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Does Financial Deepening Predict Manufacturing Growth? Evidence from a Lagged Panel Fixed-Effects Analysis of 158 Economies, 1990–2024

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Abstract

This study examines whether domestic credit to the private sector, measured as a percentage of gross domestic product, is associated with manufacturing value-added growth in the subsequent year. Using an archived World Development Indicators dataset, an unbalanced panel of 3,496 annual observations across 158 economies over 1990–2024 is estimated with country and year fixed effects. The explanatory variable and four macroeconomic controls—foreign direct investment, trade openness, consumer-price inflation, and gross capital formation—are lagged one year. The main model yields a negative coefficient on private-sector credit depth ($\beta = -0.0298$; country-clustered $p = 0.0023$), equivalent to approximately 0.30 percentage point lower subsequent manufacturing growth for a 10-percentage-point higher credit-to-GDP ratio, conditional on the specified controls and fixed effects. This association persists in several outlier and sample checks. Exploratory interactions suggest that the negative association is less pronounced after 2010 (difference = +0.0303; $p = 0.0101$), whereas interaction tests at 2005 and 2008 do not establish significant changes. A quadratic specification indicates a possible U-shaped pattern, but its high-credit turning point is weakly supported by the available observations. The findings caution against equating economy-wide credit depth with productive credit reaching manufacturing firms. Because the design does not identify a causal effect or observe sectoral credit allocation, the results support a conditional association rather than a claim that credit expansion reduces industrial growth.

Keywords: *financial deepening; private-sector credit; manufacturing value added; panel data; fixed effects; World Development Indicators; industrial development*

1. Introduction

Financial intermediation occupies a central position in explanations of economic development because it can mobilize savings, assess investment opportunities, manage liquidity, and facilitate the allocation of resources toward productive enterprises. The manufacturing sector is especially relevant to this argument. Many manufacturing activities require up-front expenditures on machinery, structures, inventories, technology, and working capital before revenues are realized. A sufficiently developed financial system could, in principle, relieve these financing constraints and permit firms to expand output, innovate, and participate in domestic and international markets. The empirical work of Rajan and Zingales (1998), for example, showed that industries more dependent on external finance tended to develop more rapidly in economies with stronger financial systems. Beck, Levine, and Loayza (2000) likewise linked financial intermediary development with productivity-driven aggregate growth. These arguments suggest that deeper private-sector credit markets could precede stronger manufacturing performance.

Nevertheless, the presence of a large financial sector is not equivalent to the availability of affordable and appropriately structured credit for manufacturing enterprises. Aggregate private-sector lending also finances households, housing, commerce, and services, and its distribution across borrowers may vary significantly across countries. The indicator conventionally used to measure credit depth—domestic credit to the private sector as a percentage of GDP—captures financial claims extended to private borrowers by financial corporations, including instruments beyond conventional bank loans. It does not identify how much financing reaches manufacturing firms or whether borrowing terms are conducive to productive capital formation (World Bank, n.d.-a). Moreover, a credit-to-GDP ratio can increase because the numerator expands, because GDP weakens, or because both change simultaneously. These measurement issues complicate a straightforward interpretation of national credit depth as an industrial growth input.

Prior research also disputes whether financial deepening generates uniformly positive growth outcomes. Rousseau and Wachtel (2011) reported a weaker finance–growth relationship in more recent periods than in early historical samples. Arcand, Berkes, and Panizza (2015) presented evidence of diminishing or negative aggregate growth effects when private credit reaches particularly high proportions of GDP. By contrast, manufacturing-specific research is not uniformly pessimistic. Daway-Ducanes and Gochoco-Bautista (2019) identified nonlinear relationships between the size of the financial sector and manufacturing and services growth in developing countries, including settings in which financial scale may be insufficient to support large productive investments. More recently, AlKathiri and Bhattacharyya (2026) reported positive associations between private credit and manufacturing value added, conditional on economic development, while also finding evidence of saturation. These studies differ in outcome definitions, time periods, estimation strategies, and financial measures, and their results should not be treated as interchangeable.

The remaining uncertainty is therefore not simply whether credit is beneficial or harmful. It is whether *economy-wide financial depth in an earlier year* is consistently associated with *manufacturing growth in a later year* after accounting for stable country characteristics, common global shocks, and macroeconomic covariates. A lagged panel framework can provide useful evidence on this temporal association, even though lagging predictors alone does not solve endogeneity. Concentrating specifically on manufacturing growth also avoids equating aggregate GDP expansion with the performance of a productive sector whose financing needs may differ from those of households or services.

This study addresses that question through an unbalanced country-year panel constructed from the World Development Indicators (WDI), covering 1990–2024. The outcome is real manufacturing value-added growth. The main exposure is domestic credit to the private sector as a share of GDP, measured one year earlier. Foreign direct investment, trade openness, inflation, and gross capital formation are also lagged one year. The main estimator uses country and calendar-year fixed effects with standard errors clustered by economy. Its principal objective is an association test; it does not assert that the coefficient constitutes the causal effect of private credit or that the WDI series directly measures access to finance among manufacturers.

The paper makes three contributions. First, it connects aggregate credit depth with a specifically industrial, growth-rate outcome rather than total GDP growth. Second, it documents the sign, magnitude, and uncertainty of the one-year-lagged credit association in a broad, reproducible panel. Third, it evaluates whether this association is sensitive to unusual observations, estimation windows, possible temporal differences, and nonlinear functional forms. These checks are important because cross-national financial and manufacturing data are unevenly observed and can contain extreme values. The analysis is designed to distinguish an overall empirical association from stronger, unsupported claims about financial-sector mechanisms or policy thresholds.

The overarching research question is: **Is a higher level of domestic private-sector credit relative to GDP associated with faster manufacturing value-added growth in the following year, conditional on observed macroeconomic controls and country and year fixed effects?** Following the financial-constraints literature, a positive association is theoretically plausible. Nevertheless, the empirical null hypothesis is that the lagged credit coefficient equals zero, evaluated using a two-sided test. Nonlinear and historical heterogeneity analyses are treated as exploratory supplements rather than prespecified causal tests.

2. Review of Related Literature and Conceptual Framework

2.1 Financial Deepening and Manufacturing Growth

Financial deepening is generally understood as the expansion of financial intermediation, financial-market capacity, and access to financial services. Its measurement also varies across studies; related ASEAN work, for example, has operationalized financial deepening through stock-market capitalization rather than private credit (Lantin-Magana & Atento, 2026). Its potential relevance to manufacturing arises from the financing requirements of machinery, inventories, production facilities, research, and technological upgrading. In the conventional supply-leading interpretation, financial institutions mobilize savings, screen investment opportunities, and allocate capital toward productive enterprises. Rajan and Zingales (1998) showed that industries with greater external-financing dependence grow relatively faster in economies with more developed financial markets. Beck et al. (2005) further identified financing and institutional constraints as material obstacles to firm growth, particularly among smaller firms. These studies establish mechanisms through which finance could support manufacturing, but do not imply that a larger national credit-to-GDP ratio must generate higher manufacturing growth in the following year.

The manufacturing-specific international evidence is mixed. Asongu and Odhiambo (2022) used generalized method of moments estimation for 25 Sub-Saharan African economies during 1980–2014. They found that enhanced financial access, proxied by private domestic credit, did not significantly improve agricultural or manufacturing value added, although the services sector exhibited a more favorable relationship. Agbonrofo and Olusegun (2023) studied 24 Sub-Saharan African countries during 1995–2020 using panel autoregressive distributed lag methods. Domestic credit to the private sector was not significantly related to manufacturing value added over either the short or long run; adverse long-run relationships were documented for interest and exchange rates. Tabash et al. (2022), examining Nigerian agricultural

and manufacturing performance, similarly reported that financial deepening need not be accompanied by comparable gains across sectors.

Other results indicate that the financial conditions confronting manufacturers can matter substantially. Chavarín Rodríguez and Tlatoa Chávez (2023) found positive and significant associations between commercial-bank credit and output for Mexico's overall manufacturing sector and selected manufacturing subsectors using ARDL bounds models. Nguyen (2023) examined Vietnamese manufacturing firms during 2010–2015 and identified favorable productivity associations with sufficient internal financing and financial-sector development, while higher leverage was associated with lower productivity. The latter finding is important: access to productive finance and the accumulation of debt are not interchangeable constructs. Financial development can ease constraints while substantial indebtedness creates additional vulnerabilities.

More recent international evidence makes the contrast particularly clear. Daway-Ducanes and Gochoco-Bautista (2019) examined manufacturing and services growth across 77 developing economies and reported a U-shaped relationship with financial-system size, suggesting that financial scale may initially be insufficient to support large productive investments. AlKathiri and Bhattacharyya (2026), using up to 95 countries and sectoral real value-added measures during 1970–2017, reported a positive relationship between private credit depth and manufacturing value added along with evidence of diminishing marginal benefits. Their dependent variable is sectoral real value added, whereas the present study examines its annual growth rate. Levels and growth rates are empirically distinct outcomes; apparently contrasting coefficients should not be presented as strict replications.

Evidence from aggregate economic growth supplies context but not a substitute for manufacturing-specific tests. Vo and Ho (2025) identified a negative private-credit relationship with aggregate GDP growth across five ASEAN economies, while foreign direct investment was positively associated with growth. That finding demonstrates a possible limitation of credit expansion at the national level, but it does not itself establish what happens to manufacturing output. Within ASEAN, bank credit to the private sector has instead been positively associated with formal new-business density in a WDI panel (R. G. Atento, 2026), indicating that credit depth may relate differently to different real-economy outcomes. In summary, the literature supports plausible positive financing mechanisms while rejecting an unconditional expectation that aggregate credit depth uniformly precedes stronger manufacturing growth.

2.2 Sectoral Credit Allocation and Nonlinear Effects

A second strand of research distinguishes the quantity of financial resources from their allocation across economic activities. Domestic credit to the private sector as a share of GDP pools claims involving a range of borrowers and financing purposes. It does not reveal whether funds finance manufacturing capacity, household expenditure, property development, distribution, or other activities. Consequently, the association between economy-wide credit and manufacturing growth may depend on the destination and productive efficiency of credit. Comparable concerns have been raised about other depth indicators: for the Philippines and its ASEAN peers, market capitalization has been described as an incomplete proxy, with capital-market depth, FDI, and portfolio investment treated as analytically distinct financing channels (Chen et al., 2026).

Hirano and Stiglitz (2024) provide a two-sector endogenous-growth model in which manufacturing investment contributes to long-run productivity while land speculation can draw credit away from productive capital formation. Their theoretical demonstration indicates that lower financing costs or relaxed collateral conditions may produce different outcomes depending on which sector receives credit. This is a mechanism, not an empirical cross-country finding that property lending always lowers manufacturing output. Yuan and Zhou (2022) provide industry-level evidence from China, analyzing 19 industries over 2007–2017. They documented structural credit misallocation and a negative association between misallocation and industrial growth, with substantial financial resources directed toward tertiary activities while manufacturing credit was comparatively scarce.

Gizaw et al. (2024) studied domestic-credit allocations and economic performance in Ethiopia during 1991–2022. Their findings indicate that the distribution of credit across public, private, and economic sectors matters for observed performance, although some sector-specific short-run effects and aggregate long-run associations differ. The study concerns sectoral economic output more broadly, and should not be treated as a test of the WDI aggregate credit ratio on annual real manufacturing growth. Such evidence supports credit composition as an explanation worth investigating rather than a mechanism established by the present study.

The nonlinear literature further cautions against assuming that each additional percentage point of credit has a uniform relationship with output. Arcand et al. (2015) identified diminishing and potentially adverse associations between very high financial depth and aggregate economic growth. Nguyen (2025) reported that private credit in Vietnam was associated with aggregate growth up to an estimated level near 91% of GDP, after which marginal benefits declined. Ogbuagu et al. (2021) estimated an industrial-performance turning point using a financial-deepening index for Nigeria. Their reported index threshold of 36.8% is not an internationally transferable private-credit-to-GDP threshold. Related threshold research on inflation and per-capita growth in China and the Philippines likewise found country-specific regimes rather than a single common threshold (Chen & Atento, 2026).

However, nonlinear effects do not always take the form of a negative relationship above a maximum threshold. Kinda and Sawadogo (2023) analyzed 35 Sub-Saharan African countries during 1996–2018 and found negative financial-development relationships with industrialization below a threshold but favorable relationships above it. He and Yoo (2024) reported an inverted-U association involving financial development and domestic investment across 152 economies, but their outcome concerns economy-wide investment rather than manufacturing growth. Daway-Ducanes and Gochoco-Bautista (2019) identified a U-shaped association for manufacturing and services growth. Different forms of nonlinearity are therefore plausible, reflecting differences in sample, financial indicator, sectoral outcome, and estimator.

Because the present WDI dataset does not identify loan recipients or sectoral lending, credit misallocation cannot be directly estimated. The quadratic specification serves only as an exploratory functional-form check. In particular, an estimated turning point in the sparsely observed upper tail should not be interpreted as a universal optimal credit level or a basis for changing regulatory credit limits.

2.3 Temporal Dynamics and Macroeconomic Conditions

The credit–manufacturing relationship may unfold over different horizons. Manufacturing investment often involves a sequence of financing, equipment acquisition, implementation, and production before changes in output become observable. Conversely, revolving working capital may affect near-term activity without producing lasting capacity improvements. Lagged and distributed-lag specifications are therefore relevant, although temporal precedence does not, by itself, eliminate reverse causation, anticipated demand, or omitted shocks.

The direct manufacturing evidence remains inconclusive. Agbonrofo and Olusegun (2023) did not identify significant private-credit associations with manufacturing value added in short- or long-run specifications for 24 Sub-Saharan African countries. By contrast, Nigo and Gibogwe (2023), studying 14 Sub-Saharan African countries, found a significant short-run credit association with industrial value added while gross fixed capital formation had greater long-run importance. Their industrial measure is broader than manufacturing. Ur Rehman et al. (2022) found positive relationships involving private investment, exports, and large-scale manufacturing output in Pakistan. Such studies emphasize the importance of distinguishing borrowing from the real investment activity that it may finance.

The broader macroeconomic environment may alter the relationship. Foreign direct investment can provide capital and managerial and technological linkages, but it need not flow to manufacturing. In the Philippines, lagged FDI intensity was not statistically associated with either manufacturing value-added growth or manufacturing's share of GDP once macroeconomic dynamics and the pandemic shock were controlled (Refozar et al., 2026). The investment effects associated with FDI attraction are also conditioned by institutional quality and private-sector absorptive capacity (R. G. Atento, Espelita, et al., 2026). Trade openness may improve access to inputs and export markets while intensifying import competition. Consumer-price inflation can affect real financing costs, investment expectations, and operating expenditure. Gross capital formation captures economy-wide investment intensity, although it is not a manufacturing-specific measure and may partly lie along the pathway between credit and output. These factors support the inclusion of FDI, trade, inflation, and capital formation as conditional covariates rather than mechanistic proof of specific transmission channels.

There is also evidence of time-varying financial relationships. Altăr et al. (2021) investigated credit-supply shocks and investment responses in Central and Eastern European economies and documented differing historical responses; their analysis is not an international manufacturing-growth test. Vo and Ho (2025) found differing short- and long-horizon finance–GDP growth relationships within ASEAN-5. The results warrant attention to sample periods and possible historical heterogeneity, but none independently identifies 2010 as a common global structural break in the finance–manufacturing relationship.

Finally, financial development may respond to earlier or anticipated economic activity rather than operate solely as an exogenous input. Loan demand, credit supply, GDP changes in the denominator, exchange rates, and other developments can influence private-credit ratios. Philippine time-series evidence, for instance, links foreign direct investment more strongly than remittances to private credit depth (R. G. Atento, Feng, et al., 2026). The temporal interpretation of one-year-lagged credit must therefore remain associative. In the present study, year and country fixed effects address selected shared and persistent influences, but cannot fully resolve time-varying confounding or causality.

2.4 Synthesis of the Literature

Across the reviewed evidence, the financial system's scale and its ability to finance productive manufacturing are related but distinct concepts. Classical financial intermediation theory establishes mechanisms through which better functioning finance may stimulate investment and firm growth. Manufacturing-specific studies, however, yield negative, insignificant, and positive findings. The evidence differs across Sub-Saharan Africa, Mexico, China, Vietnam, and broader developing-country panels. Sectoral allocation, firm leverage, financial maturity, and investment conditions offer plausible reasons for these differences.

A second synthesis concerns the outcome being measured. Studies of aggregate GDP growth, real manufacturing value-added levels, sectoral productivity, industrial shares, and annual manufacturing value-added growth address different questions. The present study evaluates the final measure and therefore must not describe positive associations with manufacturing output levels as necessarily contradictory to short-horizon growth-rate findings. A third synthesis concerns temporal and nonlinear heterogeneity: short-run versus long-run models and threshold designs demonstrate that constant slopes cannot always be assumed. Nevertheless, threshold figures taken from individual countries or different indices are not directly comparable.

Taken together, these findings justify an international panel test that is explicitly manufacturing-specific, uses credit depth in the preceding year, controls for selected macroeconomic conditions, and reports robustness and exploratory heterogeneity without presenting observational coefficients as causal effects.

2.5 Research Gaps

Five interconnected gaps motivate this investigation. First, much of the finance–growth literature evaluates aggregate GDP rather than subsequent annual real manufacturing growth. Second, directly relevant manufacturing-credit research often concentrates on particular countries or regions, limiting comparisons under a common data definition. Third, levels of financial depth are frequently conflated with increases in credit or access to manufacturing-specific financing; they are not equivalent measures. Fourth, varying choices of covariates, periods, and estimators make results difficult to compare. Fifth, nonlinear and temporal differences are often inferred from isolated thresholds or separate subgroup significance tests rather than interpreted within one consistent framework.

The present study contributes by estimating a one-year-lagged credit–manufacturing association in a broad WDI panel using country and year fixed effects; by placing FDI, trade openness, consumer-price inflation, and gross capital formation on the same lagged temporal basis; and by distinguishing the main model from outlier, period, and nonlinear sensitivity checks. It does not fill the separate, important gap concerning manufacturing-directed credit allocation, which requires borrower- or sector-specific credit data. Nor does it resolve causal identification. These boundaries define both the contribution and its limitations.

2.6 Conceptual Framework and Hypothesis

The dependent variable is real manufacturing value-added growth in economy i during year t. The explanatory variable of interest is private-sector credit depth, expressed as domestic credit to the private sector divided by GDP and measured at t−1. FDI inflows, trade openness, inflation, and gross capital formation are also measured at t−1. Country fixed effects account for time-invariant economy attributes; year fixed effects absorb annual influences common to the panel. The estimated coefficient on credit captures the conditional average within-economy association after adjusting for the other lagged variables and shared annual factors.

Principal model: $MFG(i,t) = \alpha(i) + \lambda(t) + \beta1\ CREDIT(i,t-1) + \beta2\ FDI(i,t-1) + \beta3\ TRADE(i,t-1) + \beta4\ INF(i,t-1) + \beta5\ GCF(i,t-1) + \varepsilon(i,t)$.

H0: $\beta1 = 0$; preceding private-sector credit depth is not conditionally associated with subsequent manufacturing value-added growth. **H1:** $\beta1 \neq 0$; preceding private-sector credit depth is conditionally associated with subsequent manufacturing growth. The hypothesis is nondirectional because the literature supports competing mechanisms and inconsistent empirical signs. Exploratory period interactions and quadratic curvature are complementary specifications rather than separate confirmatory causal hypotheses.

3. Research Methodology

3.1 Research Design

This quantitative longitudinal study employed an observational country-year panel. Its empirical purpose was to estimate the conditional relationship between private-sector credit depth in year t−1 and the annual rate of growth of real manufacturing value added in year t. The two-way fixed-effects estimator is a linear panel regression with country and calendar-year indicators. Lagged two-way fixed-effects designs using WDI country–year panels have been applied in related ASEAN studies of financial deepening and labor productivity (Lantin-Magana & Atento, 2026; Patron et al., 2026). The study makes no claims of experimental manipulation, random assignment, or causal identification.

3.2 Data Source, Coverage, and Sample Selection

The source was an archived bulk World Development Indicators CSV. The research used the years 1990–2024; the archived file contained observations through 2024, rather than 2025. Six WDI indicator series were extracted by their published codes. Geographical and income-group aggregates were excluded using recognized three-letter economy codes (ISO alpha-3 and the XKX designation for Kosovo). The eligible screening pool contained 216 economies or territories. The resulting analytic sample consists of 3,496 complete country-year observations in 158 economies over 35 calendar years. Because coverage differs by indicator and economy, the estimation panel is unbalanced; the average economy

contributes 22.13 observations, the median 23, and the range 1–35. No missing values were imputed. Economies and separately reported territories are described collectively as 'economies' rather than assumed to be sovereign states.

3.3 Variables and Operational Definitions

Role	Variable (unit)	WDI code	Model timing
Outcome	Manufacturing value added, real annual growth (%)	NV.IND.MANF.KD.ZG	t
Main explanatory variable	Domestic credit to private sector (% of GDP)	FS.AST.PRVT.GD.ZS	t−1
Control	FDI net inflows (% of GDP)	BX.KLT.DINV.WD.GD.ZS	t−1
Control	Trade, exports plus imports (% of GDP)	NE.TRD.GNFS.ZS	t−1
Control	Consumer-price inflation, annual (%)	FP.CPI.TOTL.ZG	t−1
Control	Gross capital formation (% of GDP)	NE.GDI.TOTL.ZS	t−1

The outcome measures annual growth in real manufacturing value added, not manufacturing's contribution to GDP (World Bank, n.d.-b). The credit indicator measures economy-wide credit claims on the private sector relative to GDP; it is not the flow of new lending to manufacturing firms. FDI and capital formation are economy-wide measures, trade covers goods and services, and inflation uses the consumer price index. Conditioning on investment can also condition away part of an indirect relationship through capital formation; therefore, the credit coefficient is not an estimate of the total causal effect through all channels.

3.4 Data Preparation and Lag Construction

The WDI source's country-indicator-year structure was reshaped into one row per economy and year. Records were screened for duplicated geographical indicator combinations and converted to numeric values without interpolation. Each lagged variable was shifted within its own economy, and calendar continuity was checked to prevent a missing year from being treated as the immediately previous calendar year. Only observations with nonmissing manufacturing growth and all five lagged predictors entered the principal complete-case model. Annual coverage, country participation, descriptive statistics, and the code and snapshot checksum were retained for replication.

3.5 Estimation and Statistical Inference

Model: $MFG(i,t) = \alpha(i) + \lambda(t) + \beta1\ CREDIT(i,t-1) + \gamma'X(i,t-1) + \varepsilon(i,t)$, where X contains FDI, trade, inflation and gross capital formation. Ordinary least squares with country and year indicator variables estimates the two-way fixed-effects specification. Country-clustered standard errors accommodate heteroskedasticity and serial dependence within economies. A comparable two-way fixed-effects application with economy-clustered standard errors and lagged-predictor timing checks is reported by R. G. Atento and Quinto (2026). Two-sided tests and 95% confidence intervals use the same clustered covariance estimator. Model fit is reported using the overall OLS R^2 with indicator variables; it must not be described as a within R^2 or the unique explanatory share attributable to credit.

The principal parameter β1 is interpreted as the difference, in manufacturing-growth percentage points, associated with a one-percentage-point higher preceding credit/GDP ratio, conditional on regressors and fixed effects. Lagging predictors establishes an earlier observed exposure but does not remove endogeneity from anticipatory borrowing, reverse causality, denominator effects, or time-varying omitted factors.

3.6 Robustness and Exploratory Specifications

The analysis compared a credit-only fixed-effects model with the fully adjusted model. Sensitivity analyses used a two-year credit lag, a 2000–2024 window, exclusion of 2020–2021, exclusion of extreme manufacturing growth, predictor winsorization at the first and ninety-ninth percentiles, exclusion of absolute inflation ≥100%, a minimum ten-year economy-coverage requirement, and deletion of the highest 1% of credit observations. Restricting estimation to a later window follows comparable WDI panel practice, in which post-crisis robustness windows are used to reduce sensitivity to late-1990s shock dynamics (Balingit et al., 2026). An alternative inference check clustered standard errors

in both the country and year dimensions. A separate model replaced the credit level with the preceding annual change in credit/GDP, and a joint model included both measures.

Historical differences were investigated through formal post-cutoff interactions, not solely by comparing significance in separate subperiods. Cutoffs at 2005, 2008, and 2010 were explored after inspection of the initial results; period comparisons should therefore be regarded as exploratory and not as prespecified structural-break tests. A quadratic credit term evaluated possible curvature, with attention to the share of observations around any implied turning point and sensitivity to truncating very high credit observations. All listed robustness analyses report associations rather than causal policy responses.

3.7 Reproducibility, Research Integrity and Limitations

The original WDI file was processed using Python, pandas, NumPy, pycountry, and statsmodels. The archived source SHA-256 is f213fd01944510a7cd97daf0448136ae1cdf71ca65382af70e16be040c94abc8. The reproducibility archive contains the resulting estimation panel, descriptive summaries, model specifications, coefficients, and sensitivity-test outputs; the 199 MB original source remains separately available. The data are published national aggregates, with no individual respondents, intervention, or personal information.

Limitations include incomplete and potentially nonrandom reporting across countries and years; extreme outlying observations; heterogeneity in statistical definitions and national reporting quality; the aggregate credit measure's lack of information on borrowing costs and sectoral destinations; time-varying confounding; feedback between credit and production; and the possibility that credit/GDP shifts because of the GDP denominator. The robustness checks address specification and influential-data sensitivity, but do not resolve these identification limits.

4. Results and Findings

4.1 Panel Coverage

Complete-case estimation yielded 3,496 country-year observations for 158 economies during 1990–2024. The panel is unbalanced and the median economy contributes 23 years of observations. The sample contains 143 economies with at least ten complete observations. Coverage increased from 38 valid economies in 1990 to 65 in 2000, 129 in 2010, and a peak of 146 in 2017; 110 economies contributed observations in 2024. Accordingly, some economies and historical periods are more heavily represented than others. Table 1 summarizes the structure of the analytic panel.

Table 1. Coverage of the estimation panel

Characteristic	Result
Eligible economies/territories initially screened	216
Economies with complete-case observations	158
Observation period	1990–2024
Calendar years	35
Country-year complete cases	3,496
Mean complete years per economy	22.13
Median years per economy	23
Minimum / maximum years per economy	1 / 35
Economies with at least 10 complete observations	143

4.2 Descriptive Statistics

Table 2 reports descriptive statistics for the principal estimation sample. Manufacturing value-added growth averaged 3.47% annually (median 3.10%) but displayed substantial dispersion. The lagged private-credit ratio averaged 51.05% of GDP (median 37.38%). FDI and consumer-price inflation were highly skewed, with extreme observations; the highest annual inflation rate exceeded 23,000%. These distributions warranted sensitivity analyses that limited the influence of exceptional macroeconomic values.

Table 2. Descriptive statistics for complete country-year observations (N = 3,496)

Variable	Mean	Median	SD	Minimum	Maximum
Manufacturing growth (%)	3.47	3.10	11.25	−52.80	375.16
Prior-year private credit (% GDP)	51.05	37.38	43.95	0.38	301.02
Prior-year FDI net inflows (% GDP)	5.28	2.37	24.64	−391.56	452.22
Prior-year trade (% GDP)	86.35	73.74	56.95	11.09	442.62

Variable	Mean	Median	SD	Minimum	Maximum
Prior-year inflation (%)	19.51	3.61	432.22	−16.86	23,773.13
Prior-year gross capital formation (% GDP)	24.36	23.32	8.02	−15.68	76.78

Note: SD = standard deviation. All explanatory variables are measured at t−1. Source: calculations from the audited archived WDI file.

4.3 Principal Two-Way Fixed-Effects Model

The main adjusted model produced a negative coefficient on lagged private-sector credit (β = −0.02981, SE = 0.00962, p = 0.00231; 95% CI [−0.04881, −0.01081]). The simpler credit-only fixed-effects specification yielded β = −0.02937 (p = 0.00410). The similarity indicates that adding the four selected macroeconomic controls did not meaningfully change the estimated credit association in this sample.

Table 3. Main two-way fixed-effects estimates

Predictor (at t−1)	Model 1: Credit only	Model 2: Adjusted
Private credit/GDP	−0.02937** (0.01008)	−0.02981** (0.00962)
FDI inflows/GDP	—	0.00172 (0.00806)
Trade/GDP	—	0.01828 (0.01922)
CPI inflation	—	0.000328*** (0.000082)
Gross capital formation/GDP	—	0.05496 (0.05221)
Country fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
N; economies	3,496; 158	3,496; 158
Overall OLS R^2 with FE indicators	0.1199	0.1214

*Note: Country-clustered standard errors in parentheses. **p < .01;** *p < .001. Significance applies to the unadjusted main specification; sensitivity of the inflation coefficient is discussed below. Overall R^2 includes country and year indicators and is not the within R^2.*

A 10-percentage-point higher prior-year credit-to-GDP ratio is associated with about 0.298 percentage point lower manufacturing value-added growth in the current year, conditional on the included regressors and fixed effects. This is a comparison of credit-depth levels, not an estimate of the causal effect of introducing new lending or reducing the stock of loans. The coefficient's 95% confidence interval excludes zero; therefore H0 is rejected in the main specification.

FDI (p = 0.831), trade openness (p = 0.343), and gross capital formation (p = 0.294) did not have statistically distinguishable conditional slopes in the main adjusted regression. The inflation coefficient was initially positive and significant (p = 0.000107), but its magnitude was tiny and its sign was strongly sensitive to extreme inflation observations; it should not be interpreted as evidence that inflation benefits manufacturing.

4.4 Robustness Across Specifications

Table 4. Sensitivity of the lagged private-credit coefficient

Specification	β for credit	p-value	N
Main adjusted model	−0.0298	0.0023	3,496
Credit lagged two years	−0.0209	0.0182	3,463
Sample 2000–2024	−0.0202	0.0729	3,006
Excluding 2020–2021	−0.0291	0.0034	3,221
Winsorized predictors, 1st/99th percentiles	−0.0352	0.0004	3,496
Trim 1% tails of manufacturing-growth outcome	−0.0285	0.0037	3,426
Exclude absolute inflation ≥100%	−0.0306	0.0027	3,471
At least 10 complete years per economy	−0.0292	0.0027	3,396
Exclude highest 1% of credit depth	−0.0396	<0.001	3,461

Note: All models include country and year fixed effects and the four macroeconomic controls, unless explicitly noted. Standard errors are clustered by country. The two-year credit model retains one-year lags for controls. Different N values indicate differing composition as well as specification.

The credit slope remains negative in every listed model and significant at 5% in all but the 2000–2024 subsample. Two-way clustering of standard errors by economy and calendar year preserved the main coefficient of −0.02981 but produced SE = 0.01035 (p = 0.00682). These results strengthen the descriptive reliability of the main association, but do not establish a common causal effect across all economies.

The positive inflation coefficient in Table 3 was not robust. Restricting absolute inflation to below 100% produced an inflation coefficient of −0.01276 (p = 0.607); combining this restriction with trimming extreme manufacturing growth yielded −0.03926 (p = 0.0589). Thus, no stable positive inflation finding is supported. Notably, the credit coefficient remained negative and significant under these restrictions.

4.5 Historical Differences in the Credit Slope

Estimating different periods separately produces β = −0.05383 (p = 0.0109) for 1990–2004 and β = −0.01400 (p = 0.3121) for 2005–2024. Separate significance levels cannot test whether two coefficients differ. Formal interaction regressions on a common sample therefore assessed post-cutoff changes in the slope.

Table 5. Exploratory post-period interaction tests

Cutoff	Pre-cutoff credit β	Post-cutoff credit β	Estimated difference	p for difference
2005	−0.02974	−0.02982	−0.00007	0.9945
2008	−0.04022	−0.02720	+0.01302	0.2603
2010	−0.04990	−0.01962	+0.03028	0.0101

Note: N = 3,496; 158 economies; same lagged controls and two-way fixed effects. The period main effect is absorbed by year fixed effects. Interactions estimate a difference in the credit slope, not a causal structural break.

The 2005 and 2008 interaction tests found no significant difference. The post-2010 difference was significant and indicated a less negative slope thereafter. The post-2010 slope itself was not significant at 5% (p = 0.0768). The post-2010 difference remained significant after outcome trimming (p = 0.0354), excluding extreme inflation (p = 0.0080), restricting to economies with observations in both periods (p = 0.0292), and allowing control slopes to differ by period (p = 0.0211). These tests were exploratory, and multiple historical cutoffs were considered; they do not validate 2010 as a globally common structural-break date.

4.6 Quadratic Model and Credit-Depth Threshold

Including credit and its square yielded β1 = −0.09119 and β2 = +0.000283 (p < 0.001 for both in the full sample), implying a convex, or U-shaped, fitted association with a mathematical minimum near a credit-to-GDP ratio of 161%. Yet the 95th percentile of the credit distribution is only 142.66%, and just 2.63% of observations lie beyond the fitted minimum. Restricting the sample to credit observations at or below the 95th percentile raised the squared-term p-value to 0.0705. The marginal slope at the original sample's 95th percentile was also not significantly different from zero (p = 0.1468). Consequently, the data provide weak support for a stable high-credit regime or an economically actionable credit threshold.

4.7 Level of Credit Depth Compared with Its Annual Change

Replacing the preceding level of credit/GDP with the preceding annual percentage-point change in that ratio yielded β = −0.05565 (p = 0.0830; N = 3,350), which was not statistically significant at 5%. Including the level and change jointly produced β = −0.02342 (p = 0.0107) for the level and β = −0.04180 (p = 0.1688) for the change. This distinction indicates that the main empirical relationship is tied more clearly to existing credit depth than to recent credit/GDP growth. The annual ratio change does not isolate new lending because movements in GDP or reporting can also affect the ratio. Related WDI time-series work has similarly found that levels and first-differenced specifications can yield materially different readings of the same relationships (R. G. Atento, Quinto, Espelita, A. G. Atento, Teodosio, et al., 2026).

4.8 Summary of Findings

The principal result is a negative, statistically significant conditional association between prior-year aggregate private-credit depth and current real manufacturing value-added growth. Its sign survives several outlier, lag, inference, and sample checks, but statistical precision weakens in the 2000–2024 window. The macroeconomic-control estimates are mostly not statistically significant, and the apparently positive inflation result is outlier-sensitive. Historical interactions provide exploratory evidence of a less negative slope after 2010, but not of a common structural break. Quadratic results are sensitive to an inadequately populated upper tail. Finally, the annual change in credit/GDP is a weaker predictor than the preceding credit-depth level.

4.9 Discussion of Findings

The inverse credit coefficient challenges the expectation that a deeper economy-wide financial system must precede faster manufacturing expansion. It is consistent with manufacturing-specific null results in parts of Sub-Saharan Africa (Asongu & Odhiambo, 2022; Agbonrofo & Olusegun, 2023), although the present estimate is significantly negative rather than merely indistinguishable from zero. At the same time, it contrasts with positive associations reported for manufacturing in Mexico (Chavarín Rodríguez & Tlatoa Chávez, 2023) and for manufacturing value-added levels in a wider international panel (AlKathiri & Bhattacharyya, 2026). Differences in outcomes, lag lengths, countries, and estimators mean that these findings are complementary evidence rather than direct contradictions.

Sectoral allocation offers one plausible mechanism. Hirano and Stiglitz (2024) explain theoretically how lending that finances land speculation can displace productive investment, while Yuan and Zhou (2022) identify industrial credit misallocation in China. Nonetheless, the WDI credit indicator used here does not distinguish lending to manufacturers from credit to property developers, other firms, or households. The present study therefore cannot establish that credit misallocation explains its negative coefficient. It also cannot prove that additional manufacturing lending would be harmful.

The role of gross capital formation deserves similar care. Its insignificant conditional coefficient does not demonstrate that investment is immaterial; the aggregate measure is broader than manufacturing investment, and conditioning on it could absorb part of an indirect relationship between finance and output. The country-level panel likewise may conceal differences across small and large firms, financing maturities, credit costs, and industrial subsectors. FDI and trade have ambiguous sectoral implications because they can support manufacturing investment and exports but may also be concentrated in other activities or reflect exposure to competitive pressures. This interpretation is consistent with Philippine evidence in which aggregate FDI intensity showed no significant association with manufacturing growth (Refozar et al., 2026).

The robustness findings support the overall negative sign without transforming an associational design into a causal experiment. The weaker post-2000 significance and exploratory post-2010 difference point to possible historical heterogeneity rather than a definitive regime shift. The quadratic minimum near 161% of GDP is too far into the thinly observed upper tail to serve as a policy benchmark. The annual change model further prevents interpreting the main coefficient as the response to a new wave of credit expansion.

These results are most appropriately interpreted as evidence that **the size of economy-wide private credit is not synonymous with effective finance for manufacturing**. A similar caution about top-line ratios has emerged in other policy domains, where aggregate education-spending intensity proved an imprecise predictor of short-run outcomes (Dela Cruz & Atento, 2026). A deeper system may support industrial development when financing reaches productive projects on viable terms, yet high financial depth alone does not guarantee that outcome. Future work using manufacturing-specific lending, credit costs, better identification, and explicit distributional analysis will be necessary to distinguish among mechanisms.

5. Conclusions, Recommendations, and Policy Implications

5.1 Conclusions

Using 3,496 complete annual observations for 158 economies over 1990–2024, this study found a statistically significant negative conditional association between prior-year domestic private-sector credit as a percentage of GDP and subsequent manufacturing value-added growth. The main coefficient, −0.02981 ($p = 0.00231$), corresponds to approximately 0.30 percentage point lower manufacturing growth for a 10-percentage-point higher preceding credit/GDP ratio, after controlling for lagged FDI, trade openness, inflation, gross capital formation, and country and year fixed effects. The principal null hypothesis of no conditional linear association was rejected. This result does not prove that credit expansion reduces manufacturing output.

The negative coefficient retained its sign under numerous robustness checks. Its precision weakened in the 2000–2024 sample; the post-2010 difference was exploratory; and the estimated quadratic minimum was poorly identified in the upper tail. The level of credit depth displayed a stronger conditional association than its preceding annual change. These qualifications point to a finance–manufacturing relationship that is neither uniformly positive nor reducible to a single global threshold.

5.2 Policy Implications

A central implication concerns measurement. Policymakers should distinguish the aggregate stock of private credit relative to GDP from credit actually accessible to manufacturing enterprises on commercially viable terms. The estimates do not justify restricting aggregate credit or imposing a numerical ceiling. Instead, they support supplementing conventional financial-depth indicators with information on sectoral lending, maturities, costs, collateral, and productive use.

A second implication is that finance and industrial development should be evaluated jointly but not conflated. The effectiveness of manufacturing lending likely depends on the availability of investable projects, infrastructure, technical capability, market demand, and financial risk assessment. The present data cannot determine which financial intervention would be most effective, and broad industrial policy recommendations should therefore be piloted and evaluated using manufacturing outcomes rather than disbursement volumes alone.

A third implication concerns the limits of generalization. Country-specific credit thresholds, period shifts, and regression signs should not automatically be translated into universal policy rules. Different national financial structures, stages of industrialization, and historical conditions may produce different associations.

5.3 Recommendations for Financial and Industrial Institutions

First, central banks and statistical agencies should improve the regular publication of manufacturing-specific lending statistics, separating borrower types and industrial subsectors whenever possible. Second, development-finance initiatives intended to support manufacturing should report not only loan amounts but also incremental real investment, productivity, manufacturing value added, employment outcomes, financial sustainability, and repayment performance. Third, financing constraints should be diagnosed by type: price, collateral, maturity mismatch, lack of credit information, and inadequate expected returns require different responses. Philippine policy analysis of MSME credit support similarly stresses viability screening, risk-sharing architecture, and simplified documentation as conditions for effective enterprise credit (A. G. Atento, Quinto, et al., 2026). Fourth, public support programs, where introduced, should be evaluated against transparent counterfactuals and adverse selection and fiscal risks, rather than assuming that increasing loan supply necessarily increases manufacturing activity.

5.4 Directions for Future Research

Future work should combine country-level credit and output data with manufacturing-specific lending, interest rates, firm leverage, and financial-access indicators; investigate differences by income group and industrial structure; use dynamic specifications that capture manufacturing-output persistence; and examine longer temporal horizons. Firm-level survey evidence indicates that financial inclusion among manufacturers differs significantly with digital access (R. G. Atento, Quinto, Espelita, & A. G. Atento, 2026), while cross-national evidence from Asia shows that expanded connectivity and account ownership do not automatically translate into active financial use, so conventional inclusion metrics can understate exclusion (A. G. Atento, R. G. Atento, et al., 2026). Research designs exploiting plausibly exogenous credit-supply shocks or natural experiments would be better suited to causal interpretation. Predefined historical breakpoints and threshold confidence intervals would strengthen subsequent heterogeneity tests. Finally, alternative transformations of the credit-to-GDP indicator could help distinguish changes in outstanding credit from GDP-denominator movements.

5.5 Final Conclusion

Greater economy-wide private-sector credit depth does not necessarily precede faster growth of real manufacturing value added. The negative conditional association observed in the present WDI panel underscores the importance of distinguishing financial-system depth from the accessibility, composition, and productive utilization of financing. It is a reason for more precise measurement and policy evaluation—not evidence that lending to productive manufacturers should be curtailed.

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