



Impact of Financial Innovation on the Sustainable Development of Mexico

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Abstract. The financial system plays a fundamental role in economic growth by facilitating the mobilization and efficient allocation of resources toward productive activities. In this context, the objective of this study was to analyze the impact of financial innovation, measured through monetary deepening and private credit, on productive capital accumulation in Mexico during the period 1990–2021. The research adopted a quantitative approach with an explanatory-correlational scope and a non-experimental longitudinal design. Annual time-series data obtained from the World Bank and the Bank of Mexico were analyzed using the Augmented Dickey-Fuller (ADF) unit root test and an Autoregressive Distributed Lag (ARDL) model with a maximum of three lags. The results indicate that the variables are integrated of order one, I(1), and that the original sustainable development variable had to be replaced by Gross Fixed Capital Formation (GFCF) due to econometric considerations. The ARDL model revealed temporal persistence in GFCF and a positive effect of per capita income on productive investment. However, financial innovation did not exhibit statistically significant effects, while private credit showed negative lagged effects. Furthermore, the Bounds Test found no evidence of a long-run cointegration relationship. The findings suggest that financial innovation has not generated structural effects on productive capital accumulation in Mexico, pointing to inefficiencies in credit allocation that limit its contribution to sustainable development.

Keywords: Financial innovation; sustainable development; gross fixed capital formation; ARDL model; Mexican financial system.

1 Introduction

The pursuit of sustainable development has been identified as one of the foremost global priorities of the twenty-first century. This approach encompasses economic, social, and environmental dimensions, gaining particular significance in developing economies seeking to narrow the gap with industrialized nations [1]. Within this process, economic theory maintains that the financial system directly influences macroeconomic performance by reducing transaction and information cost, mobilizing savings, diversifying risk, and facilitating exchange [2].

When discussing financial innovation, we refer to the implantation of new products, processes, and institutional frameworks, which are regarded as fundamental precursors to development. In this sense, the financial sector operates as a key driver of growth, as efficient intermediation optimizes resource allocation and expands access to productive credit [2]. More specifically, the Schumpeterian tradition argues that finance promotes the structural transformation of markets by channeling capital toward new ventures and productive combinations [3].

This phenomenon is reflected in the modernization of payments systems, the expansion of credit, and the adoption of financial technologies (FinTech), mechanisms that enhance operational efficiency and foster capital formation [4]. In this regard, the World Bank (2023) indicates that financial innovation is an indispensable element in closing the development financing gap, which is estimated at more than USD 3.9 trillion annually in emerging economies.

Over the last decade, the development model has undergone profound changes. Traditionally, development was centered on economic growth, focusing exclusively on increases in gross domestic product (GDP); however, this approach has proven to be inefficient and, in many cases, detrimental to long-term stability. The establishment of the United Nations Sustainable Development Goals (SDGs) and the Paris Agreement has transformed the concept of national success, which is now understood as a balance between economic prosperity, social equity, and environmental integrity. The relationship between financial sector development and economic growth has therefore gained a prominent place on the agenda of emerging economies. In Mexico, this challenge arises within a context in which macroeconomic stability must coexist with sustainable development objectives. Financial innovation, understood not only as the adoption or introduction of new technologies but also as the incorporation of new instruments, services, processes, organizations, or technologies that transform the way financial intermediation is produced and utilized [4], while simultaneously improving the provision of credit and financial services, has emerged as a fundamental element for achieving sustained real growth.

For emerging economies such as Mexico, balancing economic growth with environmental stewardship represents a significant challenge due to their vulnerability to climate-related risks. Since financial liberalization in the 1990s, which included bank privatization; the post-1994 crisis reforms; the 2012 financial reform; and the recent expansion of the FinTech ecosystem [5], institutional and technological innovations within the financial system have affected monetary aggregates and the structure of credit, directly influencing the country's sustainable development goals. In this regard, the financial sector functions as the circulatory system that makes sustainability feasible. Nevertheless, sustainability requires the large-scale mobilization of capital toward clean technologies and resilient infrastructure [6], while such flows continue to face significant barriers, including information asymmetries, unquantified climate risks, and reliance on analog platforms. In response to these challenges, financial innovation, including FinTech, blockchain technology, green bonds, and crowdfunding, has emerged as a global

necessity for democratizing access to credit, reducing transaction cost, and improving market efficiency [7]. It is important to note that digitalization reduces environmental, social, and governance (ESG) risks by enabling real-time monitoring, thereby mitigating greenwashing practices [6]. From a theoretical perspective, a well-developed financial system stimulates savings and promotes credit to the private sector [8], a crucial dynamic for attracting sustainable foreign investment and preventing trade openness from resulting in the specialization of carbon-intensive sectors.

In Mexico's economic environment, the challenge is twofold: reducing poverty and narrowing the economic gap while complying with increasingly stringent international environmental standards. Credit to the private sector symbolizes a driver of real growth; however, when it is channeled through traditional methods toward extractive or polluting industries, progress tends to be short-lived [8]. Nevertheless, cointegration techniques such as Fully Modified Ordinary Least Squares (FMOLS) provide evidence of a positive relationship between financial development and GDP, although variables such as inflation and exchange rate volatility may undermine these benefits. Notably, the literature in Mexico reveals a significant gap: studies have largely been limited to analyzing economic growth as the dependent variable, overlooking highly relevant multidimensional indicators of welfare such as Adjusted Net Savings (AANS), an initiative originally proposed by. ([9] & [10]) On the one hand, Mexico has been a regional pioneer through its FinTech Law, designed to foster SME inclusion and mitigate informational blind spots through artificial intelligence and digital standards [6]. On the other hand, the country must continue to orient its financial instruments toward transforming its intensive reliance on fossil fuels.

Therefore, determining whether financial innovation is effectively decoupling economic growth from environmental degradation in Mexico constitutes a strategic undertaking. To address this gap, the present research examines how the strengthening of private credit, inflation control, and trade openness can transform the financial system into a leading actor of resilience. Focusing on the period 1991-2021, this study measures the impact of financial innovation—through monetary aggregates M1 and M2, private credit, and per capita income—on the country's sustainable development by applying the Autoregressive Distributed Lag (ARDL) approach developed by. [11] Which simultaneously estimates short- and long-run dynamics under mixed orders of integration, $SI(0)\$$ and $SI(1)\$$.

The concept of sustainable development gained prominence following the Brundtland Report, which defines it as development that meets the needs of the present without compromising the ability of future generations to meet their own needs [12]. In economics, this notion is associated with the sustainability of the total capital stock (natural, human, and produced), where intertemporal welfare depends on maintaining or increasing the economy's total wealth [13].

The theoretical foundation of this research is grounded in Schumpeter's Theory of Economic Development [14], which identifies innovation as the primary engine of

growth through the process of “creative destruction.” Within the financial sphere, this theory suggests that the introduction of new products, services, and processes optimized resource allocation by reducing transaction costs and improving capital efficiency [15] while also enhancing the mobilization of savings toward productive investment [8].

In the field of sustainable development, the theory of financial intermediation and Shaw's financial liberalization hypothesis 1973 provide the basis for its conceptual foundation. These approaches argue that a deep and technologically advanced financial system enables savings to be channeled toward productive investments that not only generate economic wealth but also promote environmental and social stability. From an empirical macroeconomic perspective, the assessment of sustainable development has involved macroeconomic indicators toward metrics that integrate environmental and social dimensions. In the Mexican case, this is reflected in the banking system's capacity to finance projects that improve Adjusted Net Savings (ANS), a measure that, according to the World Bank [10], represents a country's true savings rate after accounting for natural resource depletion and pollution-related damages. For Mexico, the use of ANS provides an opportunity to simultaneously capture effects associated with capital accumulation and environmental pressures derived from the prevailing growth pattern, making it an appropriate dependent variable for evaluating the contributions of the financial system to more sustainable development trajectories.

Likewise, the theory of financial innovation argues that advances in the monetary and financial sectors—such as the digitization of payments and the expansion of credit to the private sector—serve as powerful drivers of sustainability by facilitating access to financial services for historically excluded groups [16]. The relationship among these variables is estimated under the premise that financial innovation is not an end in itself but rather a means of achieving development that is economically viable and environmentally responsible in the long term. Financial innovation enhances efficiency in financial intermediation by reducing cost and streamlining processes; promotes financial inclusion by facilitating access to services; mobilizes resources towards productive investment through new credit mechanisms and schemes; and improves risk management through the implementation of instruments that provide coverage and diversification.

In contrast to the traditional notion of conventional economic growth, sustainable development requires a financial system that is not only efficient but also capable of promoting the long-term preservation of capital and environmental stewardship. In this regard, [17] proposes Adjustment Net Savings (ANS) as the fundamental metric. The theory suggests that financial innovation—measured through monetary depth and credit efficiency—has a positive and significant impact on ANS by providing resources for projects that offset natural resource depletion and foster human capital development.

The strong relationship between finance and development is reflected in the high degree of competition within the banking system. On the one hand, economic theory

recognizes that the financial system influences macroeconomic performance by reducing transaction and information cost, mobilizing savings, diversifying risk, facilitating exchange, and efficiently allocating resources toward productive projects [2]. On the other hand, from the perspective of the Schumpeterian tradition, this process is dynamic, as finance supports innovation and structural transformation by directing credit towards entrepreneurial ventures and new productive combinations ([18] & [19]), argues that effective competition acts as a catalyst that pressures financial institutions to reduce operating costs and improve their services through the continuous adoption of the technological innovations aimed at the efficient use of resources. In the Mexican context, this perspective suggests that sustainable development depends not only on the availability of new financial products but also a competitive environment that encourages banking intermediaries to improve the allocation of resources toward the most efficient productive sectors.

The effect of financial innovation on development trajectories is highly sensitive to the type of instruments employed. According to [19], tools such as ATMs and debit cards reduce the use of physical cash in favor of banked money. Economic theory analyzes this behavior from two perspectives. On the one hand, there is a deterrence effect, whereby substantial shifts in agents' asset portfolios may limit transactional liquidity, thereby affecting consumption and growth. On the other hand, there is an efficiency effect, under which the optimization of payment platforms reduces operating cost and reallocates idle resources toward productive investment, thus promoting sustainable development in a comprehensive manner.

The current economic literature highlights the evident lack of consensus regarding the directionality of the impact of financial innovation on sustainable development. On the one hand, the optimistic perspective, supported by authors such as ([20] & [21]), converges on the view that technological adoption and increasing market sophistication mitigate information imperfections and optimize the allocation of capital toward projects with high social and environmental value. In contrast, a more critical perspective, led by ([22] & [23]) Argues for the existence of negative effects. From this standpoint, certain innovations may induce relative financial exclusion, increase carbon emissions through uncontrolled industrial expansion, divert resources towards unproductive consumption or speculative activities, and consequently undermine Adjusted Net Savings (ANS). In the context of Mexico, understanding this duality is essential, as the net impact will largely depend on the absorptive capacity of the Mexican financial ecosystem.

In line with the conceptual framework proposed by Chimezie et al. [17], financial innovation should be analyzed through two distinct dimensions: innovation in the financial sector (\$FIF\$) and innovation in the monetary sector (\$FIM\$). Financial Sector Innovation (\$FIF\$): commonly represented by the ratio between broad money and narrow money (M_2/M_1 or similar measures), it captures the structural transformation generated by technology in the payment system and the velocity of money circulation. Theoretically, an increase in \$FIF\$ reflects greater financial complexity, which reduces transaction cost and facilitates the retention of financial assets within the financial system.

Monetary Sector Innovation (\$FIM\$): measured as the ratio of private sector credit to GDP, it reflects the intensity of traditional banking intermediation. Interestingly, the credit channel theory warns that an increase in the level of financing (\$FIM\$) does not automatically translate into sustainable development when monitoring mechanisms are weak. If resources are diverted toward current consumption or sectors with a high carbon footprint, the impact on the intertemporal welfare and ANS may become significantly negative. This phenomenon reflects the consequences of resource misallocation and resulting deterioration of natural capital.

When analyzing sustainable development, it is necessary to incorporate per capita income (\$PCI\$) as a macroeconomic control variable in order to capture the effect of economic activity on both social welfare and environmental pressure. From the perspective of conventional growth theory, higher per capita income is expected to increase savings and investment in human capital. However, sustainable development theory and empirical evidence from emerging economies indicate that increases in \$PCI\$ are often associated with energy-intensive consumption patterns and accelerated environmental degradation. When income growth is achieved through the accelerated exploitation of non-renewable resources and the emission of pollutants, the net effect on adjusted net savings tends to be negative, revealing a temporal trade-off between short-term economic growth and long-term sustainability.

The transmission of the benefits of financial innovation to sustainable development is strictly conditioned by the quality of the operational environment and the digital infrastructure of the economy. From this perspective, the diversification of financial services and the adoption of advanced technologies require substantial investments in basic and telecommunication infrastructure. Structural constraints in energy supply or inadequate digital connectivity increase the operating cost of financial intermediaries, and these externalities are directly transferred to users through higher interest rates, burdensome risk premiums, or elevated services fees. Consequently, the theoretical framework proposes that technological innovation is a necessary but insufficient condition; it must be complemented by robust infrastructure capable of democratizing access to credit, reducing financing costs for vulnerable productive units such as SMEs, and ultimately decreasing financial exclusion.

Based on the foregoing discussion, the following research question emerges: What has been the impact of financial innovation on the accumulation of productive capital in Mexico during the period 1990-2021, and to what extent has this impact contributed to the objectives of sustainable development?

2 Research method

This analysis aims to evaluate the impact of financial innovation on the accumulation of productive capital in Mexico during the period 1990-2021. To this end, the methodological approach proposed by ([19] & [24]) Originally applied to the Nigerian case, it is adapted to reflect the structural and financial characteristics of the Mexican economy. In their study, sustainable development was proxied through the

Adjusted Net Savings (ANS) indicator. In the present research, this variable was replaced by Gross Fixed Capital Formation (GFCF). This modification is justified on both econometric and theoretical grounds. From an econometric perspective, adjusted net savings exhibited second-order integration I (2), thereby violating the assumptions required for the application of the ARDL model. From a theoretical standpoint, gross fixed capital formation constituted a more direct measure of productive capital accumulation, allowing for a more precise assessment of the effects of the financial system on the expansion of the productive capacity of the Mexican economy.

(Table 1) represents the variables employed in the econometric model and their respective conceptual definitions. Financial innovation is analyzed through two complementary dimensions: financial sector innovation (FIF), associated with financial intermediation and access to credit, and monetary sector innovation (FIM), linked to monetary deepening and the availability of liquidity within the economy. In addition, Gross Fixed Capital Formation (GFCF) is included as an indicator of productive capital accumulation, while Per Capita Income (PCI) is incorporated as a control variable. Together, these variables allow for a comprehensive evaluation of the factors influencing productive investment in Mexico throughout the study period.

Table 1. Variables used in the Econometric Model.

Code	Variable	Description
FIF	Financial Innovation in the Financial Sector	Financial innovation associated with credit and financial intermediation
FIM	Financial Innovation in the Monetary Sector	Financial innovation associated with monetary deepening and liquidity
GFCG	Gross Fixed Capital Formation	Gross Fixed Capital Formation
PCI	Per Capita Income	Per Capita Income

Note. Author’s own elaboration.

The contribution of this research lies in providing the empirical evidence on the relationship between financial innovation and productive capital accumulation in Mexico through the application of an autoregressive distributed lag (ARDL) model. Furthermore, the study offers insights into the structural limitations of the Mexican financial system in promoting productive investments that are consistent with the principles of sustainable development, thereby contributing to the academic debate regarding the effectiveness of financial innovation as a mechanism for long-term economic growth. The functional specification of the model is expressed as follows:

$$FBCF = f(FIF, FIM, PCI) \tag{1}$$

The general econometric representation is defined as:

$$\ln(FBCF_t) = \beta_0 + ([\beta_1 * \ln(FIFt)] + [\beta_2 * FIMt]) + [+ \mu t \tag{2}$$

Where:

- $\ln FBCF$: Natural logarithm of Gross Fixed Capital Formation, used as a proxy for productive capital accumulation.
- $\ln FIF$: Natural logarithm of financial innovation, approximated by the $M2/M1$ ratio, an indicator of financial deepening and monetary expansion.
- FIM : Domestic credit provided by the financial sector to the private sector as a percentage of GDP, used as a proxy for financial intermediation.
- $\ln PCI$: Natural logarithm of per capita income, incorporated as a macroeconomic control variable.
- μ_t : Error term.
- t : Annual time period.

The financial innovation variable is formed by the ratio between the broad monetary aggregate ($M2$) and the restricted monetary aggregate ($M1$). This indicator allows us to know the degree of financial deepening, reflecting the expansion of monetary instruments, financial savings, and intermediation capacity within the financial system.

The study adopts a quantitative approach with an explanatory and correlational scope, supported by econometric time series methods to understand the short- and long-term dynamic relationships between financial innovation and productive investment. Macroeconomic variables are used in their real-world context without experimental manipulation.

The data used consists of annual series for the period from 1990 to 2021, with indicators obtained from the World Bank's World Development Indicators and official statistics from the Bank of Mexico. To eliminate heteroscedasticity and stabilize data variance, the variables were subjected to logarithmic transformations.

Prior to econometric estimation, Augmented Dickey-Fuller (ADF) unit root tests were applied to identify the order of integration of the variables and verify compliance with the assumptions of the ARDL model. The results showed that the variables used are integrated of order one, $I(1)$, allowing the implementation of the Autoregressive Distributed Lags (ARDL) approach developed by [11].

The ARDL methodology was selected due to several econometric advantages relevant to this study: i) it allows working with small samples, ii) it accepts integrated variables of mixed order $I(0)$ and $I(1)$, iii) it enables the simultaneous estimation of short- and long-term relationships, and iv) it exhibits relative robustness to potential endogeneity problems among explanatory variables. The general formulation of the ARDL model can be expressed as:

$$\Delta \ln(FBCF_t) = \alpha_0 + \frac{\sum_{i=1}^p \alpha_i \Delta \ln(FBCF_t - i)}{i=1} + \frac{\sum_{i=1}^q \alpha_{2i} \ln(FIF_t - i)}{i=1} + \frac{\sum_{i=1}^r \alpha_{3i} \Delta FIM_t - i}{i=1} + \frac{\sum_{i=1}^s \alpha_{4i} \Delta \ln(PCI_t - i)}{i=1} + \mu_t \quad (3)$$

Where $ECT_{(t-1)}$ represents the error correction term associated with the long-term equilibrium relationship. This specification allows for the simultaneous evaluation of the short-term effects of financial innovation and per capita income on Gross Fixed Capital Formation (GFCF), represented by the variables in first differences (Δ); the temporal dynamics of productive investment through the lags of the dependent variable itself; the existence of a long-term equilibrium relationship, captured by the error correction term (ECT_{t-1}); and the speed of adjustment toward equilibrium, measured by the coefficient λ .

The optimal number of lags was determined using the Akaike Information Criterion (AIC). Subsequently, the Bounds Test of Pesaran et al. [11] was applied to assess the existence of cointegration among the model variables. Additionally, bivariate ARDL models were estimated to identify individual long-term relationships between productive investment and each financial component separately (see Table 2).

Table 2. Lag selection.

Criterion	Optimal lag
AIC	5
HQ	5
SC	5
FPE	5

Note. Own elaboration.

3 **Results**

Augmented Dickey-Fuller (ADF) tests indicate that the variables used in the model exhibit unit roots at certain levels but achieve stationarity at the first difference, thus classifying them as first-order integrated variables $I(1)$. This result validates the use of the ARDL methodology, which allows working with zero- and first-order integrated variables.

The variable “Adjusted Net Savings,” used in the original study as a proxy for sustainable development, exhibited second-order integration $I(2)$, failing to meet the assumptions required by the ARDL approach. Therefore, this variable was replaced by Gross Fixed Capital Formation (GFCF) due to its econometric compatibility and its capacity to measure the accumulation of productive capital (See Table 3).

Table 3. Stationarity Tests.

Variable	Level	First Difference	Order of Integration
LnFBCF	Non-stationary.	Stationary	$I(1)$
LnFIF	Non-stationary	Stationary	$I(1)$
FIM	Non-stationary	Stationary	$I(1)$
LnPCI	Non-stationary	Stationary at 10%	$I(1)$

Note. Own elaboration.

The lag in gross fixed capital formation showed a positive and statistically significant coefficient, demonstrating temporal persistence in capital accumulation. This result indicates that productive investment in Mexico maintains a dynamic behavior with intertemporal continuity.

Financial innovation, measured by the M2/M1 ratio, did not show a statistically significant impact on gross fixed capital formation. This result suggests that financial deepening in the Mexican economy will not necessarily lead to higher levels of productive investment.

Financing provided by the monetary sector showed mixed results on capital accumulation, as the effect was slightly positive, and the credit lag had a negative and statistically significant impact, indicating possible problems of inefficient allocation of financing towards productive activities.

Per capita income had a positive and highly significant impact on gross fixed capital formation, demonstrating that higher income levels favor the expansion of productive capacity and long-term investment. The Mexican financial system fails to translate into long-term structural capital accumulation. Financial innovation and deepening in Mexico appear to generate predominantly transitory, rather than structural, effects on capital accumulation (see Table 4).

Table 4. ARDL Model Results.

Variable	Coefficient	p-value	Interpretation
L(lnFBCF,1)	0.573	0.001	Investment persistence
lnFIF	-0.042	0.449	Not significant
FIM	0.005	0.102	Weak positive effect
L(FIM,1)	-0.006	0.032	Negative lagged effect
lnPCI	1.227	0	Strong positive impact
L(lnPCI,1)	-0.954	0.006	Dynamic adjustment

Note. Own elaboration.

Although the general ARDL model specification was estimated, the Bounds Test did not provide sufficient evidence of cointegration among the variables. Therefore, the results indicate that the relationship between financial innovation and productive capital accumulation is mainly characterized by short-run dynamics rather than a stable long-run equilibrium.

The results suggest that the Mexican financial system generates predominantly transitory effects on capital accumulation, without consolidating structural

mechanisms for sustained long-term growth. This could be related to structural limitations in the Mexican economy, including low productivity, credit concentration, and insufficient channeling of financing toward productive activities.

4 Discussion

The ARDL model allows us to identify a temporal persistence in Gross Fixed Capital Formation (GFCF) in Mexico ($\beta = 0.573$, $p < 0.001$), which demonstrates that productive investment in the national context has a dynamic of intertemporal continuity or its own inertia, where past capital accumulation decisions strongly delimit the levels of infrastructure and installed capacity today, so today's decisions will surely define future ones. Conversely, the positive and highly significant effect of per capita income ($\ln PCIS$) on GFCF ($\beta = 1.227$, $p = 0.000$) fits with conventional economic theory, which proposes that a higher level of economic activity and purchasing power stimulates aggregate demand and fosters the expansion of productive capacity, without forgetting that the negative coefficient of its first lag ($\beta = -0.954$, $p = 0.006$) reveals a firm process of dynamic adjustment or cycles of overinvestment followed by corrective contractions within the Mexican economy.

The most impactful finding of this analysis is the lack of statistical significance of general financial innovation ($\$FIF$), measured by the ratio $\$M_2/M_1$, on gross fixed capital formation ($\beta = -0.042$, $p = 0.449$). From the perspective of the Schumpeterian tradition [25] and Shaw's 1973 hypothesis of financial liberalization, it would be assumed that technological advances, the sophistication of payment systems, and monetary deepening act as major drivers for improving resource allocation and directing savings toward productive investment. In the Mexican case, the data for the period 1990–2021 show that financial deepening has not effectively translated into fixed capital accumulation, revealing the existence of a process of partial financialization. Instead of the dematerialization of money and the speed of circulation optimizing real investment circuits, under an efficiency effect, the institutional and technological innovations implemented in recent years seem to have been directed towards attending to short-term transactional or liquidity activities, forgetting the country's long-term structural productive base.

This finding aligns with [22], who found that the benefits of financial innovation on sustainable development depend on institutional capacity and the quality of financial intermediation mechanisms. Similarly, [26] point out that financial expansion does not, in itself, guarantee greater productive investment when structural constraints persist in credit markets. However, these results contrast with those obtained by Haq et al. ([27] & [28]) For Nigeria, where financial innovation showed positive effects on economic growth and sustainability indicators, suggesting that the institutional context plays a determining role in the effectiveness of financial innovation processes.

Analyzing innovation in the monetary sector ($\$FIM\$$), as reflected in bank credit to the private sector, reveals a two-way relationship. While the immediate impact shows a positive, albeit statistically weak, relationship, ($\beta=0.005$, $p=0.102$), credit lagged by one period ($\$L(FIM, 1)\$$) exhibits a significant negative effect ($\beta = -0.006$, $p=0.032$). This phenomenon empirically supports the credit channel hypothesis and the warnings about resource misallocation, since although the immediate provision of financing resulting from the use of innovation generates a marginal stimulus in the economy, the contractionary lagged effects suggest that the allocation and monitoring mechanisms of the Mexican banking system have been inadequate. Ultimately, the credit market in Mexico is characterized by a high concentration of banks and a strong bias towards consumer credit and low-productivity activities, to the detriment of financing long-term industrial or infrastructure projects.

5 Conclusions

This research analyzed the impact of financial innovation on the accumulation of productive capital in Mexico for the period 1990–2021. The empirical findings allow for important conclusions regarding the nature and limitations of financial transmission mechanisms in the Mexican economy. It concludes that there is no stable long-term relationship or cointegration between financial innovation and Gross Fixed Capital Formation (GFCF) in Mexico for the analyzed period, as demonstrated by the results of the Bounds Test ($F=2.3557$, $p=0.4067$). The effects of financial dynamics on real investment are essentially transitory and short-term. These findings contradict the optimistic assumptions of Schumpeterian traditions and financial liberalization hypotheses, demonstrating that, in the Mexican case, monetary sophistication does not automatically translate into the accumulation of physical capital.

One of the initiatives of this study is to propose legislation to ensure the financial system maintains its capacity to drive processes of deepening productivity and structural growth. In Mexico, the current situation is closer to a process of partial financialization, where the growth of the financial system does not necessarily translate into sustained accumulation of productive capital. From a Schumpeterian perspective, financial innovation should incentivize the efficient allocation of capital toward activities capable of generating economic growth, productive transformation, and sustainable development for society and the environment. However, data for Mexico indicate that this transmission is not yet fully consolidated, which limits the long-term structural impact of the financial system on economic development.

The statistical neutrality of financial innovation ($\$FIF\$$) and the effects of credit to the private sector ($\$FIM\$$) highlight a process of partial financialization and severe asymmetries in credit allocation in Mexico. It is concluded that technological modernization and monetary deepening in the country have prioritized the development of transactional platforms, immediate liquidity, and mass consumption financing, neglecting the structural needs for long-term infrastructure investment or

the industrial capitalization of SMEs. The banking system in Mexico is characterized by high market concentration, which generates analytical inefficiencies that promote the allocation of economic resources to consumption rather than productive projects, limiting the sector's potential as a driver of real and sustainable development.

Regarding the macroeconomic control variables, we deduce that per capita income is the fundamental and direct driver of productive investment in Mexico. However, the lagging nature of this variable shows pronounced dynamic adjustment cycles. Likewise, the temporal persistence observed in gross fixed capital formation (GFCF) confirms the inertia of fixed capital. It is noteworthy that current investment continues to depend on the infrastructure and industrial decisions established previously, rather than on emerging stimuli from the formal financial sector.

In conclusion, the implications of this study demonstrate the need to reorient financial and regulatory public policy in Mexico toward a development banking and sustainable finance approach with structural impact. Digital expansion and nominal increases in broad monetary aggregates have proven insufficient to induce economic resilience or decouple the economy from environmental factors. More meticulous and rigorous monitoring and evaluation mechanisms, along with guarantee schemes, are needed to prioritize credit allocation toward the transformation of the energy matrix and green infrastructure.

We are aware of the methodological limitations of this study due to the substitution of the multidimensional indicator Adjusted Net Savings (ANA) derived from econometric consistency, limiting the scope of the study to the physical capital produced. Therefore, in future studies we propose to evaluate the implementation of non-linear models or incorporate variables that directly reflect environmental, social, and governance (ESG) risks, as well as the specific impact of the FinTech ecosystem and green fixed-income instruments on the reduction of climate change and social equity in the Latin American context and not only in the Mexican one.

This research has some limitations that should be considered when interpreting the results. First, due to econometric consistency constraints, it was necessary to replace the multidimensional indicator of sustainable development (Adjusted Net Savings) with Gross Fixed Capital Formation, thus focusing the analysis on the economic dimension of sustainability. Second, the study is limited to the Mexican case, so the results cannot be automatically generalized to other national contexts. Finally, the use of aggregate indicators may mask relevant sectoral differences in credit allocation and the adoption of financial innovations.

In an environment characterized by the increasing digitalization of financial services and the need to promote more sustainable growth models, the results suggest that financial innovation must transcend the expansion of monetary instruments and focus on mechanisms capable of channeling resources toward productive projects, sustainable infrastructure, and long-term value-generating activities. In this way, financial innovation can consolidate itself as an effective instrument for promoting sustainable economic development in Mexico and other emerging economies.

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