Advanced Journal of Interdisciplinary Studies
Volume 10, Issue 1, 2026 | Pages 2988–3001
Journal homepage: www.ajids.dmu.edu.et

Research Article

Impact of industrialization on capital formation in Ethiopia: Autoregressive distributed lag modeling approach

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ARTICLE INFO

Received: 26 March 2026
Revised: 10 June 2026
Accepted: 25 August 2026
Available online: 15 September 2026

KEYWORDS

Industrialization, Gross Fixed Capital Formation , Autoregressive Distributive Lag, Error Correction Model, Ethiopia, Remittances

ABSTRACT

This study empirically investigates the impact of industrialization on capital formation in Ethiopia over 1980-2023 using annual time series data from the World Bank Development Indicators and the African Development Bank. The Autoregressive Distributed Lag bounds testing approach and the associated error correction model estimate short-run dynamics and long-run equilibrium relationships among gross fixed capital formation, industrial value added, gross domestic product per capita, urbanization, remittance inflows, the consumer price index, and the domestic saving rate. The findings reveal that industrial value added is not statistically significant as a determinant of capital formation, reflecting three binding constraints: the manufacturing sector's persistently low gross domestic product share , macroeconomic instability characterized by chronic inflation and foreign exchange shortages, and structural bottlenecks including shallow credit markets and infrastructure deficits. This neutral long-run effect contradicts standard structural transformation hypotheses and aligns with evidence from other credit-constrained sub-Saharan economies. Urbanization and remittances have a positive long-run effect on capital formation, exhibiting around 4% elasticity. The Consumer Price Index has a negative significant long-run effect, showing persistent inflation discouraged capital formation through uncertainty and real interest rate channels. In the short run, inflation shows a transient positive association reflecting inventory and cash-flow effects, which the error correction mechanism resolves, removing around 93% of disequilibrium within one period. The study contributes empirical evidence on the industrialization-capital formation nexus in Ethiopia, underexplored in existing literature. Policymakers should prioritize stabilizing inflation, deepening financial markets, and channeling remittances before pursuing structural transformation, as these upstream factors constrain industrialization's capacity to drive capital formation.

1. Introduction

Capital formation is fundamental for the development of a country. It contributes a crucial part to the economic growth of the economy, increases financial intermediation, and advances self-sufficiency in the economy. Moreover, it increases living standards, advances production, and stimulates saving and investment. Capital formation also ensures effective use of natural resources, delivers funding for growth, decreases dependence on foreign investments, relieves the burden of foreign debt, and enlarges the market (Abdullahi, Hassan, &Bakar, 2016; Nadabo, 2023). Capital formation is a key constituent of economic growth (Harrod, 1934). Uzoechina et al. (2024) stated that economic development has its base on the building of both physical and nonphysical assets, and capital accumulation has historically been interconnected to investments in machinery, equipment, and real estate.

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DOI: http://doi.org/10.20372/ajids.2026.2988

According to Todaro and Smith (2011), capital formation comprises progress in job skills, education, and health, as well as new human capital investments and physical instruments to stimulate future economic development.

Many nations have acquired gross fixed capital creation. For example, in Europe and Central Asia, since 2006, it has grown significantly, registering 22.2 percent of GDP in 2022. Likewise, in East Asia and the Pacific, it supplied 29.3 percent of GDP. Nevertheless, as a result of a shortage of capital of, deficiencies in governance, monetary system uncertainties and debt loans and inadequate infrastructure (Fonchamnyo, Dinga, &Ngum, 2021; World Bank, 2023).

Sub-Saharan Africa, including Ethiopia, despite global experience, especially in East Asia, indicates that rapid industrial development has greatly backed capital accumulation and long-term growth has not pursued a similar path (Lin & Chang, 2009; UNIDO, 2021). This indicates that the manner in which industrialization results in capital accumulation is significantly influenced by institutional, financial, and governance elements unique to each country. The term "industrialization" designates the fast socioeconomic transformation that typically takes place in the manufacturing sector and is characterized by the multiplicity of labor systems and production techniques throughout an economy. When a nation's manufacturing sector surpasses other sectors in proportion, it is deemed to have reached a high level of industrialization (Asongu&Odhiambo, 2019).

Ethiopia's capital formation has shown a considerable downward trend over the last four years, failing from 35.3 percent in 2019 to 22.2 percent in 2023. This reduction has hampered the country's growth trajectory as a result of growing public debt to 52% of GDP and broadening fiscal deficits after the war in northern Ethiopia. In addition, due to large part to persistent security concerns, skyrocketing inflation that hit over 30% in 2023 (UNDP, 2023; UNDP, 2024).

Despite ten years of government focus on structural change, the productivity and competitiveness of the Ethiopian economy remain lackluster (Berihu, 2021; Tsegaye, 2021). Given these factors, the present study fills a significant research gap by investigating the relationship between industrialization and capital formation in Ethiopia from 1980 to 2023. Specifically, it raises the following question: Does industrial value added, expressed in constant 2015 USD, have a significant impact on Ethiopia's gross fixed capital formation in the short and long terms? Prior research has mostly focused on macroeconomic factors that influence capital formation, such as inflation and savings rates, without adequately addressing the impact of industrialization. In Ethiopia, where industrialization is a central pillar of the government's development objectives, this gap is chiefly evident (Gebrehiwot & Haile, 2022).

Despite the central role allocated to industrialization in consecutive Ethiopian development frameworks from the Industrial Development Strategy of 2002 through the Growth and Transformation Plans (GTP I and GTP II) and the current Ten-Year Development Plan (2021-2030) no empirical study has employed long-run dynamic time series methods to test whether industrialization as actually measured by industrial output has translated into measureable capital formation over Ethiopia's full post-1980 macroeconomic history. This empirical gap is not only academic: if industrial value added does not drive capital formation, then the resource allocation logic underlying Ethiopia's industrial park program, state-owned enterprise growth, and directed credit policies requires fundamental re-evaluation (World Bank, 2022; Berihu, 2021).

This study has three unique contributions to the current body of knowledge. From previous empirical work, structural adjustment events, the industrial park era, and post-conflict macroeconomic shocks were mainly missing to fully capture Ethiopia's post-Derg economic transition. This study first used a prolonged dataset covering 1980 to 2023. Second, this study uses the ARDL bounds testing approach together with an ECM, which permits a clear separation of short-run dynamics from long-run equilibrium relations, in contrast to previous studies that anchored on cross-sectional or static methodologies. Third, to account for the changes in policy regimes and exogenous shocks that have characterized Ethiopia’s macroeconomic history, the study comprises structural break testing using the Zivot-Andrews approach.

Taken together, these methodological choices make it likely to draw conclusions about whether industrialization considerably influences capital formation that is more robust and relevant to policy. Considering these three features the extended 44-year annual dataset, the ARDL-ECM dynamic methodology distinguishing short-run from long-run effects, & the explicit incorporation of structural break testing via Zivot-Andrews constitute the methodological novelty of this study relative to prior Ethiopia-focused research, which relied predominantly on shorter samples, cross-sectional approaches, or single-period static frameworks (Gebrehiwot & Haile, 2022; Kebede, 2020).

The three methodological innovations of this study,the 44-year dataset, the ARDL-ECM separation of short- and long-run dynamics, and Zivot-Andrews structural break correction together represent contributions that advance the empirical literature on the industrialization-capital formation nexus in low-income Sub-Saharan African economies beyond what shorter-sample or static estimations can provide (Pesaran et al., 2001; Kripfganz& Schneider, 2020).

2. Materials and Methods

To address the goals of this study, secondary quantitative historical data from 1980 to 2023 was used. Important macroeconomic indicators related to capital formation and industrialization is included in the collection.

2.1. Data sources and variable construction

This study produced 44 observations prior to lag adjustment using annual secondary time-series data from 1980 to 2023. All variables were subjected to a natural logarithmic transformation, which allowed the coefficients to be directly interpreted as long-run elasticities and linearized possibly nonlinear relationships preceding the estimation. In this study, "inflation rate" denotes only to the time from one period to the next change in that index (ΔlnCPI) in the short-run error correction equation, while "CPI" refers firmly to the price level captured by the logged index variable (lnCPI) in the long-run equation. This difference clarifies the theoretically constant sign reversal between the short-run positive inflation rate result stated in Section 3.2 and the negative CPI effect across the sample period.

The source of the dependent variable, gross capital creation, which is expressed in constant 2015 US dollars, is the World Bank's Development Indicators. By removing the unclear effect of general price variations, constant price values guarantee that the detected actions precisely signify changes in actual investment actions. Since this study is concerned with the complete volume of investment activity rather than a macroeconomic ratio that would complicate investment and production dynamics, it is appropriate to explain capital formation in log-levels rather than as a share of GDP (Levine &Renelt, 1992).

The general degree of economic progress has been accounted for by the World Bank's GDP per capita, expressed in constant 2015 USD. The main indicator of industrialization, which embraces manufacturing, utilities, mining, and construction, is industrial value added in constant 2015 USD from the African Development Bank. This indicator captures the real productive contribution of the industrial sector to the entire economy.

Table 1. Summary of variables and data sources.

Variables	Definition	Source
CF	capital formation in (constant 2015 USD	World Bank
GDPPC	GDP per capita (constant 2015 USD)	World Bank
IVA	Industry value added in constant 2015 USD	AfDB
URB	Urban inhabitants (percent of total population)	AfDB
REM	personal remittance received from abroad	AfDB
CPI	Headline inflation as measured by Consumer Price Index	World Bank
SR	saving rate as percentage of GDP	World Bank

Source: Prepared by Author (2026)

Industrial value added is selected as the industrialization proxy in preference to manufacturing value added alone for three reasons specific to Ethiopia's structural context. First, Ethiopia's industrial base remains highly diversified across construction, utilities, and extractives, with manufacturing contributing less than 5 percent of GDP throughout the sample period; restricting the proxy to manufacturing alone would omit the dominant components of industrial activity (World Bank, 2023). Second, industrial value added in constant prices directly captures the real productive contribution of the entire industrial sector, consistent with how industrialization is operationalized in comparable Sub-Saharan African studies (Asongu&Odhiambo, 2019; Szirmai&Verspagen, 2015). Third, the mechanism through which industrial value added should influence gross fixed capital formation operates through retained earnings reinvestment, supply-chain backward linkages, and the demand for machinery and equipment that industrial expansion generates channels that aggregate industrial output captures more completely than manufacturing alone (Haraguchi et al., 2017). The robustness of this proxy choice is confirmed in Section 3.8, where the manufacturing value-added share of GDP is substituted as an alternative industrialization measure and the direction and significance of findings are qualitatively unchanged.

The percentage of the population living in urban areas is used to enumerate urbanization. Personal remittances received from abroad in current US dollars are referred to as remittances (R). The elasticity of capital formation in relation to the general level of prices since the Consumer Price Index, which measures headline inflation, enters the model in natural logarithm form by the representation of long-run coefficient.

2.2. Model specification

This study aims to analyze how industrialization impacts capital formation. To accomplish this, the study employs the following empirical model:

$$lnCF = f(lnCF, lnGDPPC, lnIVA, lnURB, lnREM, lnCPI, lnSR) \quad (1)$$

where the natural logarithm of capital formation , expressed in constant 2015, is represented by $lnCF$. USD ;$lnGDPPC$ denotes the natural log of per capita GDP, also in constant 2015 USD;$lnIVA$ is the natural logarithm of industrial value added, expressed in constant 2015 USD;$lnURB$ stands for the natural logarithm of the percentage of the population that lives in cities ;$lnREM$ shows the natural logarithm of the personal remittances received from abroad; While $lnSV$ is the saving rate expressed as a proportion of GDP, $lnCPI$ signifies the exponential log of inflation.

The level equation of an autoregressive distributed lag (ARDL) model of order is used for our empirical model $(p, q_1, q_2, q_3, q_4, q_5, q_6)$, denoted by $ARDL(p, q_1, q_2, q_3, q_4, q_5, q_6)$ can be expressed as follows:

$$lnCF_t = \beta_0 + \sum_{i=1}^{p} \alpha_i lnCF_{t-i} + \sum_{i=0}^{q_1} \beta_{1i}\, lnGDPPC_{t-i} + \sum_{i=0}^{q_2} \beta_{2i}\, lnIVA_{t-i} + \sum_{i=0}^{q_3} \beta_{3i}\, lnURB_{t-i} + \sum_{i=0}^{q_4} \beta_{4i}\, lnREM_{t-i} + \sum_{i=0}^{q_4} \beta_{5i}\, lnCPI_{t-i} + \sum_{i=0}^{q_4} \beta_{6i}\, lnSR_{t-i} + u_t \quad (2)$$

We can re-parameterize the above equation in the following **Error-correction** form:

$$\Delta lnCF_t = \alpha_0 + \sum_{i=1}^{p-1} \theta_i \Delta lnCF_{t-i} + \sum_{i=0}^{q_1-1} \varphi_{1i}\, \Delta lnGDPPC_{t-i} + \sum_{i=0}^{q_2-1} \varphi_{2i}\, \Delta lnIVA_{t-i} + \sum_{i=0}^{q_3-1} \varphi_{3i}\, \Delta lnURB_{t-i} + \sum_{i=0}^{q_4-1} \varphi_{4i}\, \Delta lnREM_{t-i} + \sum_{i=0}^{q_5-1} \varphi_{5i}\, \Delta lnCPI_{t-i} + \sum_{i=0}^{q_6-1} \varphi_{6i}\, \Delta lnSR_{t-i} + \psi ECT_{t-1} + \varepsilon_t \quad (3)$$

Where $ECT_{t-1} = lnCF_{t-1} - \theta_1 lnGDPPC_{t-1} - \theta_2 lnIVA_{t-1} - \theta_3 lnURB_{t-1} - \theta_4 lnREM_{t-1} - \theta_5 lnCPI_{t-1} - \theta_4 lnSR_{t-1}$

It distinguishes the adjustment parameter for resolving long-term equilibrium deviations and discovers the coefficients that reflect both short and long run relationships.

2.3. Justification for the ARDL approach

Several features of the data and the nature of the research topic influence the selection of the ARDL bound testing approach, which was first developed by Pesaran, Shin, and Smith (2001). First, as shown by the unit root results in Table 3, the ARDL framework is especially well-suited to circumstances in which variables show mixed orders of integration, some stationary at level I(0) and others at first differences I(1). In contrast to the Johansen method, which necessitates that every variable have the same integration order, the ARDL allows for this combination without imposing stringent pre-testing presumptions.

Second, the ARDL bounds test performs reliably for small to moderate sample sizes (Narayan, 2005). The present study works with 44 annual observations, yielding 40 usable observations after lag adjustment, which places it at the

lower boundary of reliable asymptotic inferences. To address this directly, critical values for the bounds test were drawn from Kripfganz and Schneider (2020), whose response surface simulation procedure generates case-specific critical values calibrated to the exact sample size, number of regressors, and deterministic specification. This approach is functionally equivalent to bootstrapped critical values in its finite-sample correction properties and represents the current methodological standard for small-sample ARDL inference.

Third, the short-run dynamics and long-run equilibrium relationships within a single equation distinguish the immediate from the sustained effects of industrialization on capital formation estimated by the ARDL specification simultaneously. Fourth, as a well-documented feature of Ethiopia's macroeconomic history, the ARDL framework is robust to structural breaks. The Zivot-Andrews unit root test was explicitly used to verify integration properties while endogenously controlling for potential regime shifts, confirming that all variables remain I(1) even after allowing for a single endogenous break in intercept or trend. Parameter stability was assessed using CUSUM and CUSUMSQ tests following Brown, Durbin, and Evans (1975), with plots remaining within 5% critical bounds throughout the sample period.

In development economics, the bidirectional relationship between industrial value-added and capital formation is recognized, and this study openly acknowledges the weak exogeneity as a condition of the single-equation framework. The inclusion of two lags of capital formation as an autoregressive component in the selected ARDL(2, 0, 0, 1, 1, 1, 1) specification reduces the risk of reverse causality affecting short-run dynamics. Future research incorporating Toda Yamamoto Granger causality testing or a VAR system with longer panel data would provide a more complete identification of causal direction (Toda & Yamamoto, 1995).

3. Results and Discussion

3.1. Descriptive statistics

Table 2 presents the statistical for the variables summary included in the empirical model. During the sample study period, Ethiopia received an average of USD 255 million in remittances yearly, with an average annual inflation rate of nearly 23 percent. On average, 16% of the population lived in towns. Between 1980 and 2023, every variable exhibited a general upward trend, except saving rate.

Table 2. Descriptive Statistics of model variables, 1980-2023.

Variables	Mean	Std.Dev.	Min	Max
Capital Formation (constant 2015 USD) (in billions)	7.501	8.08	0.85	24.72
GDP per capita (constant 2015 USD)	409.29	206.66	215.64	890.35
Industry value added(constant 2015 USD) (in billions)	5.92	7.41	0.99	26.34
Urbanization (% of the total population)	15.66	3.62	10.41	23.16
Remittance (current USD) (in millions)	255.24	361.77	5.22	1796.38
Consumer price index	123.45	179.99	12.92	858.42
Saving ate (% of GDP)	17.66	10.84	5.73	51.03

Source: Prepared by Author (2026)

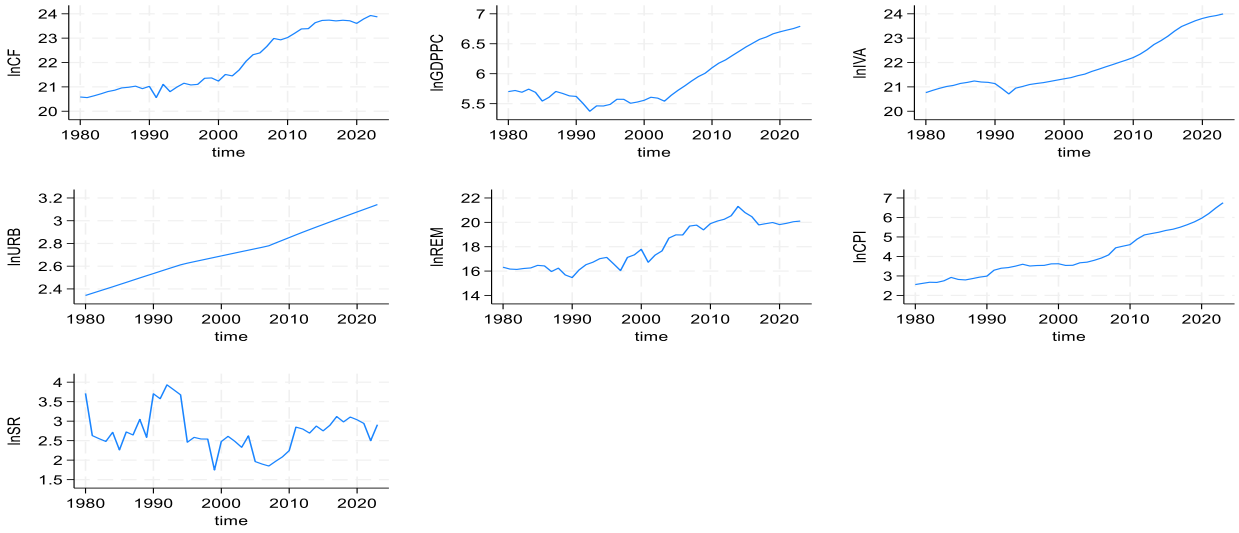

Figure 1. The trend of model variables in natural logarithm over (1980-2023).

Source: Prepared by Author (2026)

3.2. Unit Root test results

To confirm the stationary properties of the series, the Augmented Dickey-Fuller (ADF) test was applied to all variables at both levels and the first differences. As shown in Table 3, all variables are non-stationary at levels but become stationary after first differencing, proving that all are integrated of order one, I(1). As no variable reaches I(2), the ARDL bounds testing approach is validated as the most fitting estimation framework. In addition, Zivot - Andrews tests, allowing for endogenous structural breaks in both intercept and trend, validated this I(1) classification across all series, maintaining the validity of the bounds testing procedure.

Table 3. ADF Unit Root test results

Variables	Level		First difference		Conclusion
	Constant	Constant & trend	constant	Constant & trend	
lnCF	0.005	-0.112	-1.198***	-1.226***	I(1)
lnGDPPC	0.023	-0.059	-0.748***	-1.104***	I(1)
ln IVA	0.015	-0.035	-0.420***	-0.620**	I(1)
lnURB	0.001	-0.034	-0.110*	-0.137	I(1)
lnREM	-0.031	-0.221	-1.109***	-1.109***	I(1)
lnCPI	0.034	-0.006	-0.587***	-0.847***	I(1)
ln SR	-0.248	-0.248	-1.177***	-1.175***	I(1)

***Significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.
Source: Prepared by Author (2026)

3.3. Optimal lag selection

Determining the optimal lag length is a vital pre-estimation step in ARDL modeling. An insufficient lag structure risks omitting relevant dynamics and creating serially correlated residuals, while an excessively generous lag structure wastes degrees of freedom and presents multicollinearity (Pesaran et al., 2001). This study used four complementary information criteria simultaneously: the Akaike Information Criterion (AIC), the Hannan-Quinn Information Criterion (HQIC), the Schwarz Bayesian Information Criterion (SBIC), and the sequential likelihood ratio (LR) test, together with the Final Prediction Error (FPE). Given the yearly data covering 1980 to 2023, a maximum lag length of four was set as the upper bound, consistent with the standard convention for yearly data (Lütkepohl, 2005).

As presented in Table 4, the lag selection results converge at lag 4 for the majority of the criteria. The SBIC selects lag 1, consistent with its well-documented tendency to favor parsimonious specifications in small-to moderate-sized samples. Given the main objective of capturing the full dynamic adjustment path between industrialization and capital formation, the AIC-selected lag 4 is retained as the baseline. The final ARDL(2, 0, 0, 1, 1, 1, 1) specification was selected based on the lowest AIC value. Robustness to alternative lag structures selected by HQIC and SBIC was confirmed, with the direction, sign, and magnitude of long-run coefficients continuing to be stable and the error correction term retaining its predictable sign and significance across all specifications.

Table 4. Optimum lag length criteria for the model capital formation result. Number of obs = 40, Sample: 1984 - 2023

LAG	LL	LR	Df	p	FPE	AIC	HQIC	SBIC
0	0.682864			5.30E-08	0.26586	0.357454	0.519189	
1	350.368	699.37	36	0	8.30E-15	-15.4184	-14.7772	-13.6451*
2	400.488	100.24	36	0	4.60E-15	-16.1244	-14.9336	-12.8311
3	448.752	96.528	36	0	3.60E-15	-16.7376	-14.9973	-11.9243
4	528.216	158.93*	36	0	9.0e-16*	-18.9108*	-16.6209*	-12.5775

Endogenous: lnGDPPClnIVAlnURBlnREMlnCPIlnSR, Exogenous: _cons, * indicates the optimum lag length selected by the criteria. Source: Author's compilation based on stata output (2026)

3.4. Cointegration Bounds Test

Table 5 presents the results of the cointegration bounds test. The computed F-statistic of 6.134 and t-statistic of -4.313 were compared against critical values from Kripfganz and Schneider (2020), which were standardized to the exact sample size and regressor count of this study. Both statistics surpass the upper critical bounds at the 5 percent significance level, leading to the categorical rejection of the null hypothesis of no long-run relationship. This validates the existence of a stable long-run cointegrating relationship among capital formation, industrial value added, GDP per capita, urbanization, remittances, the consumer price index, and the saving rate.

Table 5. The cointegration bound-test.

Test statistic	Value	K	
F-statistic	6.134	6	
T-statistic	-4.313	6	
Critical thresholds at the 5% significance level:			
F-statistic	0.001	0.008	0.001
T-statistic	0.002	0.059	0.002

Source: Prepared by Author (2026)

3.5. Long-Run model results

Table 6 presents the long-run model estimates. Among the six explanatory variables, three urbanization, remittances, and the consumer price index show statistically significant effects.

Table 6. Long-run model results.

The model selected is ARDL(2, 0, 0, 1, 1, 1,1) based on AIC			
Dependent Variable: ln Capital Formation			
The long-run model result			
Variable	coefficient	Standard error	probability
lnGDPPC	0.791	0.472	0.105
lnIVA	0.120	0.229	0.602
lnURB	3.982***	0.931	0.000
lnREM	0.304***	0.052	0.000
lnCPI	-0.632***	0.172	0.001
lnSR	-0.085	0.058	0.157

*** significant at 1%, ** significant at 5%, * significant at 10%, Source: Prepared by Author (2026)

In Ethiopia, the long-term impact of industrial value added (lnIVA) on capital formation was not statistically significant. When equated to the structural features of Ethiopia's economy from 1980 to 2023, this conclusion is theoretically sound and empirically supported, despite the fact that it primarily seems paradoxical considering the importance placed on industrialization in Ethiopia's subsequent development initiatives. This result can be explained by three channels.

First, there are timing and capital-deepening lags. Capital deepening is a slow process whereby industrial production growth first produces retained earnings, inspires reinvestment choices, and finally results in an evident rise in gross capital formation. This process may take several years. The coefficient remained statistically insignificant across all extended lag specifications when the model was re-estimated to permit extended lags of up to four periods of industrial value added within the ARDL bounds testing framework. This suggests that the lack of a significant relationship is not due to an inadequate lag window but rather indicates a true structural disconnect. This result is in line with Szirmai and Verspagen (2015), who show that industrialization's potential to stimulate investment depends on a minimum level of industrial complexity and technological capability, which several low-income African economies have not yet reached.

Second, sectoral composition: in Ethiopia, industrial value-added embraces mining and quarrying, manufacturing, construction, and utilities into a single aggregate metric. Manufacturing has remained below 5% of GDP for the duration of the sample period, whereas the construction subsector, which is primarily driven by publicly financed infrastructure, has contributed a disproportionately large percentage of industrial value-added growth, particularly after 2010 (World Bank, 2023). Therefore, rather than the growth of productive manufacturing capacity that theoretical models identify with self-reinforcing capital formation multipliers, Ethiopia's growth in aggregate industrial value added has typically signified public construction activities.

Additionally, the construction component of industrial value added and the dependent variable partially measure overlapping economic phenomena, which mechanically attenuates the estimated long-run coefficient because gross capital formation, as measured in this study, already includes public infrastructure investment within its accounting definition.

Third, crowding-out and financial constraints: Ethiopia's industrialization strategy has been primarily state-directed, with the government using domestic bond issuance, external concessional borrowing, and administratively directed credit allocation to finance industrial parks, state-owned businesses, and large-scale infrastructure. This financing model has well-established crowding-out consequences: public sector borrowing increases effective real borrowing costs, decreases the amount of commercial bank credit available to the private sector, and competes with private firms for limited loanable funds (Aschauer, 1989; Erden and Holcombe, 2005).

Throughout the entire sample period, credit to the private sector as a percentage of GDP has continuously been among the lowest in sub-Saharan Africa, averaging less than 15% (World Bank, 2023). Because the financial transmission mechanism is structurally hindered at the credit allocation stage, even real industrial output development may not encourage wider capital formation under these structural conditions.

Estimated at 3.982, the long-run coefficient for urbanization is statistically significant at the 1 percent level. This indicates that when all other factors are held constant, a 1 percent increase in urbanization corresponds to almost a 4 percent increase in capital formation.

Urban locations promote capital formation by concentrating economic activity, easing agglomeration economies, improving market access, and inspiring entrepreneurial activity through denser local markets and better access to financing (Jacobs et al., 2023; El HediArouriet al., 2014). This indicates the model's highest elasticity and validates urbanization as Ethiopia's primary long-term driver of capital increase.

According to the long-run coefficient for remittances, which is 0.304 and statistically significant at the 1% level, a 10 percent rise in remittance inflows is connected to a roughly 3 percent increase in capital formation over time. Remittances contribute to capital formation through several channels: enhancing household income, encouraging savings, supporting education, and nurturing entrepreneurial activities. They also serve as a significant basis for foreign exchange, supporting the procurement of capital goods and intermediate inputs. Financial sector development intensifies this positive impact by channeling remittances more efficiently into productive investment (Ferdaous&Rahman, 2019).

The consumer price index has a long-run coefficient of -0.632, which is statistically significant at the 1 percent level. This indicates that a 10 percent increase in prices is equivalent to a 6.32 percent decrease in capital creation.

Inflation erodes the real value of savings, discourages investment performance, strengthens price volatility, and creates uncertainty regarding predictable returns on investment projects. Investors become more cautious as a result of increased uncertainty, which ultimately slows capital formation. Moreover, high inflation may make it more difficult to obtain the external and domestic funding vital to endure investment operations (Aisen &Veiga, 2013; Pindyck&Solimano, 1993).

3.6. Short-run model results

Table 7 presents the results of the short-run error correction model. The period-to-period change in the logged price index is signified by the regressor ΔlnCPI in the short-run equation, which efficiently captures the inflation rate rather than the price level. A transitory 5.91 percent rise in capital formation is correlated with a 10 percent acceleration in the short-run inflation rate, according to the lagged short-run CPI coefficient (ΔlnCPI(-1)), which is 0.591 and statistically significant at the 5 percent level. This short-term positive relationship is consistent with several theoretical works: the cash-flow channel acknowledges that moderate short-run inflation can temporarily increase firm revenues in nominal terms faster than costs adjust; the inventory estimate result suggests that firms facing rising input prices quicken capital accumulation as a hedge against additional cost increases; and the Tobin's q channel suggests that unexpected inflation temporarily raises the nominal market value of existing capital assets relative to replacement cost, inspiring new investment (Tobin, 1969; Pindyck&Solimano, 1993). The difference between nominal cash-flow stimulation effects that predominate over short horizons and real interest rates and uncertainty channels that predominate over longer horizons is reflected in the sign reversal between the short-run and long-run CPI coefficients, which is a well-established empirical regularity in investment equations estimated within the ARDL-ECM framework. Approximately 93.1 percent of any short-run divergence from the long-run equilibrium path is rectified in a single period, according to the error correction coefficient ECM(-1), which is -0.931 and statistically significant at the 1 percent level. Thus, the inflationary stimulus observed in the short run is transitory, and the dominant long-run contractionary effect prevails.

Remittances show a short-run negative connection (-0.108, significant at the 10 percent level), which is consistent with the well-established pattern that recipient households first use remittances for consumption smoothing before activating channels for productive investments. This short-run versus long-run dynamic shows that the investment advantage of remittances demonstrates with a lag and is in line with theoretical prospects.

Table 7. Short-run error correction model results.

The short-run model result			
Variable	coefficient	Standard error	probability
$\Delta(lnCF(-1))$	-0.247	0.145	0.101
$\Delta(lnURB)$	19.045	12.905	0.151
$\Delta(lnREM)$	-0.108*	0.058	0.071
$\Delta(lnCPI)$	0.369	0.260	0.167
$\Delta(lnCPI(-1))$	0.591**	0.259	0.031
$constant$	0.682	2.225	0.761
$ECM(-1)$	-0.931***	0.215	0.000

Source: Prepared by the Author (2026)

3.7. Model Diagnostic Tests

A structured set of post-estimation diagnostic techniques was used to assess the robustness of the estimated ARDL model. All the findings, which are compiled in Table 8, demonstrate that the model satisfies the fundamental classical presumptions that underpin sound inference. Urbanization (3.982), remittances (0.304), and CPI (-0.632) are reported as long-run elasticities with significant effects at the 1 percent level.

The Breusch-Godfrey LM test yields a statistic of 0.751 with a p-value of 0.386, confirming no serial correlation in the residuals. The homoscedastic error variance is confirmed by the Breusch-Pagan test for heteroskedasticity, which yields a statistic of 2.400 with a p-value of 0.121.

Cameron and Trivedi's decomposition of the information matrix test produces a joint statistic of 48.310 with a p-value of 0.692, concurrently evaluating heteroskedasticity, skewness, and excess kurtosis, including what a separate Jarque-Bera normality test would assess. The Ramsey RESET test for functional form misspecification yielded a

statistic of 1.840 with a p-value of 0.164, confirming the double-logarithmic specification. Figure 2 shows that both the CUSUM and CUSUMSQ statistics endure within the 5 percent critical bounds throughout the estimation period, delivering strong evidence of parameter stability across Ethiopia's major macroeconomic breaks, including the political transition of 1991, the Ethio-Eritrean conflict of 1998-2000, and the multiple shocks of the post-2019 period.

Table 8. Model diagnostic test.

Test	Statistic Value	probability
Breusch-Godfrey LM test for autocorrelation	0.751	0.386
Breusch-Pagan test for heteroskedasticity	2.400	0.121
Ramsey RESET Test	1.840	0.164
Cameron &Trivedi's decomposition of IM-test	48.310	0.692

Source: Prepared by the Author (2026)

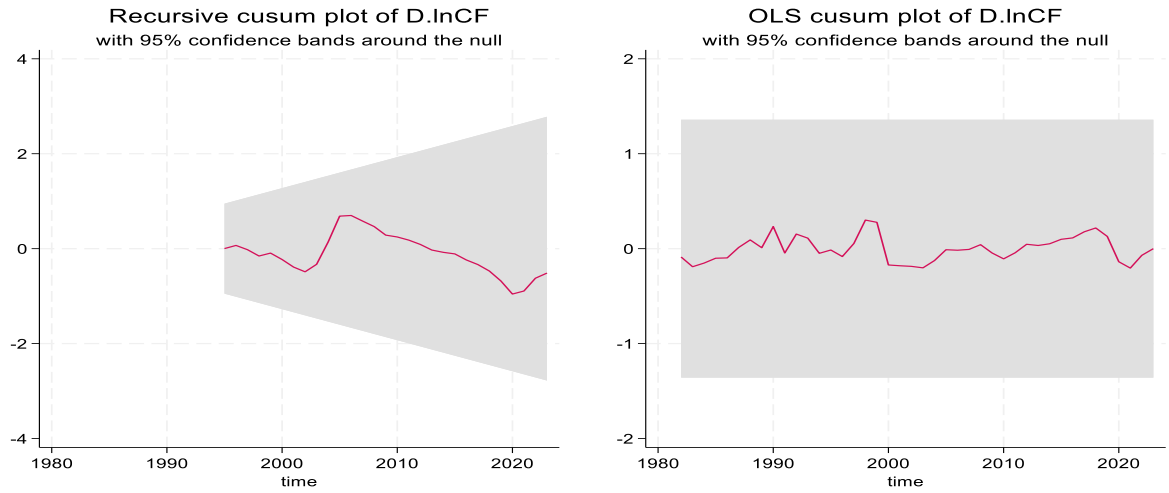

Figure 2. CUSUM and CUSUMSQ Stability Plots.

Source: Prepared by the Author (2026)

3.8. Robustness checks

Several robustness checks were conducted to confirm that the main conclusions were not artifacts of a specific specification, variable definition, or sample makeup. First, according to Haraguchi et al. (2017), the manufacturing value-added share of GDP was substituted for the baseline industrialization proxy of industrial value added. The coefficient remained statistically insignificant across all alternative specifications, showing that the insignificant finding represents real structural constraints rather than a measurement artifact. Second, the direction, magnitude, and significance of all long-run coefficients remained qualitatively unchanged when the dependent variable was re-expressed as gross capital formation as a percentage of GDP instead of real log-levels, indicating that the results are not dependent on a single measurement convention (Levine &Renelt, 1992).

Third, binary dummy variables were used to account for the multiple post-2019 shocks, the high inflation phase (2008–2011), and the Ethio-Eritrean conflict era (1998-2000). The essential coefficient estimates were consistent across all the dummy-augmented specifications. Since dividing the 44 data points would lower each sub-period below the minimum threshold for trustworthy ARDL inference (Narayan, 2005), formal sub-sample splits were not explored. Instead, the CUSUM and CUSUMSQ tests indicate parameter stability throughout the policy episodes.

4. Conclusion and policy implications

4.1. Conclusion

Although Ethiopia's economy has grown significantly over the last 15 years, this expansion has mostly been fueled by capital formation from significant governmental investments in social and physical infrastructure rather than structural change brought about by industrialization (Berihu, 2024). Using annual data from 1980 to 2023, this study assessed the effect of industrialization on capital formation in Ethiopia. The results show that, in line with accepted economic theory, urbanization and remittance inflows have a statistically significant and positive relationship with capital formation, whereas the consumer price index has a significant negative influence. However, during the study period, industrial value addition did not have a substantial impact on capital formation.

The manufacturing sector's share of Ethiopia's GDP has remained below 5% for the entire sample period, and the contribution of manufactured goods to total merchandise exports and overall GDP has remained negligible. These results demonstrate the limited contribution of the industrial sector to Ethiopia's GDP (Kebede, 2020).

This study is innovative for three reasons. Methodologically, the ARDL-ECM framework distinguishes between short- and long-run effects, a feature absent from previous studies on Ethiopia. The 44-year dataset provides empirical coverage of structural changes that shorter studies cannot wholly capture. Conceptually, this study explicitly examines whether Ethiopia's industrialization program results in quantifiable capital accumulation by separating industrial value added as a separate explanatory variable. It concludes that it does not, at least not during the study period. The macroeconomic relationship between industrialization and capital formation in early stage developing countries is still very context-dependent, as demonstrated by this empirical discrepancy, which entirely justifies the re-examination of traditional structural transformation assumptions.

4.2. Policy implications

The empirical results yield an organized and empirically braced set of policy recommendations based on a purposeful sequencing logic that is directly derived from the dynamic properties of the estimated model: rather than functioning as parallel or interchangeable priorities, macroeconomic stabilization and financial deepening must come before easing industrial policy and urban investment strategies.

First priority: Price stabilization and a credible monetary framework (anchored to the CPI elasticity of -0.632) are the top priorities. The most reliable conclusion of this study is that incessant inflation has a strong negative long-run elasticity of -0.632 on capital formation, which means that a 10% increase in the price level eventually lowers real capital formation by approximately 6.32%. Establishing a reliable, rules-based monetary policy framework that stabilizes inflation expectations, lowers nominal uncertainty, and reestablishes positive real interest rates must be the top priority for policymakers. Fiscal consolidation, which reduces the monetization of public deficits, a persistent driver of inflationary pressure in Ethiopia, is equally vital.

It is openly highlighted that the transitory positive short-run relationship between inflation and capital formation identified in this study should not be interpreted as a policy justification for tolerating inflation as an investment stimulus. According to the error correction process, 93% of any inflationary disequilibrium is resolved in a single period, and the long-run contradictory effect is clearly dominant.

Second Priority: Financial market deepening and private credit expansion. The crowding out of private investment through a state-directed financial system provides the most convincing explanation for the insignificance of industrial value added as a driver of capital formation. To address this, financial sector policy must be chiefly reoriented toward increasing private sector credit access through the development of capital market instruments, such as corporate bond markets and equity financing platforms, the liberalization of directed credit ceilings, and the strengthening of credit information infrastructure. Further evidence that deepening financial intermediation will heighten this channel by offering savings products and investment vehicles that change household liquidity into capital formation comes from the beneficial long-term impact of remittances on capital formation.

Third Priority: Remittance policy and diaspora investment mobilization (anchored to remittance elasticity of 0.304). A 10% increase in remittance inflows results in a 3% increase in real capital production, according to the statistically significant positive long-run elasticity of 0.304 that remittances exert on capital formation. The lag between the inflow and capital formation response will be compressed by interventions that speed up the shift from remittance consumption to investment use. Reducing the cost of international transfers, inspiring mobile banking services that

direct remittances into savings and investment accounts, and creating diaspora bond instruments based on effective models from Israel and India are all feasible ways to direct diaspora savings into profitable investments. Enhancing the legitimacy of the foreign currency market will also increase the amount of money sent through official channels.

Fourth Priority: Urban investment and agglomeration channeling (anchored to the 3.982 urbanization elasticity). Urbanization has the strongest long-run elasticity in the model at around 4 percent, signifying that the spatial concentration of economic activity in Ethiopian cities causes powerful agglomeration effects. To realize this potential, deliberate tools that direct the demand produced by urbanization toward profitable physical investment rather than informal settlements are needed. These include municipal bond markets for the long-term financing of urban infrastructure, industrial parks with entrenched finance linkages, urban land titling, the provision of serviced industrial and commercial plots, and transit-oriented development strategies that concentrate residential and commercial density around transportation nodes (Jacobs et al., 2023; El HediArouri et al., 2014).

Fifth Priority: Enabling conditions for industrial policy effectiveness. The lack of industrial value added as a direct driver of capital formation should not be seen as evidence against industrial policy in and of itself, but rather as proof that industrial policy has been working in an enabling environment that is too limited to permit industrial expansion to produce quantifiable investment multipliers able to create the forward and backward investment links necessary to convert the development of industrial output into capital formation.

To the opposite of the traditional development policy narrative, which views structural transformation as the main lever of capital formation regardless of the macroeconomic and financial context, this research's main policy lesson is to stabilize and deepen first, then scale industrial and urban investment (Rodrik, 2016; Szirmai&Verspagen, 2015).

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