growth) and development finance policy in transitional economies.

Keywords: Financial Development, Technical Efficiency, Stochastic Frontier Analysis, Transitional Economies, Financial Institutions.

1. INTRODUCTION

Economic growth, particularly within the context of emerging economies, remains a central focus of economic research and policy. As these economies grapple with shifting global dynamics, institutional restructuring, and external vulnerabilities, understanding the drivers of growth requires frameworks that account for both traditional production inputs and deeper structural factors. While Classical growth models, notably those introduced by Solow (1956) and developed further by Romer (1986), highlighted the importance of physical inputs such as Capital, Labor, and Technological progress as central drivers of growth, Modern theories have extended the framework to include Governance Structures, Institutional Quality, Financial Systems, and Trade Openness (Acemoglu et al., 2001, Acemoglu, 2008). Within this evolving framework, the financial sector holds a vital position in enabling economic activities and promoting structural transformation, an aspect that is particularly critical for transitioning and emerging economies, where financial systems are still working towards resilience.

Financial development, as described by Levine (1997), refers to the increase in efficiency and quantity of services by financial intermediaries that play a pivotal role in Economic Development. It embodies the intricate interaction of Financial Markets, Financial Institutions, and Instruments that enable Risk management, Capital flow, and economic activities. Through sophisticated Financial Products, enhanced access to Financial Services, and most importantly, increased Market Depth and Liquidity, Financial Development empowers firms and households to perform efficiently. This process is vital for fostering inclusive growth, poverty reduction, and increased resilience to external shocks (King and Levine, 1993; Beck et al., 2000; Demirguc-Kunt and Levine, 2008).

An important yet sometimes overlooked concept in measuring the quality of growth is Total Factor Productivity (TFP), composed of a part of output growth in an economy that is not accounted for by labor and capital Solow, 1957). It captures the efficiency with which these inputs are utilized, incorporating factors such as technological change, innovation, human capital, and institutional improvements Hulten, 2001). As a residual in growth accounting, TFP serves as a key indicator of long-term productivity gains and sustainable economic development. My paper aligns with findings from Arestis et al. (2005), who argue that financial policies impact growth fundamentally through TFP, with empirical evidence suggesting that TFP is influenced more significantly by financial development than by capital accumulation or savings.

Recent empirical evidence by (Beck et al., 2014; Shen et al., 2010)and (Arcand et al., 2015) further complicates this picture by revealing a non-linear (and context-dependent) relationship and threshold effect between financial development and growth, where the impact of financial development varies significantly across countries observing a Range of economic conditions. Similarly, Rioja and Valev (2004) present Rioja's noteworthy hypothesis of three stages of financial development where countries with very low levels of financial deepening experience minimal growth acceleration, those with high levels see larger effects, and those at intermediate levels can experience significant growth acceleration. This complexity is heightened when considering the various components of financial development that, in recent studies, are addressed as depth, access, and efficiency, each potentially affecting economic performance through different channels and with vary-

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ing intensities.

To address these analytical limitations and better investigate the complex nexus of economic growth and financial development. This study adopts a novel approach focusing on technical efficiency rather than aggregate growth measures. This essay differs from earlier studies by decomposing the growth elements in Blend countries utilizing Stochastic Frontier Analysis (SFA), deviating from the empirical techniques used by neo-classical and new growth theories that employed standard growth accounting. SFA offers the methodological advantage by separating inefficiency in production and analyzing how different components of financial development influence technical efficiency. In the context of economies in transition, this unique empirical strategy grants a contemporary view of the evolving nature of the said nexus. Recent advances in system identification and optimization-based modeling further highlight the importance of separating structural dynamics from inefficiency and noise, particularly in nonlinear and complex systems (Ali et al., 2024; Ali et al., 2025a).

Our research specifically focuses on BLEND countries, A World Bank operational lending category that comprises countries eligible for funding from the International Development Association (IDA) and International Bank for Reconstruction and Development (IBRD). This unique category provides an ideal setting for examining how different institutional frameworks and financial systems impact Technical Efficiency. BLEND countries consist of transitioning economies, revealing how Financial Development Influences Technical Efficiency across varying Economic development stages. Economies undergoing structural and financial Transition.

Although this group of countries shares common traits with developing countries, such as their susceptibility to external shocks, inadequate financial capital, and reliance on Natural Resources and agricultural produce. The 11 countries under observation are Cameroon, Kenya, Congo Republic, Nigeria, Eswatini, Fiji, St. Lucia, Cabo Verde, Saint Vincent and the Grenadines, Pakistan, and Belize.

The research leverages the IMF's recently introduced Financial Development Index (FDI), a comprehensive measure of the Financial Sector Development. This index integrates financial stock markets (FM) and Financial Intermediaries like banking Institutions (FI) with sub-indices addressing the Access, Efficiency, and Depth components for both. By examining these various components' impacts on technical efficiency, we can provide more nuanced insights into which aspects of financial development most effectively promote economic efficiency in transitioning economies.

The Objective of this research is to study the influence of both efficient and inefficient aspects of Financial Development on the Technical Efficiency of BLEND countries. By examining how different components (depth, efficiency, and access) contribute to overall efficiency, this study aims to provide valuable insights for policymakers in transitioning economies. Additionally, this research seeks to contribute to the broader interpretation of the specific components of financial development that influence economic growth through the specific channel of technical efficiency.

2. THEORETICAL OVERVIEW

The relationship between economic growth and Financial Development presents a complex puzzle that traditional growth analyses have struggled to fully unravel. The predominant growth theories, neoclassical growth theory as proposed by Solow and Swan in 1956, alongside new growth theory attributed to Romer and Lucas, typically study output growth as having capital and labour, along with Total Factor Productivity. However, these models often fall short in fully decomposing the sources of productivity improvements, particularly in the context of emerging and developing economies where institutional, financial, and structural conditions are markedly different.

Theoretical models observe that the development of financial intermediaries and instruments helps obtain accurate information, makes transactions easier, ensures contracts, and thus reduces any market frictions (Greenwood and Jovanovic, 1990). While this view recognizes the vital role of financial structures, the significance of finance in growth has historically been debated. Some influential economists like Robinson (1952) and Lucas Jr (1988) observed it to be insignificant, while King and Levine found that Financial development, at substantial levels. to be positively influencing efficiency, capital accumulation, and thus prompting growth rates. Schumpeter (1959) was among the earliest to highlight that financial intermediaries foster Innovation by channeling savings towards productive use. Financial development has long been identified as a key factor for economic growth, particularly through banking channels. Ndako (2010) found that bank credit to the private sector supports economic expansion in South Africa.

Theoretical Models were brought forward to study and identify the specific channels through which Financial Development influences growth. As Financial development occurs, the financial market, intermediaries, and instruments play a definitive role in mitigating market friction. Better access to information leads to beneficial investments and saving decisions that, in turn, increase capital accumulation and ultimately economic growth

Levine (2005) highlights that financial development enhances several critical economic functions: (i) allocation of capital into profitable investment, (ii) mobilization of savings, (iii) trading of services and goods, (iv) managing investments, and (v) risk mitigating through diversification.

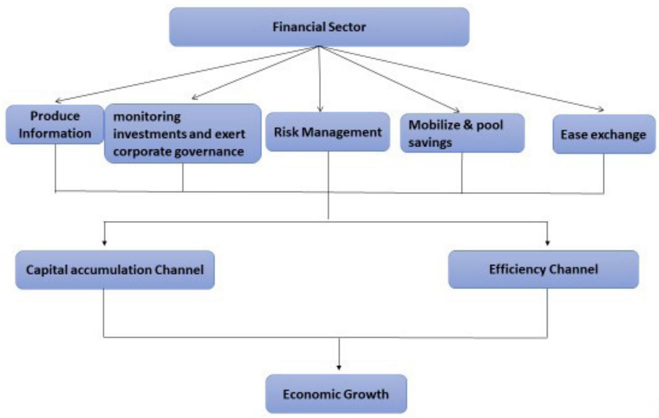


Fig. 1 Levine (2005)

These functions represent the foundational channels linking financial development and economic performance. Using a Neo-classical growth accounting framework to model these 5 broad functions, Levine identifies the two major mechanisms: efficiency and capital accumulation, through which economic growth is promoted. Thiel (2001) further explains that the capital accumulation mechanism/channel with lower transaction costs and efficient transformation of savings to investments will result in more savings. Meanwhile, the efficiency channel relies on the 5 economic functions to play their role by: correctly allocating/

diversifying risks, with accurate information, enforcing corporate laws, and monitoring firms. It also ensures liquidity by mobilizing savings.

While these models advance our understanding of the finance-growth nexus, they often fail to clarify the distinct ways in which financial development affects productivity, particularly through its influence on efficiency. A significant limitation is the persistent handling of Total Factor Productivity (TFP) as a residual, a "black box" that captures all growth unexplained by capital and labor inputs (Hulten, 2001; Solow, 1957). However, TFP is composed of two distinct elements: Technical Efficiency (TE), which refers to the optimal use of resources within a given production frontier, and Technological Change (TC), which reflects shifts in the frontier due to innovation and technology transformation.

Garzarelli et al. (2014) critique this generalized approach of TFP with their "lumpy factor" approach, arguing that TFP, particularly its TE component, masks the specific channels, such as financial development, that influence economic performance. This critique underscores the critical need to isolate and examine TE, a task necessary in the context of developing and transitioning economies. Similar concerns regarding hidden inefficiencies within aggregate performance measures have been raised in nonlinear system identification literature, where auxiliary model–based optimization techniques are employed to explicitly separate system dynamics from estimation errors (Ali et al., 2024; Ali et al., 2025b).

To address this analytical gap, this study focuses on Technical Efficiency as a channel through which financial development impacts economic performance. We employ Stochastic Frontier Analysis (SFA) to decompose TFP into efficiency and technological change. Unlike conventional growth accounting approaches, SFA enables the identification and analysis of inefficiency in production, which is a concerning factor for many emerging economies struggling with structural rigidities and underutilized resources. The focus on technical efficiency aligns with the growing emphasis on micro-level performance in development finance, a theme explored in the edited volume Development Finance: Innovations for Sustainable Growth. (Biekpe et al., 2017)

In summary, while the theoretical models offer extensive insights into the nexus linking financial development and growth, there is a significant gap in understanding how financial development influences technical efficiency, especially in financially underdeveloped and institutionally developing economies. By reframing the finance–growth nexus through the lens of technical efficiency, this study seeks to uncover and analyze the specific channels through which financial development influences Technical efficiency. This paper contributes to a more nuanced theoretical and empirical understanding of development in transitional economies.

3. LITERATURE REVIEW

3.1 Empirical Evidence

The nexus between Financial Development, Technical Efficiency, and Growth has been the focus of substantial studies. The empirical evidence provides important insights for understanding the mechanisms through which Productivity influences growth.

The foundational study observing the relationship between economic growth and finance, employing a cross-country approach, is credited to Goldsmith (1969). His research assessed the role of the financial system as a structure comprised of both Financial markets and financial intermediaries that could play for an economy's growth. The results suggested that as economies develop, the size of financial intermediaries also grows (to accommodate the increasing demand) and secondly, a positive relation between the scale of Economic activity and Financial Development exists.

Lack of securities market data made the evidence weak, thus continuing the observation. King and Levine (1993), utilizing more indicators for growth and financial development, explored the relation between the scale of financial development and long-term growth through the productivity and capital accumulation channels.

To measure growth, three indicators were utilized: • Real per capita GDP • capital stock per capita growth rate • productivity growth. Whereas to monitor the level of financial development, they constructed variables/measures like "DEPTH, BANK, and PRIVY". Depth measures liquid liabilities as a percentage of GDP, BANK assessing the portion of credit allocation by commercial banks (relative to the central bank's credit), and PRIVY indicating credit to the private sector by GDP. The empirical findings of this research exhibited a positive correlation between the three growth indicators and the financial development indicators employed by the methodology.

Cheng and Hou (2022) contribute significantly to the finance-growth nexus debate by synthesizing three key aspects: the role of innovation, the distinction between long-run and short-run relations, and the differentiation of effects at various stages of economic development. The paper analyzes a panel of 48 countries from 1971 to 2015, maintaining that the relationships are not uniform between finance and growth, and between innovation and growth. Instead, they vary depending on the income level of the countries and the time horizon. A key finding is that innovation plays a crucial role in the growth process, and Financial Development is not a guaranteed solution for Economic Growth. The study emphasized innovation and its nuanced approach to the finance-growth relationship

Arestis et al. (2005) argue that financial policies impact growth fundamentally through Total Factor Productivity (TFP), with their empirical evidence suggesting that TFP is influenced more significantly by financial development than by capital accumulation or savings. This finding is particularly relevant to our research as it supports our focus on technical efficiency instead of aggregate growth measures. The study demonstrates that the sustainability of economies' growth hinges upon enhancements in productivity and efficiency, rather than merely on increases in physical capital.

Arizala et al. (2013) in their paper analyzed the impact of development in the financial sector on the industry level (TFP). In this panel study of 77 economies (with 26 industries' data), the relation was found to be significantly positive. According to the level of reliance on external financing, financial development can accelerate TFP by 0.6 % per year.

Building on this foundation, Tadesse (2005) provides empirical evidence that financial development fosters technological progress by improving capital mobilization and risk-sharing mechanisms. His study, examining a panel of industries across thirty-eight countries, demonstrates that financial development accounts for significant cross-country differences in technological advancement and productivity growth. (Alhassan and Biekpe, 2015) study a developed financial market like South Africa and found that firm-level productivity in the non-life insurance sector is driven by technology and operational decisions, not scale. Emphasizing that the specific channels need to be examined.

Supporting these findings, Nourzad (2002) demonstrates that financial development positively correlates with productive efficiency. His research suggests that as financial systems mature, they contribute to more efficient production processes in both developed and developing nations, a finding particularly relevant to our analysis of BLEND countries. Complementary to economic efficiency studies, recent research in nonlinear Hammerstein and output-error systems demonstrates that optimization-driven identification methods significantly improve parameter estimation accuracy under complex, fractional-order dynamics (Ali et al., 2025a, Ali et al., 2025c).

Guillaumont Jeanneney et al. (2006) use the Data Envelopment Analysis approach (DEA) to compile the effect of financial development on efficiency. Building a dataset of 29 Provinces and utilizing the Generalized Method of Moments (GMM). The findings indicate that financial development to substantially increase efficiency and, in turn, improve the productivity growth of China.

The influence of financial capital access on technical efficiency is observed across multiple sectors. Afrin et al. (2017) and Chen et al. (2022) for the Agricultural sector find that Financial Access and Inclusion substantially increase Technical Efficiency for farmers. Research in this sector highlights how enabling financial access optimizes agricultural practices and thus financial gain for farmers. Bhattacharyya and Pal (2013) researched the impact on the banking sector, specifically the commercial banks of India. He observed a complex relation between financial reforms and Technical Efficiency as the positive effects diminished over time.

The role of access to finance capital on Technical Efficiency is examined by Schaefer et al. (2021) in their research into agricultural cooperatives in Brazil. Utilizing panel Data Envelopment Analysis (DEA), it covered 68 co-operatives. In contrast to expectations based on the theoretical background, the findings revealed no significance for the relation between financial capital and Technical Efficiency. This duality indicates that the nexus is not merely simple/linear but is influenced by various contextual factors.

Unveiling a complex relationship, recent studies by (Shen et al., 2010, Beck et al., 2014, Arcand et al., 2015) have provided evidence that financial development does not have a linear impact on economic growth. All three studies identify threshold effects in this relationship. As explained by Arestis and Demetriades (1997), these effects are influenced by the unique institutional structures, stages of development, and characteristics of financial systems across different countries. Rioja and Valev (2004) observe that financial development differs at varying stages of financial development. The study hypothesis of economies facing three levels of financial deepening is that low-level experience minimal growth acceleration, those with high levels see larger effects, and those at intermediate levels can experience significant growth acceleration.

To provide a concise overview of the theoretical and empirical landscape, Table 1 summarizes key research, particularly IMF studies, regarding the nuances of financial development, institutional dependencies, and the threshold effects relevant to transitional economies

Table 1 Summary of Key Literature and Empirical Findings

Author(s) & Year	Key Focus / Context	Main Findings & Relevance to This Study
Claessens & Laeven (2003)	Institutional Structures	The link between financial development and growth is significantly strengthened by strong institutional frameworks.
Chinn & Ito (2006)	Regulatory Policy	Institutional factors and regulatory policies are critical determinants of the success of financial development.
Dabla-Norris & Srivisal (2013)	Macroeconomic Volatility	Financial depth reduces volatility in consumption and investment up to a specific threshold.
Naceur et al. (2014)	Global Comparison	The finance-growth nexus is consistent across both developing and developed economies.
Arcand et al. (2015)	Threshold Effects	Explores “too much finance”; identifies a threshold (100% credit-to-GDP) where the finance-growth relationship can turn negative.
Sahay et al. (2015)	Speed of Deepening	Benefits of financial deepening depend on the speed and size of the developing economy.
Mlachila et al. (2016)	Sub-Saharan Africa	Banking development is more impactful than stock markets for productive efficiency in developing contexts.
Poghosyan (2022)	CCA Countries	Highlights the lag in financial market development compared to institutions; notes high cross-country performance variance.
Aman et al. (2023)	Institutional Frameworks	Validates the need to study groups like BLEND countries due to varying economic and financial structures.
Nguyen et al. (2023)	88 Countries (1980–2020)	Distinguishes between sub-sectors: Institutions drive long-term gains, while markets contribute in the short term.

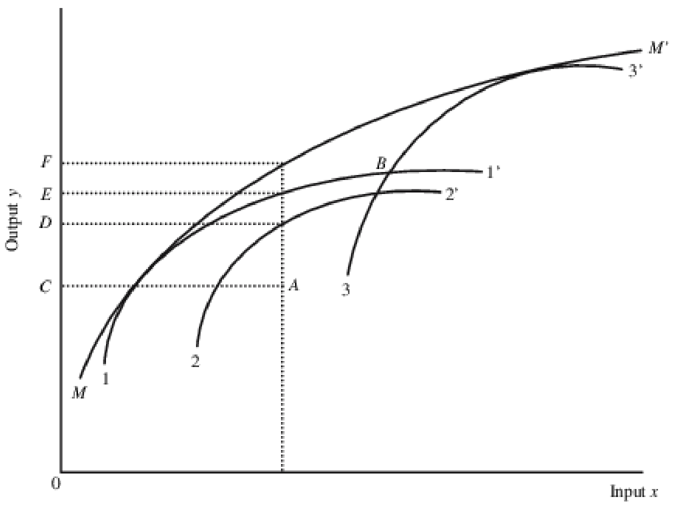
The extensive body of literature provides strong theoretical and empirical support for our research approach, particularly our focus on technical efficiency as a metric of the impact of financial development. Evidence suggests that while financial development generally enhances technical efficiency, the relationship is complex and potentially non-linear, varying across different institutional contexts and levels of development.

4. DATA AND METHODOLOGY

4.1 Empirical Strategy

Coelli et al. (2005), in their book, "An Introduction to Efficiency and Productivity Analysis," provide comprehensive details of how such analyses are conducted using the production frontier, from broad ideas to simple yet confusing details like the difference between efficiency and productivity. In our case, "firm" will be a country exhibiting how it performs on the frontier.

FARRELL (1957) presents a foundational framework on inefficiency as 'deviations from optimum behavior'. Frontier Analysis constructs an optimal benchmark through which deviations are studied. Technical Efficiency describes the ability of a firm/country to minimize input use to produce a given amount of output, so it can be measured by a ray from the origin and a point either on or below said frontier. As a firm becomes more productive, it moves to a more technically efficient point that uses the same input but gives more output. Further, for a firm to experience maximum productivity. Its slope is tangent to the frontier; thus, by exploiting scale economies, a firm can further increase its productivity as observed in Figure 2.

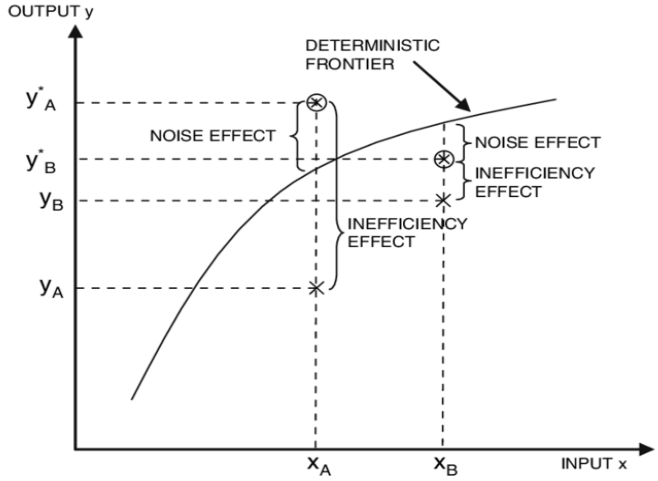


Source: Coelli, Prasada Rao, O'Donnell, and Battese (2008)

Fig. 2 Technical Efficiencies and Meta-Technology Ratios

The estimation of efficiency varies based on the technique and assumptions applied to define the production frontier. Literature finds two approaches, Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA), for constructing the frontier. Non-parametrically, DEA uses linear programming to determine linear sections that form the frontier, which enables comparison between firms or, in this context, Decision Making Units. Its advantage lies in the fact that it doesn't apply assumptions to the functional form of the equation or inefficiency.

While SFA uses statistical methods and thus parametrically constructs the frontier. Applying the assumptions of the stochastic optimal frontier, which is based on economic optimization. While it applies assumptions or requires a functional form of an equation, and distributional inefficiency. Its advantage also lies in the fact that it includes Statistical noise/exogenous shocks, as it separates noise/random error 'u' and inefficiency 'v'. DEA had attributed all the differences between a more efficient and less efficient firm to inefficiency, while SFA will provide an accurate depiction of inefficiency and is depicted in Figure 3.



Source: Coelli et al. 2005

Fig. 3 Graphical Representation of Stochastic Frontier Analysis

While Data Envelopment Analysis (DEA) represents an alternative frontier approach, we employ Stochastic Frontier Analysis (SFA) for several compelling reasons. First, SFA explicitly separates random statistical noise from technical inefficiency, a critical distinction for BLEND countries facing significant external shocks over our 40-year panel. Second, SFA provides a formal statistical framework for hypothesis testing and inference about financial development's impact on efficiency. Third, SFA aligns with economic optimization theory, making results more interpretable for policy analysis. Our robustness checks across alternative distributional assumptions (truncated normal, half-normal, exponential) confirm that findings are not sensitive to these specifications, with Financial Institutional Depth coefficients consistently ranging from -0.75 to -0.81 ($p < 0.001$) across all specifications.

Our empirical strategy to decompose TFP and utilize its technical efficiency component could relate to studies like Makiela that utilized one stage to decompose growth, or Frontier Analysis that uses two stage to decompose output growth. A method to incorporate traditional production factors such as Labour and capital, while magnifying/observing the impact technical efficiency can have by decomposing output growth. SFA as an approach was developed in 1977 by Aigner et al. and also by Meeusen, while utilized by Koop et al. in 1995 as a stochastic frontier framework to identify components of growth.

This distinction parallels auxiliary-model approaches in nonlinear system identification, where separating stochastic disturbances from structural inefficiencies has been shown to substantially improve model reliability and robustness(Ali et al., 2024; Ali et al., 2025b).To include time-varying inefficiency, Coelli suggests employing panel data as achieved by Battese and Kumbhakar in their research. So my paper will construct the frontier as:

$$Y_{\{it\}} = X_{\{it\}}\beta + v_{\{it\}} - u_{\{it\}} \quad \text{(Eq 1)}$$

where Yit denotes the output level of country i at time t; X_{it} represents a vector of input variables used in production; β is a vector of coefficients to be estimated; v_{it} captures random (error) statistical noise. And u_{it} reflects technical inefficiency (that can't be negative).

The model presented above is classified as SFA because, as shown in the figure, output values are limited by the stochastic component ($X_{it}\ \beta + v_{it}$), where $v$it is the random error that can be either positive or negative. As a result, stochastic frontier outputs vary about the deterministic function exp($X_{it}\beta$).

Then, in this framework, in the absence of inefficiency when $u_{it} = 0$, the output of the country can exceed the deterministic component if the random error is positive $Y_{it} > \exp(X_{it}\ \beta)$ when $iff\ \varepsilon_{it} \equiv v_{it} - u_{it} > 0$. Alternatively, a country's negative random error $v_{it} < 0$ makes the country fall under a deterministic function $Y_{it} < \exp(X_{it}\ \beta)\ iff\ \varepsilon_{it} \equiv v_{it} - u_{it}$.

Technical Efficiency, expressed as $(-u_{it})$ the proportion of observed output relative to the stochastic frontier output:

$$= TE_{\{it\}} = \frac{\{Y_{\{it\}}\}}{\{\exp(X_{\{it\}}\beta + v_{\{it\}})\}} = \frac{\{exp(X_{\{it\}}\beta + v_{\{it\}} - u_{\{it\}})\}}{\{\exp(X_{\{it\}}\beta + v_{\{it\}})\}} = \exp(-u_{\{it\}}) \quad \text{(Eq 2)}$$

Technical efficiency lies between the range of 0 and 1, for country i and time t in comparison to the potential output of an efficient country using identical inputs.

Maximum Likelihood estimation was used by Aigner to determine the stochastic frontier model's parameters. The following assumptions are specified for the two random components.

$v_i \sim iidN(0, \sigma_v^2)$ (normal random), and

$u_i \sim iidN\ (0, \sigma_u^2)$ (half-normal random).

Then, using the Translog production function, the model transforms as follows:

$$\ln Y_{\{it\}} = a_0 + a_1 \ln K_{\{it\}} + a_2 \ln L_{\{it\}} + a_3 \ln(K^2_{\{it\}}) + a_4 \ln(L^2_{\{it\}}) + a_5(\ln K_{\{it\}} . \ln L_{\{it\}}) + v_{\{it\}} - u_{\{it\}} \quad \text{(Eq 3)}$$

Where Y_{it} denotes output while K and L represent inputs in the form of Capital and labour for a country i and time t. v_{it} captures random (error) statistical noise. And $u$it reflects technical inefficiency.

In this Translog model, flexibility is observed between the inputs as the interaction (lnK*lnL) term and the squared terms for the inputs. Translog permits changing elasticities, in contrast to Cobb-Douglas's simple linear form.

The single-stage ML estimation of all parameters in the model (Eq. 2) was proposed by Coelli. The stochastic frontier analysis (SFA) was conducted using the built-in sfa() function from the FRONTIER package in RStudio, for the estimation of productivity/ efficiency. Coelli et al. (2005) in their research study noted two primary model specifications. Firstly, the error components specification allowed time-varying efficiencies. Secondly, the country effects that are affected by various variables, in our case, are financial development components. To mitigate potential biases associated with two-stage estimation and to address the inherent relationship between financial components and productivity, this study utilizes a single-stage Maximum Likelihood estimation. This ensures that the parameters of the production function and the determinants of inefficiency are estimated simultaneously, maintaining the distributional assumptions of the SFA framework and providing more consistent estimates of the impact of financial development on technical efficiency.

My model, using these specifications, takes the following form

$$Y_{it} = X_{it}\beta + (V_{it} - U_{it}) \qquad , i=1,\dots, N,\ t=1,\dots,T, \quad \text{(Eq 4)}$$

Where Yit at time t denotes the output level of country-i; Xit represents a vector of input variables used in production; β is a vector of coefficients to be estimated; $v$it captures random (error) statistical noise assumed as $iid.(0, \sigma_v^2)$. And $u$it reflects technical inefficiency (that can't be negative), assumed as independently distributed truncated of (M_{it} , σ_u^2) distribution.

$$M_{it} = Z_{it}\,\delta, \quad \text{(Eq 5)}$$

Where Z is a vector of Financial Development components – ($px1$); and δ are parameters that are to be estimated – ($1xp$).

4.2 Data Source and Variables

Penn World Table 10.01 is utilized to gain accurate data of Output, capital and labour represented as 'rgdpo' real GDP Output side at PPP 2017 US$ in millions inputs capital and labour as 'cn': Capital stock at current PPP 2017 US $ in millions and 'emp' [number of persons engaged (in millions)].

"BLEND" countries are an operational lending category by the World Bank. A group of countries that are eligible for both the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA). The blend classification integrates IBRD's non-concessional loans with subsidized funding from IDA to facilitate countries transitioning towards middle-income countries. The Blend category combines IDA's concessional financing for low-income countries with providing flexible support for countries transitioning to middle-income status. It includes countries at varying development stages, which enables a more refined investigation into how financial institutions (structures) and financial markets influence technical efficiency for these countries.

The IMF's Financial Development Index (FDI) provides a comprehensive, unified measure of financial sector development, addressing gaps in existing indicators (Dalloshi, 2022). The IMF's Financial Development Index (FDI) encompasses a comprehensive assessment of both banking institutions (FI) and stock markets (FM), incorporating sub-indices that reflect access, efficiency, and depth.

-Financial Markets: Access (FMA), Efficiency (FME), Depth (FMD)

-Financial Institutions: Access (FIA), Efficiency (FIE), Depth (FID)

Improved Access to financial intermediary institutions plays a prominent role by reducing inequality, as that leads to stability and growth (Levine, 2021). By lowering transaction costs, efficient financial intermediation, and maintaining information access to the public lead to better resource allocation.

Depth is an important metric or sub-index as it reflects resilience to external shocks, or if not deep enough, how long the effect of said shock can affect the economy. A deeper financial system offers various Financial Services and instruments that impact the resilience and stability of the financial system.

The study into these Sub-indicators is essential, as they highlight the importance of efficiency and institutional development in improving growth. Thus, observing the relation between these sub-indices and Technical Efficiency is crucial for examining the effectiveness of financial intermediaries in driving sustainable growth. The Financial Development Index is particularly useful for our research as it enables a more detailed micro analysis of each component of financial development. Adu et al. (2013) show that the measured impact of financial development on growth in Ghana varies significantly depending on the indicator. Credit to the private sector and total domestic credit support growth, while the broad money-to-GDP ratio does not, highlighting the importance of selecting appropriate proxies

The research focuses on BLEND countries, facilitating a more nuanced comparison of efficiency across diverse institutional contexts. Rather than a geographically homogeneous group like South Asian nations, the selection of blend countries contributes to a detailed analysis of economic growth dynamics. The blend category includes 17 countries; this study will focus on 11 (Cameroon, Kenya, Congo Republic, Nigeria, Eswatini, Fiji, St. Lucia, Cabo Verde, Saint Vincent and the Grenadines, Pakistan, Belize) as per data availability for the years under study, 1980-2019. This analysis will be conducted as a panel study, allowing for a more robust evaluation of the dynamics over time and across different countries. Using the SFA method, I will leverage the authoritative Financial Development Index (FDI) from IMF data and the robust input-output metrics from the Penn World Table to evaluate TE.

Table 2 Data Description - Financial Development

Variables	Minimum	Maximum	Mean	Median	Standard Deviation
Y	Saint Vincent (1980) 484	Pakistan (2019) 1088502	98127	7057	219211
K	Saint Vincent (1980) 447	Nigeria (2010) 4243349	303348	16856	758219
L	Saint Vincent (1980) 0.026	Nigeria (2019) 73	9.37	0.28	16.31
FIA	0.00	Belize (1983) 0.73	0.18	0.13	0.16
FID	FID Congo rep (1980) 0.01	Saint Lucia (2008) 0.38	0.13	0.11	0.08
FIE	FIE Congo rep (1980) 0.09	Saint Vincent (1981) 0.82	0.51	0.52	0.14
FMA	0.00	Nigeria (2017) 0.51	0.08	0.00	0.17
FMD	0.00	Pakistan (2007) 0.38	0.04	0.02	0.05
FME	0.00	Eswatini (1997-1998) 1	0.06	0.00	0.19

Table 2 provides summary statistics for the financial development indicators across the 11 countries in the dataset. The variables include financial access, depth, efficiency, and market-related metrics, with values reflecting the full period of observation (1980-2020). Insights into the variation and distribution across countries are presented by the above table as key statistics are revealed in the form of Min, Max, median, mean, and Standard deviation of variables under observation. This classification provides an ideal setting to examine how different institutional frameworks and financial systems impact technical efficiency across diverse developmental contexts.

4.3 Model Specification and Hypothesis Testing

The Stochastic Frontier Analysis (SFA) requires a functional form; in contrast with the DEA method, certain assumptions need to be met, as explained in the empirical Strategy. So the next step employs Likelihood Ratio Tests (LRTs) to check functional form appropriateness, by comparing Translog, Ordinary Least Squares (OLS), and Cobb-Douglas.

4.3.1 Translog vs OLS

The first test evaluates whether including an inefficiency component justifies using an SFA model over OLS. The null hypothesis H_0: $\gamma = u = 0$ implies no inefficiency, and OLS is sufficient.

LRT Statistic: 528.84 Critical Value (χ^2, 11 d.f., 5% level): 19.67

The null hypothesis is strongly rejected, confirming SFA model is better suited than an OLS model and that inefficiency is present in production.

4.2.2 Translog vs Cobb-Douglas

To assess whether the more flexible Translog functional form offers a better fit than the restrictive Cobb-Douglas, a second LRT was conducted. The null assumes interaction and squared terms in the Translog model are jointly insignificant.

Log-likelihood (Translog): 1.82

Log-likelihood (Cobb-Douglas): -149.42

LRT = 302.49, Critical Value = 7.814, Degrees of Freedom: 3

The variation in log-likelihood values exhibits the Translog model as a better fit for our data. Furthermore, the inefficiency parameter γ\gamma is substantially lower in the Translog model (0.34) compared to the Cobb-Douglas model (0.96). This indicates that the Translog model attributes a greater portion of the residual variation to statistical noise rather than inefficiency, aligning more realistically with the nature of the production environment.

4.3.3 Translog Efficiency Effects Frontier (SFA)

Following the framework of Battese & Coelli's Efficiency Effects Frontier, where inefficiency is modeled as a function of both observed factors (FDI components) and unobserved factors. The model takes the following functional form:

$$\ln Y = \alpha_0 + \alpha_1 K + \alpha_2 L + \alpha_3 (\ln K)^2 + \alpha_4 (\ln L)^2 + \alpha_5 (\ln K \cdot \ln L) \quad \text{(Eq 6)}$$

Here, the dependent variable ln(Y) is the logarithm of output, and the independent variables ln(K) (capital) and ln(L) (labor) are inputs to the production process.

Where the inefficiency term is defined as:

$$u_{it} = \delta_0 + \delta_1 \ln FIA_{it} + \delta_2 \ln FID_{it} + \delta_3 \ln FIE_{it} + \delta_4 \ln FMA_{it} + \delta_5 \ln FMD_{it} + \delta_6 \ln FME_{it} + w_{it}$$

u it is the technical inefficiency term for country 'i' and time t. The variables FIA to FME represent the six indices of the Financial Development Index. w it is the truncated normal random variable as specified in the inefficiency distribution.

This formulation allows us to directly assess how each component of financial development influences technical inefficiency across countries and time.

5. RESULTS AND DISCUSSION

In the Production Function, Capital has a negative (-1.7) and statistically significant coefficient (see Table 3). This suggests that as capital increases, inefficiency also increases, indicating that capital might not be effectively utilized. This result is quite typical in efficiency modeling, where a larger capital base may not automatically lead to better production efficiency. While Labor's coefficient is positive (1.68) and statistically significant. This implies that an increase in labor input tends to improve production efficiency, making it an important factor in reducing inefficiency.

Both squared terms, capital ($\ln K^2$) and labor ($\ln L^2$), are significant and positive, indicating diminishing returns to both labor and capital. This suggests that as capital or labor increases beyond a certain point, the additional efficiency benefit is reduced. While the Interaction term (lnK*lnL) is negative (-0.13) and significant. This shows that the combination of capital and labor has a diminishing effect on efficiency, meaning the relationship between labor and capital in the production process is not perfectly complementary.

Inefficiency (Z - Z-Variables): The inefficiency term is influenced by various factors such as FIA, FID, FMA, FMD, and FME.

Z Intercept has a negative coefficient (-0.62), suggesting that inefficiency is generally present in the data but is reduced when controlling for the other variables.

Table 3 Findings of the Regression

Variables	Coefficients	P-value
c	15.5138***	0.0000
lnK	-1.7008***	0.0000
lnL	1.6844**	0.0000
I(lnK^2)	0.1071***	0.0000
I(lnL^2)	0.1269***	0.0000
lnK*lnL	-0.1369**	0.0014
Z_(Intercept)	0.6200***	0.0000
Z_lnFIA	0.5712***	0.0000
Z_lnFID	-0.7869***	0.0000
Z_lnFIE	-0.2307	0.0772
Z_lnFMA	0.1656***	0.0000
Z_lnFMD	-0.3420***	0.0000
Z_lnFME	-0.0122	0.3707
sigmaSq	0.0677***	0.0000
gamma	0.3394**	0.0052
Note: Significance levels: *** p: < 0.001, ** p :< 0.01, * p :< 0.05, p: < 0.1		

In the context of Financial Development Index Components (FDI), the positive and highly significant value for Financial Institutions (FIA) reflects that higher access to financial institutions correlates with an increase in inefficiency (see Table 3). For our set of developing countries in transition, even if finance is readily available, but not accurately utilized in a way that could result in more profitable investments. Thus, if the structure is not effective, access cannot play its role in this framework efficiently.

While for Depth of Financial Institutions (FID), a negative and significant coefficient (-0.80) signifies that greater depth in financial institutions like banks allows inefficiency to be reduced. a more developed financial institution that caters to broader services and deeper credit markets, for example, plays its role by better allocation of resources, which in turn increases productivity. In the case of Efficiency of Financial Institutions (FIE), a negative yet hardly significant result implies an efficient institution plays its role in the financial system by lowering costs involved provision of services, and overall stability points to lower inefficiency as performing banks and institutions lead to efficient allocation and productive investments.

As for Financial Markets FMA, the access component is positive (0.16) and significant, which understates the issue most developing markets face as under-regulated and less developed financial markets carry the risk of misallocation of resources and less prospects of profitable investment, especially in an unstable political background that most of the countries in said BLEND dataset face. Similar to Financial Institutions Depth, Financial Markets Depth also has a negative (-0.34) and significant indicator. Asserting that depth provides channels to diversify investments with better risk evaluation leads to safe, profitable avenues. Lastly, for Efficiency of Financial Markets (FME), being negative but statistically insignificant relates to the fact that the direct link is seen/observed to play its role in the chosen dataset, as Depth is seen to play its role. A more developed and trusted financial market can reveal efficiency as a prime factor for growth, especially in developed countries

Sigma Squared (σ^2) is the variance of inefficiency, and it is significant. A positive and significant σ^2 suggests that there is substantial variability in inefficiency across the countries being studied. The value of Gamma (γ) indicates the proportion of total variation in output that is due to inefficiency. Since it is less than 1, the remaining variation is due to random error. A value of 0.34 suggests that inefficiency accounts for about 34% of the variation in output, which is substantial but not overwhelming. The mean efficiency across all years is 0.686, indicating that, on average, the units in the panel (countries, firms, etc.) are operating at about 69% efficiency, implying there is room for improvement in terms of reducing inefficiency.

5.1 Discussion of Key Findings

The analysis confirms that not all components of financial development uniformly improve technical efficiency. In particular, the strong negative coefficient of Financial Institutions Depth (FID) underlines the importance of well-developed and accessible credit markets. Beck et al. (2000)'s findings validate our argument that the depth of institutions improves efficiency. Similarly for Markets (Monga et al., 2023) reveal that deeper and more liquid financial markets improve the efficient functioning of capital markets, reinforcing the broader productivity benefits of financial development. Kagochi and Durmaz (2020) reveal that while human capital increases economic growth in Sub-Saharan Africa, stock market development is not a significant factor, suggesting that immature financial markets in the region may limit growth effects.

In contrast, the Access component of Financial Development Index is positive for both market and institutions may result from institutional inefficiencies, as per the argument that even when funds are available yet not utilized efficiently do not benefit the technical efficiency of such economies.

Encouraging me to examine institutional capacity in the form of access and depth, Asongu et al. (2016) study shows that information-sharing institutions (PCRs, PCBs) influence financial depth and efficiency across African economies. The observed nonlinearity and sensitivity to institutional context mirror findings from optimization-based identification studies, where system performance varies substantially depending on structural depth, parameter stability, and noise handling(Ali et al., 2025c).

The results reveal a major difference between the roles of financial access and depth. We discuss that in the presence of weak institutional frameworks, greater financial access increases inefficiency through capital misallocation. Following the 'Finance and Misallocation' literature, we recognize that when financial reach expands faster than the ability of institutions to ensure productivity, it leads to dispersion of efficiency. We observe that the 'Paradox of Plenty' plays a central role here: an influx of financial access in resource-rich but institutionally weak nations is observed to fund rent-seeking behavior. Thus, depth fosters output and stability. Access to our dataset of BLEND countries acts as a conduit for inefficient resource distribution.

The results, when observed with the supporting research, emphasize the need for certain reforms in the financial sector. Reforms need to work with all three dimensions, Access, Efficiency, and Depth, as the desired technical efficiency results cannot be experienced to a greater extent without all components complementing each other. Regulation Frameworks and Credit Quality checks need to be placed. The complex nexus and (country-to-country) context influenced impacts of financial development are empirically validated by Arestis et al. (2005) and Arcand et al. (2015).

Studies that reveal differentiated impact, such as Baborska et al. (2020), which reveal divergent impacts of financial service types (where savings reduce food insecurity while credit may worsen it), motivated me to apply a divergent lens, so we studied with the six sub-indices of the financial development index. Similarly, Chavarín (2023) research shows that credit influences productivity impacts on manufacturing and services directly, while indirect effects through consumption directed me to use both institutions and markets together to gain better insight.

The macro-level Financial development index components findings are crucial to understanding the impact of financial development components on efficiency. For a detailed perspective, it is imperative to observe the implications of this impact; thus, a deeper analysis of Technical Efficiency across countries and time is important.

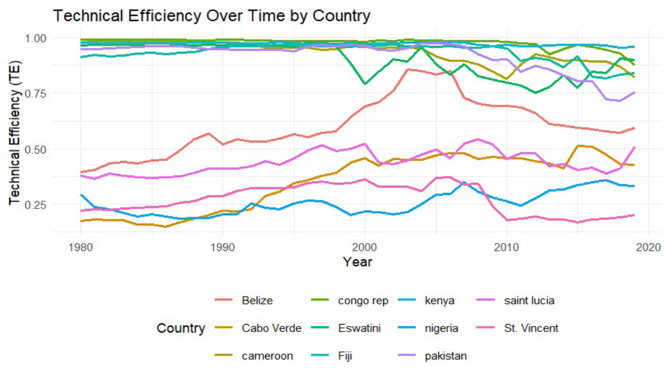


Fig. 4 Technical Efficiency over Time by Country

Significant variation in efficiency within and between countries is observed (see Figure 3) as we analyze the technical efficiency scores for the data set of 11 countries for 40 years in the study (1980-2019). Congo Republic observed the highest average technical efficiency of 0.978. Nigeria, with persistent issues and inefficiencies, recorded the lowest average (0.25) among BLEND countries. An analysis of yearly technical efficiency (to study inefficiency year-wise) scores observes the Congo Republic in 1984 to be the highest, and Cabo Verde with 0.15 to be the lowest single-year TE observation. These results underscore both structural differences in productive performance across countries and the temporal variability that can exist within a single country.

Robustness Checks

To verify the stability of our findings, we conducted several robustness checks.

First, we re-estimated the model excluding the 2008-2010 crisis period to ensure results are not driven by extreme shocks. The coefficients on FID remained negative and significant ($\delta = -0.72$, $p < 0.01$), while FIA remained positive ($\delta = 0.54$, $p < 0.01$), confirming our main findings hold outside crisis periods.

Second, we tested alternative distributional assumptions for the inefficiency term. While our main specification assumes a truncated normal distribution, we also estimated the model under a half-normal assumption (uit ~ $N^+(0, \sigma^2_u)$). Results were qualitatively similar, with FID coefficients ranging from -0.75 to -0.81 across specifications, suggesting our findings are not sensitive to distributional assumptions.

Third, we examined sub-period stability by splitting the sample into 1980-1999 and 2000-2019. The negative effect of FID on inefficiency strengthened in the latter period ($\delta = -0.89$ vs -0.68), potentially reflecting the maturation of financial systems. These robustness checks enhance confidence in our core findings regarding the differential impacts of financial development components.

5.1.1 Country-Specific Context

For this set of Blend countries, Sub-Saharan Africa (Cameroon, Kenya, Congo Rep., Nigeria, and Eswatini) contributes to the highest and lowest technical efficiencies. Zeufack et al. (2020) (World Bank) "Africa's Pulse, Analysis of Issues Shaping Africa's Economic Future". Details the productivity and the role financial development plays for different African countries. Specifically, the Republic of Congo has the highest average technical efficiency (TE), performing strongly at 97.86% (average). Range of efficiencies between 0.88 and 0.99. Bank (2018a) World Bank's country diagnostic report for Congo studies how the oil sector is the main contributor that withstood civil unrest and administrative issues. Kenya (average 0.97), efficiently operating between 0.96 and 0.98, demonstrates its diversified inputs, ranging from services, ICT, and agriculture, that countered the effects of political and administrative instability. Similarly, Cameroon (average 0.93) with ranges from 0.82 to 0.98 had its runs with administrative issues but with better economic management and regional integration, has observed progress in agriculture and infrastructure. Eswatini maintains 90% on average while fluctuating from 75% to 98%, while it faced similar challenges that are faced within this region, namely unemployment and undiversified export reliance on sugar exports. It still exhibits macroeconomic stability, one of the reasons is the preferential trade access. Lastly, among sub-Saharan African countries and BLEND countries, Nigeria records the lowest average Technical efficiency score of 25%. Persistent low efficiency that remains within the range of 19-35% throughout the 40 years under observation stems from administrative issues, mismanagement, and low accounting.

World Bank's "Nigeria: Jumpstarting Inclusive Growth" Joseph-Raji et al. (2019) assesses current issues and steps for revival and establishes that strengthening the weak financial sector will bring positive development in multiple sectors. The second group of countries under the Blend Countries is the Small Island Developing States, namely: Fiji, St. Lucia, St. Vincent and the Grenadines, and Cabo Verde.

World Bank's Small States: Vulnerability and Concessional Finance report Bank (2018b) records how these islands deal with their local and island-specific issues that affect their economic growth and efficiency overall. Like Fiji, with the highest average of 93% in the region and among the top 5 in the BLEND category. Withstanding Coups 3 times and Climate change shocks/disasters, maintaining strong technical efficiency within 82-97% is attributed to sugar exports, foreign remittances, and tourism, while notably Recovery steps and reforms in the 2010s played a crucial role too. Saint Lucia, facing climate disasters committed to transitioning from agriculture to a service-based economy; thus, its low efficiency score of 37% reflects the vulnerability these island nations face. Similar score of 35% for Cabo Verde, which fluctuates between 15-51% technical efficiency. An island nation with scarce resources yet better administrative efforts realizes low to moderate TE Scores. Saint Vincent achieves low Technical efficiency scores of 17-37% for the 40-year study, observed 27% on average, has similar circumstances, undiversified exports, and reliance on tourism, also its narrow export, which also had bananas affected by Climate shocks and liberalization.

Pakistan encountered multiple issues of administrative issues, external debt, and IMF aid reliance scored relatively well among its peers of Blend countries by averaging at 91% and recording 72% as its lowest and 97% at its highest between 1980-2019, which were the 40 years of observation. World Bank (2017), in its Development Update Report 2017 Growth: A Shared Responsibility Bank (2017) addressed satisfactory economic growth while tackling deficits and Debts.

Belize, in North America bordering Mexico to the north, faced external debt crises from 1980 to the 2000s, shuddering with similar circumstances of island nations like climate shocks and reliance on tourism, yet it endured by observing technical efficiency around 60% on average and within the range of 39% to 86% as macro-economic stability was assured.

We conducted a robustness check by estimating a translog stochastic frontier with country fixed effects (FE-SFA), which approximates a panel data specification. Efficiency estimates from this model are moderately to highly correlated with our baseline translog SFA results across the sample period. For example, the correlation between baseline and FE-SFA efficiency estimates ranges roughly from 0.49 to 0.74 in the 1980s and 0.42 to 0.62 in the 2000s. These results indicate that our main findings are robust to country-level heterogeneity, and the potential issue noted in the comment does not affect the substantive conclusions of our study.

While BLEND countries exhibit geographic diversity, they constitute a structurally homogeneous group characterized by low-to middle-income status, weak institutional frameworks, narrow export bases, climate vulnerability, and underdeveloped financial systems. Our fixed effects robustness test, which includes country-specific dummy variables, confirms that even after controlling for time-invariant country characteristics, the core relationship between financial development components and technical efficiency remains statistically significant and directionally consistent with our main findings. This suggests that the finance-efficiency mechanisms we identify operate similarly across this group despite superficial geographic differences.

Analysis of the Technical Efficiency over the years (1980-2019)

While the steep and consistent ascent in the 1990s contributed to post-Cold War reforms worldwide, which, according to 'Global Economic Prospects 2000' World Bank (Bank, 2000), helped developing economies form integration, trade liberalization, and a stronger financial sector. The 2000 to 2010 Decade observes the peak of the 40 years in observation and decline too. The peak around 2005 & 2007 relates to the Global Growth boom and commodity super cycle. World Bank in 2007's 'Global Development Finance'(Bank, 2007) records strong, promising External factors and conditions for developing countries in the Blend dataset. This peak is followed by a continuous decline following the 2008 Global Financial Crisis, as 'World Bank's Response to the Global Economic Crisis Phase-II" (Group, 2012) documents the financial systems' decline and its implications for developing nations.

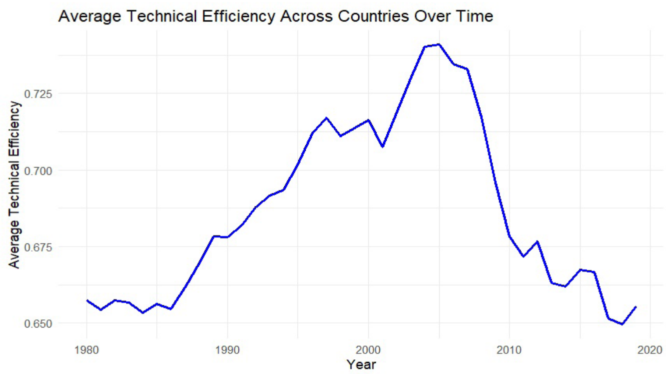


Fig. 5 Average Technical Efficiency across Countries over Time

2010 to 2019 stays above 0.65 average technical efficacy across countries (see Figure 5). These years observe recovery efforts but declines too, as new challenges and crises emerge. 2019's 'Global Economic Prospects: Darkening Skies' (Skies, 2019) study weakened financial systems reeling from financial crises and declining productivity globally.

Multiple crises in the form of • European sovereign debt crisis • Commodity Price Collapse: That caused debt to increase and fiscal/ monetary strain in the Blend Countries. Specifically, Nigeria, being dependent on oil exports, observed high inflation, currency devaluation, and the 2016 Recession. Similarly, Congo oil exporters had to get onto the IMF Programme to recover from the Debt Crisis in 2019. Cameroon, with a diversified export base, had better protection, yet, for fiscal consolidation, entered the IMF plan in 2017. Kenya, being an importer of oil, saw favorable prices, but due to downward demand globally and specifically its nearby partners, Angola and Nigeria. Eswatini, being a less dependent or non-resource dependent economy, performed better but similarly had to widen its borrowing power for support in the budget. • Taper Tantrum 2013: Developing economies are dependent on foreign capital as domestic capital is comprised of underdeveloped financial markets. U.S. Fed's tapering triggered its influence on Blend countries.

6. CONCLUSIONS

This study set out to examine the impact of financial development on technical efficiency across BLEND countries, offering insights into the underlying drivers of productivity within economies undergoing structural transformation. Rooted in theoretical perspectives that highlight the multifaceted role of financial systems in facilitating capital allocation, reducing transaction costs, and enabling technological adoption (Levine, 1997; Acemoglu, 2008), the analysis contributes to a more nuanced understanding of the finance-growth nexus. Specifically, financial development was disaggregated into its core components-depth, access, and efficiency-reflecting recent empirical approaches (Dalloshi, 2022; Cheng and Hou, 2022) that view financial development as a multidimensional construct.

Our findings carry significant implications for the Sustainable Development Goals (SDGs), particularly SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure). The evidence that financial institutional depth reduces inefficiency while unregulated financial access can increase it suggests that achieving sustainable economic growth in BLEND countries requires prioritizing the quality and depth of financial institutions over rapid expansion of access. This insight is particularly relevant for SDG 17 (Partnerships for the Goals), as it informs how international development finance institutions should structure support for transitional economies. For climate-vulnerable nations in our sample (SDG 13), improved technical efficiency through well-developed financial systems can support both economic resilience and more sustainable resource use.

In line with prior literature (Arestis and Demetriades, 1997, Beck et al., 2000), the depth of financial institutions (FID) emerged as a significant determinant of reduced inefficiency, reinforcing the argument that robust financial systems are essential to unlocking productive capacity. This finding is also consistent with Rioja and Valev (2004), who emphasize the differential impact of financial development depending on the stage of economic development. However, the relationship between access, particularly to financial markets (FMA), and efficiency appeared more complex. While greater financial inclusion is generally associated with enhanced outcomes (Afrin et al., 2017; Chen et al., 2022), this study's results suggest that in certain institutional environments, increased access without adequate oversight or risk management can introduce inefficiencies. As stated by Ahamed et al. (2021), financial inclusion without parallel institutional reform may introduce volatility or inefficiency...This supports findings by Schaefer et al. (2021), who observed a lack of direct association between financial constraints and technical efficiency under pressure, emphasizing the non-linear and context-specific nature of the finance-efficiency link.

Methodologically, the study departs from traditional growth accounting models by applying a Stochastic Frontier Analysis (SFA) framework, which allows for the decomposition of inefficiency in production rather than attributing unexplained growth to residual TFP alone. A translog functional form was employed due to its flexibility in modeling substitution effects and capturing interactions between inputs, a choice validated through hypothesis testing against more restrictive specifications. This approach enables a more refined understanding of how different dimensions of financial development influence technical efficiency across countries at varying stages of institutional and economic maturity.

Across the Blend countries under observation, the empirical results reflect a multidimensional relationship instead of a linear pattern. Financial Institutional Depth (FID) is consistently associated with lower inefficiency scores, while Financial Market Access (FMA), although important, may lead to inefficiencies in environments lacking regulatory robustness. These results underscore the importance of targeted or balanced financial sector development strategies that prioritize institutional strengthening and risk-mitigating structures.

Future research should explore formal threshold effects in the finance-efficiency relationship, potentially employing threshold regression techniques to identify critical levels of financial development or institutional quality at which the impact on efficiency changes discontinuously. Additionally, researchers could extend this analysis by grouping countries using institutional quality indices (e.g., World Governance Indicators). Such extensions would complement our findings and provide further granularity to the finance-efficiency nexus in transitional economies.

In conclusion, this research contributes to the growing literature on finance and productivity by applying a technical efficiency lens to developing and transitional economies. Our findings assert the need for financial reforms to be tailored according to country-specific conditions. As observed in the dataset under study, all countries were developing, yet facing unique problems that were observed to be hindering technical efficiency. Future research may further benefit from integrating optimization-driven identification frameworks-successfully applied in nonlinear and fractional-order systems-into macroeconomic efficiency analysis, offering new avenues for modeling institutional complexity and dynamic inefficiencies (Arain et al., 2026).

Policy Implications and Future Recommendations

Based on the empirical findings of this study, several specific recommendations are proposed for BLEND countries to enhance technical efficiency through financial sector development:

- Prioritization of Financial Depth: Policymakers should prioritize the development of deep credit markets and the expansion of financial instruments over rapid access expansion. Increasing the volume of financial transactions relative to GDP should be a precursor to aggressive financial inclusion targets to ensure the economy can effectively absorb capital.
- Regulatory Pre-conditions for Financial Access: Given that financial access (FIA) without adequate oversight can introduce inefficiencies, it is recommended that countries strengthen regulatory frameworks-including consumer protection mechanisms and credit information systems-before launching mass financial inclusion initiatives.
- Investment in Integrated Financial Infrastructure: Future strate-

gies should focus on infrastructure that simultaneously enhances both depth and efficiency. This includes the development of collateral registries, electronic payment systems, and financial literacy programs. The successful 2000s banking reforms in Pakistan serve as a relevant model for combining recapitalization with infrastructure growth.
- Tailored Regional Strategies: Recognizing the heterogeneity within BLEND countries, "one-size-fits-all" policies should be avoided. Small island states (e.g., Fiji) should pursue regional financial integration and specialized insurance mechanisms to mitigate unique constraints like climate vulnerability and limited scale.

Researchers and Policy-makers need to observe the Depth of financial institutions and markets. and the quality of institutions/regulations. As identified by our findings, all components need to be facilitated according to ground realities or country-specific contexts. Further research can be conducted on sectoral differences within a country, and or exploring the impact of institutional Quality measures, if available for the dataset/countries.

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