

Review of Business and Economics Studies

DOI: 10.26794/2308-944X



ВЫСШАЯ
АТТЕСТАЦИОННАЯ КОМИССИЯ (ВАК)
при Министерстве образования и науки Российской Федерации



WorldCat®

EconPapers





Review of Business and Economics Studies

REVIEW OF BUSINESS

AND ECONOMICS STUDIES

(*RoBES*) is the quarterly peer-reviewed scholarly journal published by the Financial University under the Government of the Russian Federation, Moscow. Journal's mission is to provide scientific perspective on topical economic and business subjects.

CONTACT INFORMATION

Financial University
under the Government
of the Russian Federation
53, Leningradsky prospekt,
office 5.6
Moscow, Russian Federation, 125167
Telephone: +7 (499) 553-10-74
(internal 10-88)
Website: <https://rbes.fa.ru/jour>

AUTHOR INQUIRIES

Inquiries relating to the submission
of articles can be sent by electronic
mail to ambotchkaev@fa.ru.

The journal was reregistered
in the Federal Service for Supervision
of Communications,
Informational Technologies,
and Mass Media:
PI No. ФС77-67072
of 15 September 2016

Publication frequency –
4 issues per year

Founder: Financial University
under the Government of the Russian
Federation

The Journal is included into the
system of Russian Science Citation
Index, Scopus, the Higher Attestation
Commission (VAK)

List of journals
for scientific specialities:
5.2.3, 5.2.4, 5.2.5

The journal is published under
the terms of Creative Commons
Attribution 4.0 International
(CC BY 4.0) license.

COPYRIGHT AND PHOTOCOPYING

© 2020 All rights reserved. No part
of this publication may be reproduced,
stored or transmitted in any form or by
any means without the prior permission
in writing from the copyright holder.
Single photocopies of articles may be
made for personal use as allowed by
national copyright laws.
ISSN 2308-944X

EDITOR-IN-CHIEF

Pavel S. Seleznev

Dr. Sci. (Political Science), Dean, Faculty of International Economic Relations, Professor,
Department of Politology, Financial University under the Government of the Russian
Federation, Moscow, Russian Federation

MANAGING EDITOR

Alexei M. Botchkarev

Cand. Sci. (Tech.) Financial University under the Government of the Russian Federation,
Moscow, Russian Federation

EDITORIAL BOARD

Sanjaya Acharya

Dr. of Economics, Professor, Department of Economics, Faculty of Humanities and Social
Sciences, Tribhuvan University, Kathmandu, Nepal

Nikolai P. Belyatsky

Dr. Sci. (Econ.), Professor, Head of the Department of Organization and Management,
Faculty of Economics and Management, Belarusian State University of Economics,
Minsk, Republic of Belarus

Andrey V. Fedorov

Dr. Sci. (Econ.), Leading Researcher, Center for Sub-Saharan African Studies, Institute
for African Studies, Russian Academy of Sciences, Moscow, Russian Federation

Konstantin P. Gluschenko

Dr. Sci. (Econ.), Professor, Chief Scientist, Institute of Economics
and Organization of Industrial Production, Siberian Branch of RAS, Novosibirsk,
Russian Federation

Lidia I. Kulikova

Dr. Sci. (Econ.), Professor, Head of the Department of Accounting, Analysis and Audit,
Kazan (Volga Region) Federal University, Kazan, Russian Federation

Sunil Kumar

Dr. of Management and Economics, Professor & Head and Deputy Registrar (E&E),
Department of Economics, Alliance University, Bengaluru, Karnataka, India

Svetlana A. Lipina

Dr. Sci. (Econ.), Professor, Deputy Head of the Council for the Study of Productive
Forces, Russian Foreign Trade Academy, Moscow, Russian Federation

Yuri N. Maksimov

Dr. Sci. (Econ.), Deputy Head of the Department of "Economics of Knowledge", Professor
Moscow State University, Moscow, Russian Federation

Dimitrios Mavrakīs

Dr. of Economics, Professor, Energy Policy and Development Centre, National and
Kapodistrian University of Athens, Athens, Greece

Stephen McGuire

Dr. of Economics, Professor, College of Business and Economics, Faculty of Management,
California State University, Los Angeles, USA

Alexander Melnikov

Dr. Sci. (Physics-Math.), Professor, Department of Mathematical Sciences and Statistical
Sciences, University of Alberta, Edmonton, Canada

Nasibu R. Mramba

Dr. of Business Informatics, Ag. Deputy Rector Academic Research & Consultancy,
College of Business Education, Dar Es Salaam, Tanzania

Thomas Renström

Dr. of Economics, Professor, Business School, Department of Economics and Finance,
Durham University, Durham, UK

Boris Rubtsov

Dr. Sci. (Econ.), Professor, Deputy Chairman of Department of Financial Markets and
Banks for R&D, Financial University under the Government of the Russian Federation,
Moscow, Russian Federation

Alan Sangster

Dr. of Economics, Professor, Business School, King's College, University of Aberdeen,
Aberdeen, UK

Sabu Thomas

PhD., Professor, Vice Chancellor, Mahatma Gandhi University, Kottayam, India

Ivan N. Timofeev

Cand. Sci. (Polit.), Assistant Professor, Moscow State Institute of International Relations
(MGIMO), Russian International Affairs Council (RIAC), Moscow, Russian Federation

Bo Xu

Dr. of Political Science, Professor, Vice Chair, Department of International Politics,
Northeast Asian Studies College, Jilin University, Changchun City, China

Mikhail V. Zharikov

Dr. Sci. (Econ.), Associate Professor, Professor of the Department of World Economy
and World Finance, Faculty of International Economic Relations, Financial University
under the Government of the Russian Federation, Moscow, Russian Federation



Review of Business and Economics Studies

ГЛАВНЫЙ РЕДАКТОР

Селезнев Павел Сергеевич

д-р полит. наук, декан факультета международных экономических отношений, профессор департамента политологии, Финансовый университет при Правительстве Российской Федерации, Москва, Российская Федерация

ВЫПУСКАЮЩИЙ РЕДАКТОР

Бочкарев Алексей Михайлович канд. техн. наук, ст. науч. сотр., Финансовый университет при Правительстве Российской Федерации, Москва, Российская Федерация

РЕДАКЦИОННЫЙ СОВЕТ

Ачарья Санджая

д-р экономики, профессор, департамент экономики, факультет гуманитарных и социальных наук, Трибхуванский университет, Катманду, Непал

Беляцкий Николай Петрович

д-р экон. наук, профессор, заведующий кафедрой организации и управления, факультет экономики и менеджмента, Белорусский государственный экономический университет, Минск, Республика Беларусь

Andrey V. Fedorov

Dr. Sci. (Econ.), Leading Researcher, Center for Sub-Saharan African Studies, Institute for African Studies, Russian Academy of Sciences, Moscow, Russian Federation

Глушенко Константин Павлович

д-р экон. наук, главный научный сотрудник, Институт экономики и организации промышленного производства, Сибирское отделение РАН, Новосибирск, Российская Федерация

Жариков Михаил Вячеславович

д-р экон. наук, доцент, профессор кафедры мировой экономики и мировых финансов факультета международных экономических отношений, Финансовый университет при Правительстве Российской Федерации, Москва, Российская Федерация

Куликова Лидия Ивановна

д-р экон. наук, профессор, заведующая кафедрой учета, анализа и аудита, Казанский (Приволжский) федеральный университет, Казань, Российская Федерация

Кумар Сунил

д-р менеджмента и экономики, профессор, заведующий кафедрой и заместитель регистратора (E&E) экономического факультета Университета Альянса, Бангалор, Карнатака, Индия

Липина Светлана Артуровна

д-р экон. наук, профессор, заместитель председателя Совета по изучению производительных сил, Всероссийская академия внешней торговли, Москва, Российская Федерация

Мавракис Димитриос

д-р экономики, профессор, Центр энергетической политики и развития (КЕРА) Национального и Каподистрийского Университета Афин (NKUA), Афины, Греция

Макгуайр Стефен

д-р экономики, профессор, факультет менеджмента, Колледж бизнеса и экономики, Калифорнийский государственный университет, Лос-Анджелес, США

Максимов Юрий Николаевич

д-р экон. наук, заместитель заведующего кафедрой «Экономика знаний», профессор, Московский государственный университет, Москва, Российская Федерация

Мельников Александр

д-р физ.-мат. наук, профессор, факультет математических и статистических наук, Университет Альберты, Эдмонтон, Канада

Мрамба Насибу Раджабу

д-р бизнес-информатики, заместитель ректора по учебной и исследовательской работе, Колледж бизнес-образования, Дар-эс-Салам, Танзания

Ренстром Томас

д-р экономики, профессор, Школа бизнеса, факультет экономики и финансов, Даремский университет, Дарем, Великобритания

Рубцов Борис Борисович

д-р экон. наук, профессор, кафедра финансовых рынков и финансового инжиниринга, Финансовый университет при Правительстве Российской Федерации, Москва, Российская Федерация

Сангстер Алан

д-р экономики, профессор, Школа бизнеса, Абердинский университет, Королевский колледж, Абердин, Великобритания

Сюй Бо

доктор политических наук, профессор, заместитель руководителя, кафедра международной политики, Колледж исследований Северо-Восточной Азии, Университет Цзилинь, г. Чанчунь, Китай

Тимофеев Иван Николаевич

канд. полит. наук, доцент, Московский государственный институт международных отношений (МГИМО), генеральный директор Российского совета по международным делам (РСМД), Москва, Российская Федерация

Томас Сабу

д-р философии, профессор, проректор, Университет Махатмы Ганди, Коттаям, Индия

Федоров Андрей Владимирович

д-р экон. наук, ведущий научный сотрудник Центра изучения стран Африки южнее Сахары, Институт Африки РАН, Москва, Российская Федерация

Редакция научных журналов

Финансового университета

при Правительстве Российской Федерации

125167, Москва, Российская

Федерация, Ленинградский пр-т, 53, комн. 5.6

Тел. +7 (499) 553-10-74

(вн. 10-88)

Интернет: <https://rbes.fa.ru/jour>

Журнал «Review of Business and Economics Studies»

(«Вестник исследований бизнеса

и экономики») зарегистрирован

в Федеральной службе по надзору

в сфере связи, информационных

технологий и массовых

коммуникаций 15 сентября 2016 г.

Издание перерегистрировано

в Федеральной службе по надзору

в сфере связи, информационных

технологий и массовых

коммуникаций:

ПИ № ФЦ77-67072

от 15 сентября 2016 г.

Периодичность издания —

4 номера в год

Учредитель: Финансовый

университет при Правительстве

Российской Федерации

Журнал включен в систему

Российского индекса научного

цитирования (РИНЦ), Scopus,

Перечень изданий ВАК по научным

специальностям: 5.2.3, 5.2.4, 5.2.5

Журнал публикует материалы

на условиях лицензии Creative

Commons Attribution 4.0

International (CC BY 4.0).

Формат 60×84 1/8.

Подписано в печать: 09.04.2026

Дата выхода в свет: 07.05.2026

Заказ № 26-2043

Отпечатано в ООО «Коми

Республиканская типография»,

г. Сыктывкар, ул. Савина, д. 81

16+



Review of Business and Economics Studies

Volume 14, Number 1, 2026

Money Laundering and Financial Instability: Exploring the Nexus in Fragile Economies

Sunil Kumar6

The Collision of Climate Narratives and Green Food Production Cost

Vladimir D. Smirnov, Irina D. Tyukhmeneva19

The Shifting Influence of Digital Transformation on Breakthrough Innovation in China

Tingqian Pu, Abdul H. Zulkafli37

The Role of Strategic Agility for Sustainable Business Performance: A Management Control and Accounting System Approach

Efendi Susana, Etty Murwaningsari, Yvonne A. Sudibyo, Sekar Mayangsari56

Determinants Affecting the Sustainable Development of Small and Medium-Sized Enterprises in a Developing Economy: A Cognitive Modeling Case Study of Cameroon

Elena A. Fomina, Yulia V. Khodkovskaya75

Increasing the Fiscal Autonomy of Regions: Reforming the Distribution of Tax Revenues in the Budget System of Russia

Michael E. Kosov, Margarita L. Vasyunina, Olga A. Polyakova91

Impact of External Debt, Capacity Utilization and Digital Infrastructural Architecture on National Savings in African Debt-Distressed Countries

*Ifeoma C. Nwakoby, Charles O. Manasseh, John O. Nwakoby, Chine S. Logan,
Ogochukwu C. Okanya, Chizoba G. Okeke*111



Review of Business and Economics Studies

Volume 14, Number 1, 2026

Отмывание денег и финансовая нестабильность: исследование взаимосвязи в неустойчивых экономиках <i>Сунил Кумар</i>	6
Коллизия климатических нарративов и стоимости производства зеленых продуктов <i>Владимир Д. Смирнов, Ирина Д. Тюхменева</i>	19
Изменение влияния цифровой трансформации на прорывные инновации в Китае <i>Тинцянь Пу, Абдул Х. Зулкафли</i>	37
Роль стратегической гибкости в обеспечении устойчивой эффективности бизнеса: системный подход к управленческому контролю и бухгалтерскому учету <i>Эфенди Сусана, Этти Мурванингсари, Ивонн А. Судибьо, Секар Майангсари.</i> ..	56
Факторы, влияющие на устойчивое развитие малых и средних предприятий в развивающейся экономике: когнитивное моделирование на примере Камеруна <i>Елена А. Фомина, Юлия В. Ходковская</i>	75
Повышение фискальной автономии регионов: реформирование распределения налоговых доходов в бюджетной системе России <i>Михаил Е. Косов, Маргарита Л. Васюнина, Ольга А. Полякова</i>	91
Влияние внешнего долга, использования производственных мощностей и архитектуры цифровой инфраструктуры на национальные сбережения в африканских странах, испытывающих проблемы с задолженностью <i>Ифеома С. Нвакоби, Чарльз О. Манассе, Джон О. Нвакоби, Чин С. Логан, Огочукву С. Оканья, Чизоба Г. Океке</i>	111

DOI: 10.26794/2308-944X-2026-14-1-6-18
UDC 336.717,336.228,343.973(045)
JEL C33, E50, H23

Money Laundering and Financial Instability: Exploring the Nexus in Fragile Economies

S. Kumar

Alliance University, Bengaluru, India

ABSTRACT

This study investigates the intricate relation between money laundering and financial instability in fragile states, particularly the impact of underground financial networks on loss of financial governance, resource misallocation, and loss of public confidence in the financial system. **Purpose:** This study examines how money laundering fosters shadow wealth, spurs inflationary pressures and reduces the effectiveness of monetary policy. **Method:** The study adopts a mixed-methods research design, combining quantitative and qualitative approaches. The research follows an explanatory sequential design and uses both quantitative and qualitative data. **Results:** It analyses how politically exposed individuals, informal financial networks, and cross-border transactions contribute to cycles of financial opacity and economic vulnerability. The paper reveals three main channels through which money laundering directly leads to instability. First, a decrease in tax revenue and, as an outcome, rising fiscal deficits. Secondly, a destabilisation of banking sectors due to the expansion of illicit credits and bad loans. Finally, capital flight and devaluation influence. The paper also examines the issues of resource scarcity for financial intelligence units and central banks in identifying and countering irregular financial activities. **Contributions:** This study suggests policy options that include regional cooperation instruments, strengthening law enforcement capacities, and incorporating anti-money laundering measures into financial inclusion policies. Reinforcing legal and institutional capacities and using digital tools for transaction tracking seems essential to countering the destabilising impact of money laundering. The results indicate the great need for comprehensive, context-sensitive policies regarding the disruption of the money laundering process and ensuring the financial stability in vulnerable regions.

Keywords: money laundering; financial instability; fragile economies; illicit finance; anti-money laundering (AML); transactional crime; economic vulnerability

For citation: Kumar S. Money laundering and Financial Instability: Exploring the nexus in fragile economies. *Review of Business and Economics Studies*. 2026;14(1):6-18. DOI: 10.26794/2308-944X-2026-14-1-6-18

ОРИГИНАЛЬНАЯ СТАТЬЯ

Отмывание денег и финансовая нестабильность: исследование взаимосвязи в неустойчивых экономиках

С. Кумар

Университет Альянса, Бангалор, Индия

АННОТАЦИЯ

В данном исследовании изучается сложная взаимосвязь между отмыванием денег и финансовой нестабильностью в неустойчивых государствах, в частности, влияние подпольных финансовых сетей на потерю финансового управления, нерациональное распределение ресурсов и потерю доверия населения к финансовой системе. **Цель:** исследование призвано показать, как отмывание денег способствует формированию теневого богатства, стимулирует инфляционное давление и снижает эффективность денежно-кредитной политики. **Метод:** в исследовании используется смешанный метод, сочетающий количественные и качественные подходы. Исследование построено на объяснительном последовательном дизайне и использует как количественные, так и качественные данные. **Результаты:** анализируется, как политически значимые лица, неформальные финансовые сети и трансграничные транзакции способствуют возникновению циклов финансовой непрозрачности и экономической уязвимости. В статье раскрыва-

ются три основных канала, отмывание денег через которые непосредственно приводит к нестабильности. Во-первых, снижение налоговых поступлений и, как следствие, рост бюджетного дефицита. Во-вторых, дестабилизация банковского сектора из-за расширения незаконных кредитов и проблемных займов. И наконец, отток капитала и влияние девальвации. В статье также рассматриваются проблемы дефицита ресурсов для подразделений финансовой разведки и центральных банков в выявлении и противодействии нерегулярной финансовой деятельности. **Научный вклад:** данное исследование предлагает варианты политики, включающие инструменты регионального сотрудничества, укрепление потенциала правоохранительных органов и включение мер по борьбе с отмыванием денег в политику расширения доступа к финансовым услугам. Укрепление правового и институционального потенциала и использование цифровых инструментов для отслеживания транзакций представляется необходимым для противодействия дестабилизирующему воздействию отмывания денег. Результаты указывают на острую необходимость в комплексной, учитывающей контекст политике в отношении пресечения процесса отмывания денег и обеспечения финансовой стабильности в уязвимых регионах.

Ключевые слова: отмывание денег; финансовая нестабильность; нестабильная экономика; незаконное финансирование; борьба с отмыванием денег (AML); транзакционные преступления; экономическая уязвимость

Для цитирования: Kumar S. Money laundering and financial instability: Exploring the nexus in fragile economies. *Review of Business and Economics Studies*. 2026;14(1):6-18. DOI: 10.26794/2308-944X-2026-14-1-6-18

1. Introduction

Money laundering is considered a transactional crime that negatively impacts the economy by contributing to rising societal violence and corruption, causing financial and banking upheaval, and leading to the failure of governance structures [1]. An estimation shows that money laundering (and big business corruption) results in around 2% to 5% of the damage of global gross domestic product (GDP) [2]. Money laundering is the process of concealing the origins of illicitly obtained money through complex financial transactions and poses a significant threat to the integrity and stability of financial systems worldwide. Money laundering has become a key player in the global economy to shape the development path which possibly distorts economic indicators, undermines financial integrity and continues economic instability which facilitates corruption, raises inequality and becomes an enabler for organised crime to flourish [3]. It becomes even easier in the integration of the global economy that provides free trade of capital and digital transactions that support commercial opportunities for businesses to flourish [4, 5]. One of the emerging criminal activities is money laundering, which has been supported through such innovations [6].

Money laundering is the activity of converting illegal property into regular money to preserve the property and works for the sole purpose of increasing money and legitimising, which is widely circulated through the construction business, where corporations are pumped across

the world to reach a final destination in property investment, prestige vehicles and luxury items [6, 7]. Globally, money is deemed legitimate when it originates from goods and financial markets; however, it can also emanate from detrimental sources, transferred illegally, referred to as illicit financial flows. This encompasses various unlawful activities, including illegal capital flight, tax evasion, drug and human trafficking, and terrorism financing. The circulation of trillions of dollars in international marketplaces is a consequence of the products and financial markets where capital is exchanged [8].

Money laundering poses a threat to the survival and soundness of financial sector development of any country where the banking system works as an intermediary and achieves a special position to detect and capture such crimes where a large amount of transactions (economic and financial) are made, where money laundering creates liquidity challenges and becomes a threat to financial stability [9–11]. The financial instability resulting from money laundering manifests through several channels: capital flight, currency volatility, inflationary pressures, and banking sector fragility. Laundered money typically flows through informal and shadow banking channels, undermining monetary policy effectiveness and eroding public confidence in financial institutions [12, 13]. Moreover, money laundering often fuels other illicit activities such as drug trafficking, terrorism financing, and political corruption, which exacerbate macroeconomic volatility.

1.1. Problem statement, objectives and research questions

While the literature extensively documents money laundering as a global financial crime, its direct link to financial instability in fragile economies remains underexplored. Fragile states face unique vulnerabilities such as weak regulatory oversight which allows criminal organisations to exploit financial loopholes. Besides, dollarisation and reliance on informal financial systems increase exposure to illicit capital inflows. Finally, external shocks, such as commodity price fluctuations or political unrest, interact with laundered funds, amplifying macro-financial volatility. Despite international efforts such as the Financial Action Task Force (FATF) recommendations and regional anti-money laundering (AML) initiatives, fragile economies struggle to implement robust AML frameworks. Empirical research investigating how money laundering channels destabilise financial systems in fragile contexts remains limited, resulting in a gap in evidence-based policy responses.

1. This paper aims to critically explore the nexus between money laundering and financial instability in fragile economies. The specific objectives are:

2. To analyse the theoretical and empirical mechanisms linking money laundering to financial instability (e.g., capital flight, exchange rate volatility, banking crises).

3. To identify case-specific manifestations of financial instability driven by illicit financial flows in selected fragile economies.

To evaluate existing AML policy responses and their effectiveness in mitigating financial instability.

The study is guided by the following research questions:

1. How does money laundering contribute to financial instability in fragile economies?

2. Which economic channels (capital flight, currency volatility, banking fragility) are most significantly affected?

3. What institutional and structural factors amplify the destabilising effects of money laundering in fragile economies?

4. What policy measures can effectively mitigate these risks?

1.2. Significance of the study

This study has significant theoretical and policy relevance.

1.2.1. Theoretical significance

The research extends the financial instability hypothesis [14] by incorporating the role of illicit financial flows in fragile economies. While traditional economic theories emphasise market imperfections and speculative bubbles as drivers of instability, this paper highlights how criminal financial activities act as an exogenous destabilising force.

1.2.2. Practical significance

The findings provide actionable insights for policymakers and international financial institutions. By identifying the specific channels through which money laundering destabilises fragile financial systems, governments and regulatory authorities can tailor AML measures to local contexts. This is particularly relevant for countries seeking compliance with FATF standards and access to international financial markets.

1.3. Scope of the study

The paper focuses on fragile and conflict-affected states, where institutional weaknesses heighten vulnerability to financial crimes. Case references include Nigeria, where oil-related money laundering fuels capital flight; Afghanistan, where narcotics-related laundering destabilises the banking sector; and Venezuela, where political corruption and illicit financial flows contribute to hyperinflation and currency collapse.

The study examines both domestic and transnational dimensions of money laundering, acknowledging that fragile economies are often integrated into global laundering networks through correspondent banking relationships, offshore financial centres, and digital cryptocurrencies.

At the core of this research is the assumption that money laundering exacerbates financial instability by distorting financial markets, eroding investor confidence, and undermining monetary policy effectiveness. The conceptual framework (to be presented in the Methodology section) hypothesises the following sequence:

Illicit financial inflows → Capital flight and asset price distortion → Exchange rate volatility and banking fragility → Macroeconomic instability

2. Literature review

This section synthesises existing research on the nexus between money laundering and financial instability, focusing on four major dimensions: (1) theoretical frameworks, (2) transmission channels of financial instability, (3) empirical evidence from fragile economies, and (4) research gaps.

2.1. Theoretical frameworks — nexus between money laundering and financial instability

2.1.1. Financial instability hypothesis

The financial instability hypothesis [14] posits that periods of economic stability encourage excessive risk-taking, which eventually triggers financial crises. While Minsky's framework primarily addresses speculative borrowing and asset bubbles, subsequent scholars [13] argue that illicit financial flows act as an exogenous destabilising factor, amplifying systemic vulnerabilities, particularly in fragile economies with weak regulatory oversight.

2.1.2. Black finance theory

The black finance theory [15] conceptualises money laundering as part of a "black economy" that distorts financial markets by introducing unproductive capital flows. Investing laundered funds in speculative real estate or informal markets, instead of productive sectors, exacerbates asset bubbles and exchange rate volatility.

2.1.3. Institutional economics perspective

From an institutional economics perspective, weak governance, corruption, and fragile legal systems facilitate money laundering and undermine financial stability [16]. The absence of strong anti-money laundering (AML) enforcement mechanisms allows criminal actors to manipulate financial systems, reducing investor confidence and increasing capital flight.

2.2. Transmission channels of financial instability

Money laundering destabilises financial systems through several interconnected channels.

2.2.1. Capital flight and illicit outflows

Illicit financial flows (IFFs) resulting from money laundering contribute significantly to capital flight, draining fragile economies of much-needed investment capital. IFFs arise with the misrepresenting of trade data, which occurs due to the presence of stricter capital control and high corruption in the economy during higher market uncertainty [17]. Kar and Cartwright-Smith [18] estimate that developing countries lose billions annually to illicit outflows, weakening domestic financial markets and causing chronic balance-of-payments deficits.

2.2.2. Exchange rate volatility and inflationary pressures

Money laundering significantly affects the international market due to asset price distortion and capital flows [3]. The flowing of illicit funds into the financial market in a non-transparent manner creates high uncertainty for investors, reduces capital allocation efficiency and triggers excessive volatility, which further makes the global financial market less stable and affects the economy with domino effects [3, 19]. Further, large inflows and outflows of laundered money distort exchange rate stability. Illicit funds are often converted into foreign currency or offshore assets, leading to demand-supply imbalances in foreign exchange markets. In Venezuela, politically connected laundering networks converted billions into U.S. dollars, accelerating hyperinflation and currency collapse [20].

2.2.3. Banking sector fragility

Failure of financial institutions has posed reputational damage to the banking sector, which further intensified with the loss of trust with the consumer due to their poor money laundering compliance practices [21]. The general loss could not be visible immediately, but the general loss associated with reputational risk, which has a destabilising effect, affected banks' capital and liquidity. The effect of money laundering has diverse impacts on the economy, such as higher rates of inflation, tax evasion, less sustainable and inward investment, audit risk, portfolio quality, stability, profitability, etc. [22]. Additionally, money laundering increases banking risks by introducing non-performing loans and reputational risks. Fragile banks with poor

compliance frameworks often become conduits for laundering, making them vulnerable to correspondent banking restrictions imposed by international regulators. The 2010 collapse of Kabul Bank in Afghanistan is a notable example where laundering-related fraudulent loans triggered a national banking crisis.¹

2.2.4. Distortion of monetary policy

Large volumes of unrecorded cash flows undermine monetary policy effectiveness, making it difficult for central banks to accurately estimate money supply and inflationary trends. Laundered funds circulating in the informal economy also hinder taxation and revenue mobilisation, further limiting the government's capacity to stabilise the economy [12]. Money laundering, tax evasion and tax avoidance pose a transactional threat which is addressed through international regimes of coordination and cooperation [23]. Empirical cases illustrate the action by the Hong Kong monetary policy authority of lowering interest rates after 2008, which evidences the growth of complex financial products and capital inflows from mainland China and heightened money laundering risk through shell companies and over-the-counter securities [24]. Money laundering reduces the bank's profitability and stability, poses a serious threat to the banking industry [22], leads to reputational damage and substantial financial penalties [25].

2.3. International and domestic anti-money laundering efforts

2.3.1. FATF recommendations and compliance

The Financial Action Task Force (FATF) provides global AML standards, but fragile economies struggle with compliance due to resource constraints, political interference, and corruption. Countries on the FATF "grey list" often face de-risking by global banks, further isolating them from the international financial system, which can exacerbate their economic challenges and hinder their ability to attract foreign investment.

2.3.2. Regional AML frameworks

Regional initiatives, such as the Inter-Governmental Action Group Against Money Laundering in West Africa (GIABA), have achieved limited success due to coordination challenges and lack of enforcement powers [26].

2.3.3. Domestic reforms

Some fragile economies have introduced AML reforms, but institutional weaknesses undermine their effectiveness. For instance, while Nigeria established the Economic and Financial Crimes Commission (EFCC), political interference often limits its ability to prosecute high-profile laundering cases [26].

2.4. Research gaps

Despite growing literature, significant gaps remain:

1. Limited Focus on Fragile Economies — Most empirical studies focus on developed or emerging economies, leaving fragile states under-researched.
2. Lack of Integrated Analysis — Few studies integrate macroeconomic indicators (inflation, currency volatility) with institutional quality measures to assess the laundering-instability nexus.
3. Neglect of Informal Financial Channels — Research often overlooks the role of informal systems (hawala, mobile money) in laundering within fragile economies.
4. Insufficient Longitudinal Studies — Most existing research uses cross-sectional data, limiting understanding of long-term dynamics.

The literature review confirms that money laundering contributes to financial instability through multiple economic and institutional channels. However, fragile economies present unique vulnerabilities due to their heavy reliance on informal markets, weak governance, and susceptibility to external shocks. This study addresses the identified research gaps by adopting a mixed-methods approach to examine how laundering influences financial stability indicators in fragile contexts, while incorporating institutional and structural variables.

3. Methodology

This study adopts a mixed-methods research design, combining quantitative and qualitative approaches to investigate the nexus between money laundering and financial instability in fragile

¹ International Crisis Group. 2011. The Kabul Bank crisis: Lessons for Afghanistan's financial system. ICG Asia Report. URL: <https://www.crisisgroup.org/opd/asia-pacific/afghanistan/cleaning-afghanistans-banking-system> (accessed on 18.01.2026).

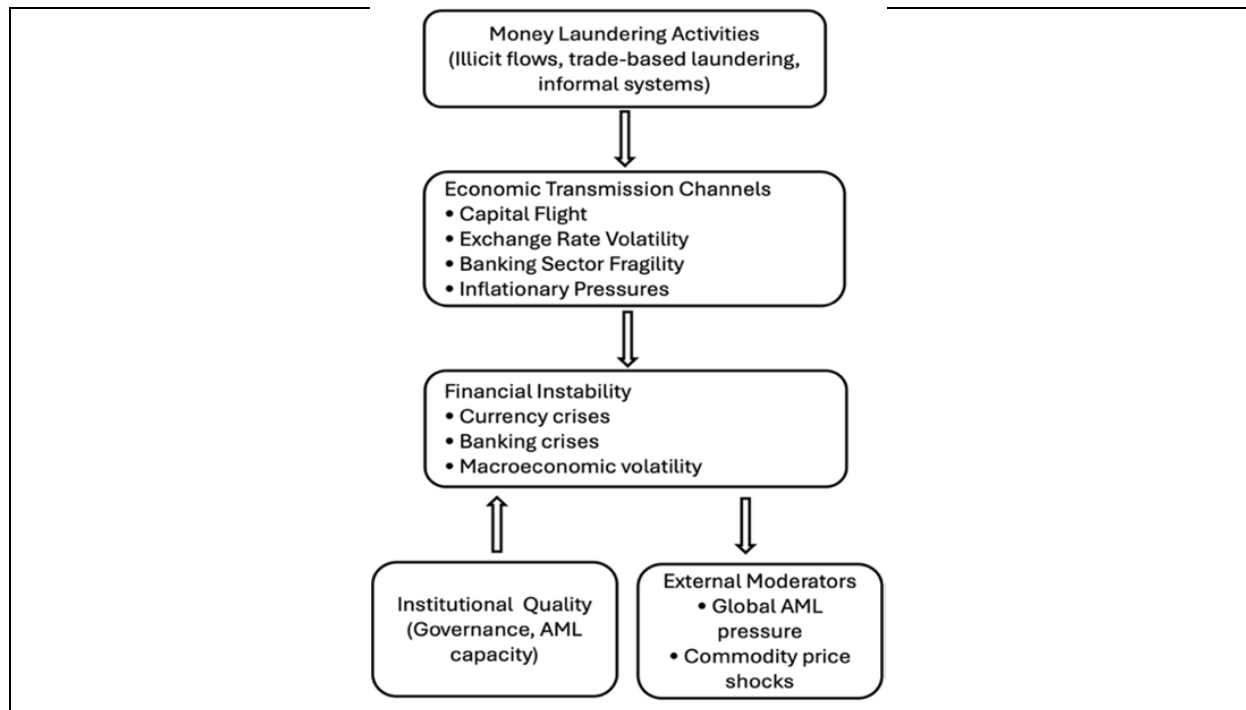


Fig. 1. Conceptual framework (the money laundering – financial instability nexus)

Source: Developed by the author based on Masciandaro et al. (2013) [13] and Minsky (1986) [14].

economies. The mixed-methods design is justified because the relationship between illicit financial flows and financial instability involves both measurable economic indicators and institutional dynamics that require qualitative interpretation.

The research follows an explanatory sequential design [27] and uses both quantitative and qualitative data. In the quantitative phase, empirical analysis of the relationship between money laundering indicators and financial instability has been measured using secondary macroeconomic data. In the qualitative phase, thematic analysis of case studies and policy documents contextualises and explains the statistical findings. This integrated approach addresses the identified research gaps by providing both statistical evidence and contextual understanding of the mechanisms at play in fragile economies.

3.1. Conceptual framework

The conceptual framework (Fig. 1) illustrates the hypothesised relationship between money laundering activities and financial instability, mediated by economic channels and moderated by institutional quality.

3.2. Population and sampling

In the quantitative phase, the study focuses on 10 fragile economies, selected based on the Fragile

States Index² and FATF grey-listing. These include Nigeria, the Democratic Republic of Congo, Sudan, Afghanistan, Yemen, Venezuela, Haiti, Myanmar, Guinea-Bissau, and Somalia. A purposive sampling strategy was used to select these countries due to the availability of macroeconomic data and their documented vulnerabilities to money laundering.

For the qualitative phase, five case studies (Nigeria, Venezuela, Afghanistan, Myanmar, and Haiti) were selected based on regional diversity and documented laundering scandals. Policy documents, investigative reports, and interviews with AML experts (as secondary sources) were reviewed.

3.3. Data

The secondary (quantitative) data were collected from multiple sources, namely, World Bank World Development Indicators (WDI) (GDP, inflation, exchange rate, banking sector indicators), Global Financial Integrity (GFI) (estimates of illicit financial flows (IFFs)) FATF and Basel AML Index (AML compliance and governance indicators), and IMF Financial Soundness Indicators (FSI) (non-performing loans, bank capital adequacy ratios). Similarly, qualitative data were also obtained

² Fragile States Index. URL: <https://fragilestatesindex.org/>

Table 1
Variables and measurements

Variables name		Measurement
Dependent variable		
Financial Instability	Exchange Rate Volatility (ERV)	Standard deviation of monthly exchange rate fluctuations (IMF data).
	Banking Sector Fragility (BSF)	Ratio of non-performing loans to total loans
	Macroeconomic Volatility (MV)	GDP growth variability and volatility
Independent variable		
Money Laundering Intensity	Proxy using Illicit Financial Flows (IFFs).	A % of GDP and AML Index Score
Control variable		
	Institutional Quality (IQ)	
	Commodity Price Shocks (CPS)	Volatility in global commodity prices for resource-dependent countries
	Foreign Direct Investment (FDI)	As a % of GDP

Source: Developed by the author.

Table 2
Descriptive statistics

Variable	Mean	SD	Min	Max
Illicit Financial Flows (% of GDP)	7.82	3.15	2.40	15.90
Exchange Rate Volatility (ERV)	12.7	6.3	3.4	28.5
Banking Sector Fragility (NPL ratio, %)	15.6	8.9	5.2	38.4
Inflation Volatility (%)	18.3	10.1	4.7	46.2
Institutional Quality (WGI, -2.5 to 2.5)	-1.33	0.72	-2.21	-0.18

Source: Developed by the author.

Note: ERV – standard deviation of monthly exchange rates; NPL – non-performing loans; WGI – World Governance Indicators.

from different sources, which include FATF mutual evaluation reports and regional AML organization publications (e.g., GIABA, APG), case-specific academic studies and policy reports, and news and investigative journalism sources (e.g., OCCRP reports for money laundering scandals). *Table 1* presents the details of variables and measurements.

Data analysis has been conducted using Stata 17. *Table 2* summarises the key variables for the 10 fragile economies over the study period (2010–2023).

Thematic analysis will follow Braun and Clarke's [28] six-step approach, which includes

familiarisation with data (policy documents, case reports), coding for key themes (AML enforcement gaps, informal channels, political interference) and identifying cross-country patterns. The findings will complement the quantitative analysis by providing contextual explanations for statistical patterns.

Although this research uses secondary data, ethical risks are minimal. However, all data sources will be appropriately cited, sensitive information from case studies handled with caution to avoid political implications and country-specific findings has contextualized to avoid stigmatization.

Table 3

Fixed-effects regression results (money laundering and financial instability)

Predictor	ERV (β)	p-value	Banking Fragility (β)	p-value	Inflation Volatility (β)	p-value
Illicit Financial Flows (IFFs)	0.39	<.001	0.28	.002	0.22	.015
Institutional Quality (WGI)	-0.31	.004	-0.26	.013	-0.19	.042
Commodity Price Shocks (CPS)	0.14	.081	0.09	.210	0.17	.064
FDI (% of GDP)	-0.11	.093	-0.08	.127	-0.12	.074
R ² (within)	0.44	—	0.38	—	0.32	—

Source: Developed by the author.

Note: All β are standardized coefficients.

Panel data regression models. A fixed-effects model will estimate the impact of laundering on financial instability:

$$FI_{it} = \alpha + \beta_1 IFF_{it} + \beta_2 IQ_{it} + \beta_3 CPS_{it} + \beta_4 FDI_{it} + \varepsilon_{it},$$

where FI_{it} is financial instability indicators for country i at time t , IFF_{it} shows illicit financial flows (% of GDP), IQ_{it} is institutional quality, CPS_{it} depicts commodity price shocks and FDI_{it} shows foreign direct investment. α is a constant term, β_1 to β_4 are the parameters and ε_{it} shows error term, respectively.

4. Results and discussion

This section presents the findings of the quantitative and qualitative analyses, followed by an integrated discussion. The results explore the relationship between money laundering (measured via illicit financial flows) and financial instability indicators in fragile economies, along with contextual evidence from selected case studies.

A fixed-effects panel regression was conducted to examine the impact of money laundering on financial instability indicators, and the results are shown in *Table 3*.

The findings from regression highlight that illicit financial flows (IFFs) significantly predict all three financial instability indicators, with the strongest effect on exchange rate volatility ($\beta = 0.39$, $p < .001$). Besides, institutional quality has a significant mitigating effect, supporting the argument that strong governance reduces financial instability. Additionally, commodity price shocks

and FDI are weakly significant, suggesting that laundering effects are more direct than external shocks.

4.1. Case study findings

The qualitative analysis provides contextual insights into how laundering destabilises fragile economies.

4.1.1. Afghanistan: banking sector fragility

The Kabul Bank scandal (2010) illustrates how laundering destabilises fragile banking systems. Fraudulent loans to politically linked individuals amounted to nearly \$ 900 million, triggering depositor panic, a bank run, and an IMF-led bailout.³ This supports the regression evidence linking laundering to banking fragility ($\beta = 0.28$).

4.1.2. Haiti: informal systems and AML weakness

Haiti's reliance on informal money transfer systems (e.g., hawala-like networks) enables laundering while undermining formal banking channels. Weak enforcement of AML laws allows criminal proceeds to circulate freely, contributing to chronic exchange rate volatility. *Table 4* provides a comparative summary of how laundering destabilises selected fragile economies and the existing gaps in anti-money laundering (AML)

³ International Crisis Group. 2011. The Kabul Bank crisis: Lessons for Afghanistan's financial system. ICG Asia Report. URL: <https://www.crisisgroup.org/opd/asia-pacific/afghanistan/cleaning-afghanistans-banking-system> (accessed on 18.01.2026).

Table 4

Comparative case study findings (laundering and financial instability)

Country	Key laundering channels	Financial instability effects	AML weaknesses
Afghanistan	Narcotics trade, fraudulent bank loans	Banking crisis (Kabul Bank), depositor panic	Weak central bank oversight, informal hawala networks
Haiti	Informal remittance systems (hawala-like)	Exchange rate volatility, limited monetary control	Limited AML infrastructure, reliance on informal finance

Source: Developed by the author.

Table 5

Structured recommendation

Sl. No.	Structure	Strategy	Supportive action
1	Policy oriented	Tailored AML strategies for fragile contexts	Develop context-specific AML frameworks that prioritize key laundering channels (e.g., trade misinvoicing in resource-rich fragile states)
		Regulation of informal financial systems	Introduce light-touch regulation for mobile-money platforms and hawala networks to integrate them into the formal financial system
		Regional cooperation	Strengthen regional AML organisations (e.g., GIABA, APG) to improve cross-border intelligence sharing
2	Institutional level	Capacity building	Provide training for financial intelligence units (FIUs) and enhance judicial independence to prosecute high-profile laundering cases
		Public-Private Partnerships (PPP)	Collaborate with commercial banks, fintech firms, and mobile money providers for transaction monitoring and suspicious activity reporting
		Anti-corruption measures	Integrate AML reforms with broader anti-corruption initiatives to address political interference
3	Operational-level	Targeted financial monitoring	Use AI-based trade and transaction monitoring tools to detect anomalies in fragile states with limited manpower
		Community Engagement	Involve local communities and civil society in monitoring resource-based laundering, especially in mining and oil sectors
		Incentive-Based Compliance	Offer tax and credit incentives for businesses adopting AML compliance standards

Source: Developed by the author.

responses. It shows a common pattern: resource-based laundering and political corruption interact with weak institutions to exacerbate macroeconomic volatility.

The findings confirm the financial instability hypothesis [14], extending it to show how illicit financial flows act as exogenous destabilising forces. The positive relationship between laundering and volatility supports the black finance theory

[15], which argues that illicit funds distort asset allocation and exchange markets. Further, the significant negative coefficient for institutional quality indicates that governance capacity mediates the laundering — instability nexus. Countries with better regulatory enforcement (e.g., Ghana in Sub-Saharan Africa, not included in this fragile sample) exhibit lower volatility despite similar exposure to IFFs, reinforcing the importance of institutional

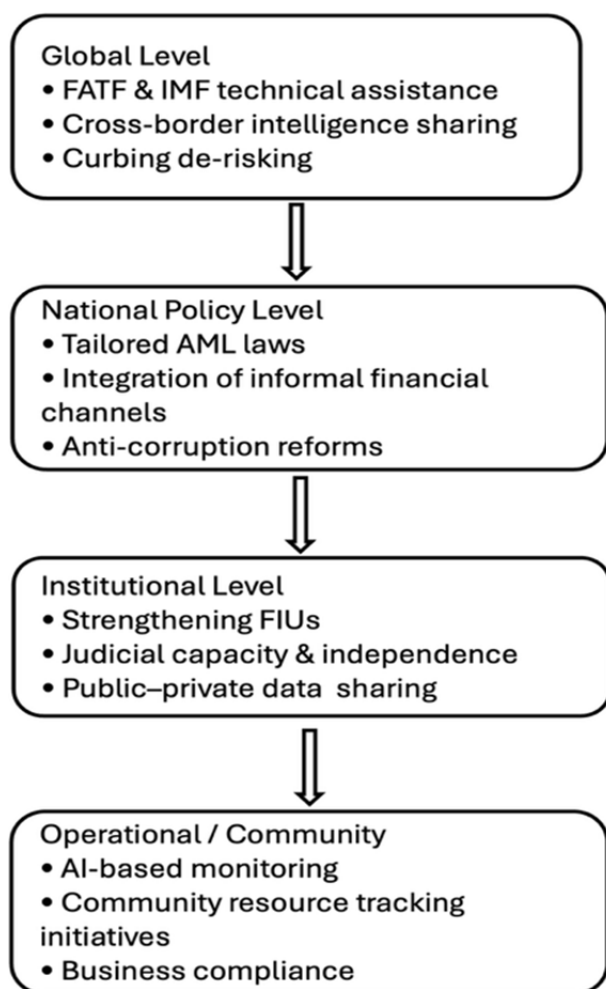


Fig. 2. Governance framework for combating money laundering in fragile economies

Source: Developed by the author.

reforms. Moreover, case study evidence highlights how informal systems (hawala, mobile money platforms) amplify laundering in fragile states, bypassing AML enforcement.

The results suggest that global AML regimes (e.g., FATF recommendations) are insufficient when local institutions are weak. Instead, context-specific interventions — such as targeting trade misinvoicing in resource-dependent economies and strengthening informal sector oversight — are required. Money laundering significantly contributes to financial instability in fragile economies, particularly through exchange rate volatility and banking sector fragility. Moreover, institutional quality moderates the relationship, with weak governance amplifying laundering's destabilising effects. Case studies confirm these patterns, showing how laundering interacts with political corruption and informal financial systems to trigger macroeconomic crises.

5. Policy implications and recommendations

The findings from this study highlight the critical nexus between money laundering and financial instability in fragile economies. This section outlines policy implications at national, regional, and global levels and provides specific recommendations for mitigating the destabilising effects of illicit financial flows (IFFs).

5.1. Policy Implications

5.1.1. Reassessing AML frameworks in fragile economies

The study underscores that FATF-compliant laws alone are insufficient in fragile contexts. Policies must account for informal financial systems, political corruption, and capacity constraints.

5.1.2. Institutional reforms as stabilizers

The strong moderating effect of institutional quality implies that building transparent regulatory institutions is a prerequisite for financial stability. Targeted institutional reforms, rather than blanket global AML pressure, are essential for fragile states.

5.1.3. Global responsibility and cooperative mechanisms

Since laundering in fragile economies is often transnational, the international community must enhance cooperation in financial intelligence sharing and provide capacity-building support. Excessive de-risking by global banks (cutting correspondent banking ties) may unintentionally push fragile economies deeper into informal channels.

Based on the study findings, the following recommendations are structured around policy, institutional, and operational levels (Table 5).

Based on the recommendation, the proposed governance framework is drawn that integrates a multi-level strategy (Fig. 2).

6. Conclusion

This study examined the complex relationship between money laundering and financial instability in fragile economies using a mixed-methods research design. The quantitative analysis, based on panel data from 10 fragile states (2010–2023), provided strong evidence that illicit financial flows (IFFs) significantly

contribute to financial instability, measured by exchange rate volatility, banking sector fragility, and inflationary pressures. Illicit financial flows were found to be the strongest predictor of exchange rate volatility ($\beta = 0.39$, $p < .001$) and also significantly influenced banking sector fragility ($\beta = 0.28$, $p = .002$) and inflation volatility ($\beta = 0.22$, $p = .015$). Institutional quality significantly moderated the laundering–instability nexus ($\beta = -0.31$, $p = .004$), confirming that strong governance frameworks reduce systemic vulnerability. The qualitative case studies of Nigeria, Venezuela, Afghanistan, Haiti, and Myanmar reinforced these statistical findings. In each case, laundering activities — whether through oil bunkering, political embezzlement, narcotics trade, or informal remittance systems — exacerbated financial crises by draining foreign reserves, destabilising currencies, and eroding confidence in banking systems. Collectively, the evidence demonstrates that money laundering acts as an exogenous destabilising force in fragile economies, amplifying existing macroeconomic and institutional vulnerabilities.

6.1. Theoretical contributions

This research contributes to the literature by extending existing economic theories:

1. Financial instability hypothesis [14] — The study expands Minsky's framework by showing that financial crises in fragile economies are not solely the result of endogenous speculative bubbles but are also triggered by criminal financial activities that distort capital allocation and monetary policy.
2. Black finance theory [15] — The results empirically confirm the theory's assertion that laundering fuels unproductive financial flows, particularly in speculative real estate and currency markets.
3. Institutional economics [16] — The findings underline the crucial role of institutional quality in moderating laundering-induced instability, reinforcing institutional economics' emphasis on governance as a determinant of economic outcomes.

6.2. Practical and policy implications

The study's findings have significant implications for policymakers, international organizations, and financial regulators:

1. Tailored AML frameworks — One-size-fits-all AML measures are ineffective in fragile economies. Context-specific strategies must prioritize

the dominant laundering channels, such as trade misinvoicing in resource-rich states or informal hawala networks in underbanked regions.

2. Institutional strengthening — Building independent financial intelligence units (FIUs), ensuring judicial independence, and combating political interference are critical to stabilizing fragile financial systems.

3. Global cooperation and technical assistance — International institutions (IMF, FATF) must move beyond punitive de-risking measures to provide capacity-building support for fragile states, helping them integrate informal systems into formal financial networks.

4. Leveraging technology — Adoption of AI-based monitoring tools and blockchain-based transaction tracking can help detect laundering patterns in resource-constrained fragile economies.

The governance framework for AML in fragile economies (presented in Section 5) provides a structured multi-level approach, linking global policy coordination, national reforms, institutional capacity building, and community-level initiatives.

Future policy directions involve the use of blockchain for AML that explores blockchain-based transaction tracking to reduce anonymity in fragile economies. Additionally, financial inclusion as an AML strategy by expanding formal financial access to reduce reliance on informal laundering-friendly systems. Finally, long-term institutional development by enabling embedded AML reforms into broader state-building and governance-strengthening efforts.

While the study offers valuable insights, it is subject to certain limitations. This limitation comes in the form of data where estimates of IFFs are based on indirect methods and may underestimate laundering flows in informal networks. The second limitation is the causality; although panel regression controls for some heterogeneity, establishing strict causal relationships remains challenging. Third, case selection bias exhibits that the focus on high-profile fragile states may over-represent extreme cases, limiting generalisability. Finally, neglect of non-financial impacts such as socio-political impacts (e.g., state legitimacy, conflict financing) is underexplored. Moreover, the methodological limitations include: data reliability — estimates of illicit financial flows are prone to measurement errors due to hidden

transactions; causality issues — while panel regression can control for some unobserved heterogeneity, establishing strict causality remains difficult and case study bias — selection of high-profile cases may overrepresent severe instances of laundering.

Future studies should address these limitations by initially employing longitudinal and time-series models to better capture dynamic interactions between laundering and macro-financial stability over extended periods. Second, expand the scope to non-financial impacts by including the political economy of laundering and its effects on state legitimacy and conflict financing. Third, exploring digital currencies and crypto-laundering was given the growing use of cryptocurrencies in fragile economies to bypass traditional AML controls. Fourth, comparative regional studies are used to identify regional variations in laundering patterns and regulatory effectiveness. Fifth, micro-level behavioural studies are used to examine how household and business actors in fragile economies interact with laundering networks.

The study confirms that money laundering is not merely a criminal justice issue but a fundamental macroeconomic risk that exacerbates financial instability in fragile economies. Unlike in developed financial systems, where regulatory institutions buffer systemic shocks, fragile states experience amplified volatility due to institutional weaknesses, political corruption, and reliance on informal financial systems. Effective mitigation requires a paradigm shift from punitive, compliance-focused AML regimes to development-orientated, capacity-building approaches. Fragile economies need multi-level governance strategies that combine global technical assistance, national policy reforms, institutional strengthening, and community-level monitoring. As fragile economies increasingly integrate into global financial networks, the international community must recognise that combating money laundering is not only a matter of financial integrity but also a prerequisite for sustainable economic stability and development.

REFERENCES

1. Santacruz R.F.S., Endara M.D.R.M., Moreno J.J.S. Analysis of money laundering crimes through multi-criteria decision methods. *Universidad y Sociedad*. 2022;14(S4):181-190. URL: <https://rus.ucf.edu.cu/index.php/rus/article/view/3125>
2. Clarke A.E. Is there a commendable regime for combatting money laundering in international business transactions? *Journal of Money Laundering Control*. 2021;24(1):163-176. URL: <https://doi.org/10.1108/JMLC-05-2020-0057>
3. Andni R. The Impact of Money Laundering on global economic stability and international business: A Multidimensional analysis. *Journal of Business Crime*. 2025; 1(1):1-10. URL: [https://doi.org/10.70764/gdpu-jbc.2025.1\(1\)-01](https://doi.org/10.70764/gdpu-jbc.2025.1(1)-01)
4. Issah M., Antwi S., Antwi S.K., Amah P. Anti-money laundering regulations and banking sector stability in Africa. *Cogent Economics and Finance*. 2022;10(1):2069207. URL: <https://doi.org/10.1080/23322039.2022.2069207>
5. Alexander K. The international anti-money-laundering regime: The role of the financial action task force. *Journal of Money Laundering Control*. 2021; 4(3):231-248. URL: <https://doi.org/10.1108/eb027276>
6. Durguti E., Arifi E., Gashi E., Spahiu M. Anti-money laundering regulations' effectiveness in ensuring banking sector stability: Evidence of Western Balkan. *Cogent Economics and Finance*. 2023;11(1):2167356. URL: <https://doi.org/10.1080/23322039.2023.2167356>
7. Ferwerda J., van Saase A., Unger B., Getzner M. Estimating money laundering flows with a gravity model-based simulation. *Scientific Reports*. 2020;10(1):1-11. URL: <https://doi.org/10.1038/s41598-020-75653-x>
8. Hanif N., Javaid A., Arshed N., Rafay A. Foreign exploration of immature markets and incidence of money laundering. *Journal of Money Laundering Control*. 2023; 26(6):1117-1130. URL: <https://doi.org/10.1108/JMLC-10-2022-0153>
9. Antwi S., Tetteh A.B., Amah P., Dankwah E.O. Anti-money laundering measures and financial sector development: Empirical evidence from Africa. *Cogent Economics and Finance*. 2023;11(1):2209957. URL: <https://doi.org/10.1080/23322039.2023.2209957>
10. Ruozi R., Ferrari P. Liquidity Risk Management in Banks: Economic and Regulatory Issues. *Liquidity Risk Management in Banks*. SpringerBriefs in Finance. 2013. URL: https://doi.org/10.1007/978-3-642-29581-2_1

11. Aluko A., Bagheri M. The impact of money laundering on economic and financial stability and on political development in developing countries: The case of Nigeria. *Journal of Money Laundering Control*. 2012;15(4):442-457. URL: <https://doi.org/10.1108/13685201211266024/>
12. Quirk P.J. Money laundering: Muddying the macroeconomy. *Finance and Development*. 1997;34(1):7-9. URL: <https://www.elibrary.imf.org/view/journals/022/0034/001/article-A003-en.xml>
13. Masciandaro D., Takáts E., Unger B. Black finance: The economics of money laundering. *Journal of Money, Credit and Banking*. 2013;45(8):1423-1447. URL: <https://doi.org/10.1111/jmcb.12070>
14. Minsky H.P. Stabilizing an unstable economy. *Yale University Press*. 1986. URL: https://digitalcommons.bard.edu/hm_archive/144
15. Masciandaro D. Money laundering: The economics of regulation. *European Journal of Law and Economics*. 1999;7(3):225-240. URL: <https://doi.org/10.1023/A:1008650204308>
16. Ngo N.Q.N., Vuong N.Y.N., Hassan M.K. Monetary policy, financial development and money laundering: International evidence. *The Quarterly Review of Economics and Finance*. 2025;104:102051. URL: <http://dx.doi.org/10.1016/j.qref.2025.102051>
17. Liu R., Stengos T. What Drives Illicit Financial Flows? An Empirical Study of Trade Data Discrepancies. *Open Economies Review*. 2023;34(2):371-409. DOI:10.1007/s11079-022-09669-3
18. Kar D., Cartwright-Smith D. Illicit financial flows from developing countries: 2000-2009. *Global Financial Integrity*. 2010. https://gfintegrity.org/wp-content/uploads/2011/12/GFI_2010_IFF_Update_Report_FINAL.pdf
19. Masciandaro D. The illegal sector, money laundering and the legal economy: a macroeconomic analysis. *Journal of Financial Crime*. 2000;8(2):103-112. URL: <https://doi.org/10.1108/eb025972>
20. Corrales J., Penfold M. Dragon in the tropics: The legacy of Hugo Chávez. *Brookings Institution Press*. 2015. DOI: 10.5771/9780815725947
21. Basaran-Brooks B. Money laundering and financial stability: does adverse publicity matter? *Journal of Financial Regulation and Compliance*. 2022;30(2):196-214. URL: <https://doi.org/10.1108/JFRC-09-2021-0075>
22. Khelil I., Khlif H., Achek I. The economic consequences of money laundering: a review of empirical literature. *Journal of Money Laundering Control*. 2024;27(5):901-916. URL: <https://doi.org/10.1108/JMLC-09-2023-0143>
23. Liang X. Curbing illicit financial flows: Global coordination in support of development. William Dorch, Joris Larik, and Richard Ponzio (eds.), *Just Security in an Undergoverned World*. 2018;22. URL: <https://doi.org/10.1093/oso/9780198805373.003.0013>
24. Ismaeel S. Money laundering: impact on financial institutions and international law — A Systematic Literature Review. *Pakistan Journal of Criminology*. 2024;16(431). URL: <https://doi.org/10.62271/pjc.16.4.823.835>
25. Alemika E.E. The impact of economic and financial crimes on the development of Nigeria. *Journal of Financial Crime*. 2013;20(1):7-17. URL: <https://doi.org/10.1108/13590791311287394>
26. Creswell J.W., Plano Clark V.L. Designing and conducting mixed methods research. Thousand Oaks, CA: SAGE. 2018. URL: <https://www.scirp.org/reference/referencespapers?referenceid=2697821>
27. Braun V., Clarke V. Using thematic analysis in psychology. *Qualitative Research in Psychology*. 2006;3:77-101. URL: <http://dx.doi.org/10.1191/1478088706qp063oa>

ABOUT THE AUTHOR / ИНФОРМАЦИЯ ОБ АВТОРЕ

Sunil Kumar — PhD in Economics, Professor and Head, Alliance School of Economics, Alliance University, Bengaluru, India

Сунил Кумар — PhD в области экономики, профессор и руководитель Школы экономики Альянса, Университет Альянса, Бангалор, Индия
<https://orcid.org/0000-0002-0478-3415>
dr.sunilkumar@yahoo.com

Conflicts of Interest Statement: The author has no conflicts of interest to declare.

The article was submitted on 27.10.2025; revised on 10.02.2026 and accepted for publication on 05.03.2026.

The author read and approved the final version of the manuscript.

DOI: 10.26794/2308-944X-2026-14-1-19-36
UDC 339.97,336.64(045)
JEL G18, 41, O44, Q57

The Collision of Climate Narratives and Green Goods Production Cost

V.D. Smirnov¹, I.D. Tyukhmeneva²

¹ Financial University under the Government of the Russian Federation,
Moscow, Russian Federation;

² Independent Economist, Moscow, Russian Federation

ABSTRACT

Context. Key factors in limiting the negative impact of human society on the planet's climate include the availability of cost-effective low-carbon technologies and manufacturers' ability to shift mass consumer demand from traditional to environmentally friendly products. Private companies, focused on maximizing profits, face a dilemma: follow a reactive logic of minimizing regulatory risks or develop proactive strategies that turn climate challenges into a source of competitive advantage. **The aim** of the study is to find a way to improve the internal operational efficiency of green goods producers to achieve price parity with conventional analogs, that, all other things being equal, will provide the mass consumer with the opportunity to realize an environmentally sound purchasing model. This work is conceptual and analytical in nature and focuses on developing a **methodology** for managing value creation in the production of green products, applicable under conditions of confidentiality of cost data specific to each company. **Results.** The article argues that mass demand for green products can only be ensured by increasing a company's internal operating efficiency to bring their production costs closer to those of traditional counterparts. The use of an internal carbon price (ICP) is proposed as a tool for achieving this goal. **Conclusions.** Unlike the traditional approach focused on hedging regulatory risks, the authors position the ICP as a tool for strategic financial planning. This allows for the a priori integration of future environmental risks' cost in target markets into project performance calculations, creating internal sources of innovation funding and establishing economic incentives to achieve price parity with traditional counterparts. The article demonstrates that this approach not only reduces strategic risks but also creates conditions for market share and company capitalization growth through proactive adaptation to changing market terms.

Keywords: internal carbon pricing; strategic management; environmental regulation; price competitiveness; green goods; financial planning; climate change

For citation: Smirnov V.D., Tyukhmeneva I.D. The collision of climate narratives and green goods production cost. *Review of Business and Economics Studies*. 2026;14(1):19-36. DOI: 10.26794/2308-944X-2026-14-1-19-36

ОРИГИНАЛЬНАЯ СТАТЬЯ

Коллизия климатических нарративов и стоимости производства зеленых продуктов

В.Д. Смирнов¹, И.Д. Тюхменева²

¹ Финансовый университет при Правительстве Российской Федерации,
Москва, Российская Федерация;

² независимый экономист, Москва, Российская Федерация

АННОТАЦИЯ

Контекст. Одними из ключевых условий ограничения негативного влияния человеческого общества на климат планеты являются наличие финансово-эффективных низкоуглеродных технологий и способность производителей переключить спрос основной массы потребителей с традиционной на экологически чистую продукцию. Частные компании, озабоченные максимизацией прибыли, стоят перед дилеммой: сле-

довать реактивной логике минимизации регуляторных рисков или разрабатывать проактивные стратегии, превращающие климатические вызовы в источник конкурентного преимущества. **Целью** исследования является поиск способа повышения внутренней операционной эффективности производителей зеленых товаров для достижения ценового паритета с конвенциональными аналогами, который при прочих равных предоставит массовому потребителю возможность реализовать экологически обоснованную модель покупок. Работа носит концептуально-аналитический характер и сосредоточена на разработке **методологии** управления созданием стоимости при производстве зеленых продуктов, применимой в условиях конфиденциальности данных о затратах, специфичных для каждой компании. **Результаты.** В статье аргументируется, что массовый спрос на зеленые товары может быть обеспечен только повышением внутренней операционной эффективности компании для приближения себестоимости их производства к традиционным аналогам. В качестве инструмента достижения этой цели предлагается применение внутренней цены на углерод (ВЦУ). **Выводы.** В отличие от традиционного подхода, ориентированного на хеджирование регуляторных рисков, авторы позиционируют ВЦУ как инструмент стратегического финансового планирования. Это позволяет априори интегрировать стоимость будущих экологических рисков на целевых рынках в расчеты эффективности проекта, создавая внутренние источники финансирования инноваций и формируя экономические стимулы для достижения ценового паритета с традиционными аналогами. В статье показывается, что такой подход не только снижает стратегические риски, но и создает условия для роста доли рынка и капитализации компании за счет проактивной адаптации к меняющимся рыночным условиям.

Ключевые слова: внутренняя цена на углерод; стратегическое управление; экологическое регулирование; ценовая конкурентоспособность; зеленые товары; финансовое планирование; изменение климата

For citation: Smirnov V.D., Tyukhmeneva I.D. The collision of climate narratives and green goods production cost. *Review of Business and Economics Studies*. 2026;14(1):19-36. DOI: 10.26794/2308-944X-2026-14-1-19-36

1. Introduction

The stable temperature on the Earth's surface during the pre-industrial era (1850–1900) began to rise steadily and rapidly in the 1970s, exceeding this level by 1.5 °C in 2024.¹ According to the European agency Copernicus, the regions of intensive industrial development located between 20 and 60 degrees north latitude have the greatest impact on the increase in global temperatures. The carbon dioxide and methane they produce are the main contributors to the greenhouse effect, trapping solar heat within the Earth's atmosphere. Remaining in the atmosphere for a long time, their concentration reached its highest level in 2023: carbon dioxide over the last 2 million years and methane over the last 800,000 years.²

The already noticeable negative consequences of this development for the planet's climate, humans, and the economy have led the international community to a consensus, recorded in the 2015 Paris Agreement, on the need to take measures to reduce the content of carbon dioxide

and other environmentally harmful substances in the atmosphere to prevent the global average temperature from rising above 2 °C. According to the United Nations (UN), more than 75% of global greenhouse gas emissions and almost 90% of carbon dioxide emissions come from fossil fuels used in the production of energy, goods, and services.³

To address this challenge, it was decided to take steps to increase the production of renewable energy sources and gradually replace fossil fuels with them, reduce energy and natural resource consumption, and preserve biodiversity. Certain successes have already been achieved in this direction. For example, in October 2024, the International Energy Agency (IEA) stated that the transition to clean energy, shaped by government policy and corporate strategies, has accelerated sharply in recent years.⁴ Investment in clean energy projects is approaching \$2 trillion per year, which is almost double the total amount spent on new oil, gas, and coal supply projects. China is the most active country in this regard, accounting for 60% of new renewable energy ca-

¹ 2024 was the hottest year on record, scientists say. Reuters. January 10, 2025. URL: <https://www.reuters.com/business/environment/2024-was-first-year-above-15c-global-warming-scientists-say-2025-01-10/> (accessed on 31.01.2025).

² The 2023 annual climate summary. Global Climate Highlights 2023. The European Union. URL: <https://climate.copernicus.eu/global-climate-highlights-2023> (accessed on 31.10.2024).

³ Causes and Effects of Climate Change. The United Nations. URL: <https://www.un.org/en/climatechange/science/causes-effects-climate-change> (accessed on 31.10.2024).

⁴ World Energy Outlook 2024. International Energy Agency. 398 p. (15–17, 46). URL: <https://iea.blob.core.windows.net/assets/5e9122fc-9d5b-4f18-8438-dac8b39b702a/WorldEnergyOutlook2024.pdf> (accessed on 31.10.2024).

capacity added worldwide in 2023. Solar power generation in China is expected to exceed the total electricity demand in the US today by the early 2030s. At the same time, EIA notes that despite the growth since 2010 of the installed capacity of solar power plants worldwide by 40 times, wind power by 6 times, bioenergy by 2.5 times, and hydropower by 1.4 times, the demand for electricity has increased faster than the production of clean energy. The resulting deficit is being covered by fossil fuel generation, which is the carbon footprint of the electricity sector.

The widening gap between renewable energy generation and demand requires both government action to encourage green energy production and business initiatives to reduce demand for non-renewable energy. In addition to the specifics of energy production, the planet's climate is also negatively affected by the growth in energy consumption as a whole, and the task of reducing this consumption makes it important to motivate enterprises to introduce energy-saving technologies. In addition, it is necessary to produce products with a smaller carbon footprint, which also pollute the environment during their use and disposal.

It is clear that many governments have limited capacity to support the green economy, a number of technologies do not provide price parity between environmentally friendly products and their conventional counterparts, which prevents companies from bringing them to the mass market, and the efficiency of wind and solar energy generation is highly dependent on weather conditions and the still imperfect ability to store electricity for later use. According to McKinsey,⁵ only 10% of the technologies needed to meet global emission reduction commitments by 2050 have been implemented. The development, industrialization, and commercialization of the remaining 90% are still pending.

To reduce emissions to zero between 2021 and 2050, it will be necessary to spend US\$ 275 trillion on physical assets alone, or approximately US\$9.2 trillion per year. About \$2.8 trillion of this will go toward reducing the carbon footprint of critical high-emission assets that cannot be completely

phased out. The remaining \$6.4 trillion will go towards financing the creation of new low-emission green assets or assets transitioning to less carbon-intensive technologies: \$2.7 trillion will be needed in economically developed countries, \$1.5 trillion in China and India, and \$2.2 trillion in other developing economies. It is expected that 55% of the required funds will be provided by private investors and commercial banks, and only 17% by governments and related institutions.⁶

Governments are using a variety of economic measures to achieve progress toward carbon neutrality, which are very similar to carrot-and-stick policies. These include fines for companies that pollute excessively, bans on the production of certain goods or the use of certain materials, and incentives for manufacturers to develop and implement new technologies, produce environmentally friendly goods, and provide relevant services. The state encourages consumers to purchase certain environmentally friendly goods. The state may ban the import of goods that exceed the carbon footprint standards of local manufacturers of similar products or impose higher import taxes on them. There is also the opposite practice, where the authorities restrict the import of overly environmentally friendly and competitively priced foreign goods, thereby protecting not consumers and nature, but local manufacturers of less environmentally friendly alternatives.

Despite government incentives, compliance with sustainable development principles in the production of green goods is not a primary goal for businesses, as maximizing profits is their priority. If environmental protection, in terms of regulating their activities and consumer preferences, is consistent with the achievement of this goal, they will take appropriate measures to reduce the consumption of non-renewable natural resources and energy, making their products more environmentally friendly in terms of production, consumption, and use. However, when environmentally responsible practices, such as the introduction of resource-saving technologies or

⁵ McKinsey Global Institute: 2024 in charts. McKinsey Global Institute. December 2024. 18 p. (6). URL: <https://www.mckinsey.com/mgi/our-research/mckinsey-global-institute-2024-in-charts> (accessed on 11.11.2024).

⁶ Financing the net-zero transition: From planning to practice. McKinsey & Company in cooperation with the Institute of International finance. 2023. 60 p. (4, 6, 19). URL: <https://www.mckinsey.com/capabilities/risk-and-resilience/our-insights/financing-the-net-zero-transition-from-planning-to-practice> (accessed on 25.08.2025).

the reduction of harmful emissions, conflict with economic efficiency and the goal of maximizing profits, companies tend to limit their environmental activities. This occurs in cases of technological unavailability, high implementation costs, or low effective demand for green products. Under such conditions, corporate strategy primarily focuses on complying with mandatory regulatory requirements, without taking proactive steps to prevent environmental degradation.

In other words, the only way to get manufacturers to actively participate in reducing their carbon footprint and environmental pollution is to show them that the relevant technologies are available and accessible to them, and that using these technologies will enable them to create new products or add new properties to traditionally manufactured goods at a price that is acceptable to consumers in both cases. The lack of effective demand for environmentally friendly products is a fundamental constraint on their commercial production. In this context, government regulation measures do not always correlate with corporate profit maximization goals. When compliance with increasingly stringent environmental standards or competition with foreign counterparts undermines the economic viability of companies, two scenarios are possible: relocation of production to jurisdictions with less stringent regulations or complete cessation of operations, as illustrated by examples of a number of European companies in 2024.⁷ Both scenarios lead to negative socio-economic consequences: rising unemployment, declining tax revenues, and a decline in consumer welfare due to weakened competition, rising prices, and a narrowing of the supply of goods on the domestic market.

As a result, there is a dissonance between the ability and desire of governments to reduce the negative impact of the economy on the environment and compliance with the principles of economic globalization, which are based on the international division of labor, market openness, and free competition to provide consumers with goods that offer the best value for money. In a more pragmatic sense, there is a conflict between society's desire to reduce environmental

pollution and companies' obligation to maximize profits while producing goods that are acceptable to society in terms of quality and price, as well as in volumes that allow the company to increase shareholder returns on investments in this production and satisfy the interests of other stakeholders. Accordingly, the purpose of this article is to find a way to mitigate this conflict by satisfying both sides.

To resolve this contradiction, the article is structured as follows. The subsection "Public policy and environmental regulation" of the section with a review of the literature critically assesses the effectiveness of traditional carrot-and-stick measures. The subsection "Attitudes of retail and corporate buyers toward green products" in the same section examines a key market condition: achieving price parity. The section "Corporate behavior and incentives" identifies systemic barriers to green investment. On this basis, the section "Internal carbon pricing as a strategic tool" proposes a proactive management model that transforms climate risks into a source of financing for innovation and competitive advantage.

2. Literature review and institutional context

2.1. Public policy and environmental regulation

The transfer of production capacity from developed to developing countries and the focus of developed countries on knowledge-intensive and high-tech industries as part of the process of economic globalization have led to an increase in environmental pollution in developing countries and a decrease in developed countries. Absolute indicators confirm this trend, which, if all other factors are equal, should facilitate the transition to carbon neutrality for developed countries while making it more challenging for developing countries. However, if we take into account that energy consumption largely depends on the ability of the corporate sector and the population to pay for it, the picture of the associated environmental pollution looks somewhat different.

According to International Monetary Fund experts, carbon dioxide emissions per capita are the highest in the world in the United States (14 tons per person in 2021), while in China this figure is about 8 tons, in the European Union about 5 tons,

⁷ European companies cut jobs as economy sputters. Reuters, November 5, 2024 URL: <https://www.reuters.com/business/european-companies-cut-jobs-economy-sputters-2024-07-15/> (accessed on 05.11.2024).

and in developing countries, which account for half of the world's population, about 2 tons [1, p. 3]. The UN concludes in this regard that the most affluent segment of the population in economically developed countries bears the greatest responsibility for environmental pollution, given the scale of their consumption: 1% of the world's population accounts for more greenhouse gas emissions than 50% of the poorest population.⁸

Three-quarters of global greenhouse gas emissions in 2021 were related to energy production (25% for electricity and heat generation, 19% for industrial operations, 14% for transport fuel, 7% each for construction and other purposes), 15% to agriculture, and the rest to emissions from industrial processes and waste. By type of fuel used for energy generation, emissions are primarily associated with the use of coal (45%), oil (30%) and natural gas (25%) [1, p. 7].

These figures largely explain the difference between developed and developing countries. Richer countries require more energy, which they are able to pay for, to provide themselves with electricity, increased mobility, comfortable living conditions, and energy-intensive industries, particularly for data storage and processing. In this context, the climate narratives initiated by developed countries, which require significant costs, can also be interpreted as their desire to reduce the competitiveness of manufacturing companies in developing countries in terms of added value compared to high-tech products from developed countries.

The structure of greenhouse gas emission sources explains the focus of governments' environmental policies on energy generation, production processes, transport, and construction. At the same time, the most common instruments of such policies in these sectors of the economy are, as in the G-20 countries, regulatory bans and restrictions, followed by subsidies and schemes for paying for carbon emissions above the established norm in the form of a tax or within the framework of trading systems [1, p. 7]. It should be noted that the very idea of "using [government] market incentives, including pollution taxes... and tradable permits" to reduce the negative impact of industry on nature was first put

forward by M. Porter and K. van der Linde in 1995, who argued that "firms can actually benefit from well-designed environmental regulations, which, by stimulating innovation, can actually increase competitiveness" [2, p. 98, 111].

In many cases, government restrictions work in conjunction with a carbon trading system, whereby companies whose greenhouse gas emissions are below the government-set standard are issued certificates for the difference between their actual emissions and the standard. Companies that exceed this limit, which is usually constantly decreasing, are forced to purchase such certificates in order to formally comply with it; otherwise, they will be required to pay the corresponding tax. At the same time, this structure motivates companies to invest in green technologies that will allow them to comply with regulatory restrictions on their own. The European Union reports that this system and bans have reduced greenhouse gas emissions in the region by 47% between 2005 and 2023.⁹

Regarding another tool for reducing environmental pollution, government subsidies that target both consumers of green goods and their producers, there is disagreement in academic circles about their effectiveness in achieving their stated goal.

For example, C. Zhang, C. Wang, and H. Zhao argue [3] that consumer subsidies can always be beneficial to the environment, while under certain conditions they can encourage excessive consumption. At the same time, subsidies for green products indirectly undermine the financial performance of companies that produce less environmentally friendly but more affordable conventional alternatives, due to a decrease in demand for the latter. Looking at the electric vehicle industry, the authors argue that even with consumer subsidies, the major inconveniences associated with the imperfect infrastructure for their operation push buyers towards less environmentally friendly cars. This consideration points to the advisability for governments to direct subsidies toward the development of appropriate infrastructure for the use of technically complex green goods, along with encouraging their production.

⁸ Causes and Effects of Climate Change. The United Nations. URL: <https://www.un.org/en/climatechange/science/causes-effects-climate-change> (accessed on 31.10.2024).

⁹ What is the EU ETS? URL: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/what-eu-ets_en (accessed on 03.11.2024).

J. Bian, G. Zhang, and G. Zhou, comparing environmental subsidies to consumers and producers, find [4] that by stimulating an increase in production volume, the former leads to higher industrial emissions using existing technology than subsidies to producers, which are aimed at improving production technology to reduce environmental pollution, which is the goal of the state's environmental policy. The authors show that consumer subsidies also represent a higher financial burden for the government than subsidies to producers.

S. Saha, S. Majumder, and I. Nielsen conclude [5, p. 169817] that when producers are subsidized, consumers receive a more environmentally friendly product at an affordable price. In addition to short-term benefits, technological innovation or product development through producer subsidies can help ensure future sustainable development.

A comparative analysis of the profit-maximizing behavior of green product manufacturers and retail chains led Y. Yi, Y. Wang, C. Fu, and Y. Li to conclude [6] that manufacturers and the entire supply chain can be more profitable with the introduction of environmental regulations, including emissions taxes and green subsidies, but only with the right combination of parameters, than without them.

It appears that, in addition to the above consequences of its application, consumer subsidies, by guaranteeing certain sales volumes using existing technology, do not motivate manufacturers to further develop it, since profit maximization is ensured by sales growth. At the same time, government subsidies can be canceled at any time due to a budget deficit or a change in preferences by a new political force that has come to power. Under these conditions, it is difficult for companies to rely on consumer subsidies in the long term when planning business development and investments. Moreover, the market may prefer not the subsidized product but the offering of a competitor who has developed a greener product that consumers, due to their environmental preferences, may want to purchase even at a higher price.

The environmental taxes being introduced mostly ensure that companies reactively participate in reducing their carbon footprint but do not motivate them to engage in proactive in-

novation, because the basis for such taxes is the ability of the worst companies in environmental terms to pay them in order to avoid creating employment problems (in Russia, for example, in 2025, only a few of the 300 largest industrial facilities, which account for 60% of all pollution in the country, will be subject to a multiple (100 and 25 times) increase in environmental payments, which experts explain by relatively lenient requirements).¹⁰ In addition, high environmental taxes artificially increase final prices for consumers, thereby reducing their purchasing power. And although some consumers, as revealed in a global survey conducted by PwC in 2024, are willing to accept such costs in the form of a 9.7% surcharge on the price of a non-green alternative, 64% of respondents to the same survey cited price increases as their biggest problem.¹¹ This is particularly true for the end-user energy market, where prices are artificially kept high in some markets to make renewable energy production profitable, as its cost without subsidies is higher than that of energy generation from fossil fuels. As M. Frondel, S. Sommer, and K. Vance [7] state, the financial support provided by the Renewable Energy Sources Act in Germany is necessary to increase the share of green electricity. Without it, the high cost of most renewable energy technologies would make it impossible for them to compete with traditional electricity generation.

Investment bank Lazard and consulting firm Roland Berger found¹² that the average cost of a megawatt of energy from renewable sources (sun and wind) at the end of the 2009–2024 period was significantly lower than that of coal and gas (without steam generation). However, when the cost of energy storage is taken into account, the total cost of one megawatt of industrial production (including capital, fixed and variable costs, as well as the cost of fuel, where required) without subsidies is in the range of \$60–210 for

¹⁰ The top 300 industrial polluters in Russia will hardly be affected by the increase in environmental payments. *Kommersant*. 04.02.2025 (In Russ.). URL: <https://www.kommersant.ru/doc/7478390> (accessed on 15.08.2025).

¹¹ Shrinking the consumer trust deficit. PwC's Voice of the Consumer Survey 2024. Pw C. May 15, 2024. URL: <https://www.pwc.com/gx/en/issues/c-suite-insights/voice-of-the-consumer-survey.html> (accessed on 04.11.2024).

¹² Levelized Cost of Energy. Lazard with support from Roland Berger. June 2024. 48 p. (16, 33, 34, 37, 38). URL: <https://www.lazard.com/media/xemfey0k/lazards-lcoepplus-june-2024-vf.pdf> (accessed on 19.08.2025).

solar panels, \$45–133 for wind power, coal-fired power plants — \$69–168, and gas-fired power plants — \$45–108.

W. Scott found [8, p. 1, 10–11] that the reduction in carbon emissions is largely due to the choice of raw materials rather than improvements in production processes. For example, multi-level government incentives for biofuel production in the US exceed the social benefits of its use. He concludes that this discrepancy requires a reassessment of biofuel policy to ensure its economic and environmental soundness.

This problem also affects electric cars, whose CO₂ emissions, when taking into account the entire production cycle, are twice as high as those of diesel cars, due to the high carbon intensity of batteries, aluminum, which reduces the weight of the car, and the large number of electronic components.¹³ In other words, estimates of emissions during production and operation, where electric cars come out on top, vary greatly. If we also take into account carbon emissions and environmental pollution during the disposal of these types of cars, the overall result may not be so favorable for electric cars, the purchase of which is often subsidized by the state.

Thus, it can be concluded that government practices to combat environmental pollution yield mixed results, promoting the development of green technologies and their implementation in everyday life, but not always taking into account the full scale of their impact on the environment. At the same time, such subsidization of green products may result in the closure of traditional industries that do not receive government support and a decline in consumer purchasing power due to the generally higher price of green goods. In addition, the state often has more pressing problems to solve with limited budgetary resources, which require funding. Therefore, it can be assumed with a high degree of certainty that further progress in reducing greenhouse gas emissions and environmental pollution depends to a large extent on the behavior of retail consumers, often determined by non-economic factors, as well as corporations that are interested in reducing the carbon footprint of raw materials

and components, production processes, operation, and disposal of their products only when it becomes financially beneficial for them.

2.2. Attitudes of retail and corporate buyers towards green products

Experts in behavioral economics pay a lot of attention to the reasons that influence the preferences of retail buyers. V. D'Angelo, F. Kappa, and E. Peruffo argue [9, p. 1908] that the tendency to purchase green goods is a consequence of awareness of the seriousness of environmental problems, and that involvement in solving these problems gives people a sense of satisfaction because such purchases can benefit the environment and society as a whole. In other words, such decisions are based on an altruistic rather than a selfish approach to spending one's own money. However, this preference is not absolute. C. Wang, M. Shen, and M. Chu note [10, p. 7] that the positive influence of attitudes on the greening of consumer intentions can become insignificant when, for example, consumers face problems such as high prices and uncertainty about the significance of their actions.

Empirical research confirms these findings. For example, a global Boston Consulting Group (BCG) survey of consumers in developed and developing countries reveals¹⁴ that although 80% of them consider the need to promote sustainable development in their decisions about purchasing everyday goods and services, including utilities, clothing, household appliances, and cars, only 20% believe that their actions can influence the direction of this development. Far fewer shoppers are willing to pay more for green products than for conventional alternatives, and 70% of them are skeptical of corporate claims about progress toward sustainability. High-profile accusations of corporate greenwashing only reinforce this attitude. It is noteworthy that products with zero or low carbon footprints are not among the key priorities of the mass consumer. Characteristics such as the naturalness of materials, product durability, and the recyclability of packaging and the product itself come to the fore. Moreover, a comparative analysis has shown that consum-

¹³ Mastering the dual mission: Carbon and cost savings. McKinsey & Company. June 2022. 6 p. (2). URL: <https://www.mckinsey.com/capabilities/operations/our-insights/mastering-the-dual-mission-carbon-and-cost-savings>

¹⁴ Consumers are the key to taking green mainstream. Boston Consulting Group. September 2022. 25 p. URL: <https://www.bcg.com/publications/2022/consumers-are-the-key-to-taking-sustainable-products-mainstream> (accessed on 05.11.2024).

ers in developing countries are more willing to pay for the environmental friendliness of goods and services than buyers in developed economies.

In some cases, retail consumers themselves set the requirements that must be met in order for them to be able to afford a green product. For example, a 2024 BCG study shows¹⁵ that in the US, the desire to buy an electric car is realized if the charging time is no more than 20 minutes; travel time to a fast charging station and waiting time there should not exceed 30 minutes; range on a single charge should be at least 350 miles (560 km); and the price should not exceed \$ 50,000. They also demand greater variety in such vehicles. Otherwise, it is difficult to expect a transition to mass purchases of such cars. How to meet these requirements and remain profitable is now up to the manufacturer. At the same time, Chinese electric vehicles, which largely meet these requirements, are not available to American buyers, as their import into the US is virtually prohibited.

Research by L. Lorenzoni and M. Hulme shows [11] that retail consumers' own experiences and beliefs are equally important, namely that climate change has or will soon have a direct negative impact on their lives and is not some distant problem whose consequences will not affect them.

The natural priority for retail consumers is their ability to afford green goods and services, both directly and indirectly through green taxes. Thus, S. Sommer, L. Mattauch, and M. Pale found in a survey of 6,000 German households [12] that respondents who prefer green spending are likely to support a carbon tax, but support decreases significantly at higher tax rates.

For corporations, the attitude towards green products is primarily shaped by procurement policy, which is based not on an emotional component that determines preferences for greener raw materials, materials, or components, but on the company's ability to generate additional profits by using such products. Another aspect of applying environmental practices is the development and implementation by a company of technologies that reduce the consumption of energy, raw materials, and materials from non-renewable sources, as well as create new green

products. The main driver of environmentally friendly behavior by companies is the demand for the green goods they produce. At the same time, government regulations on environmental pollution force companies to adapt to them but rarely motivate them to perform significantly better than these requirements. Thus, companies are only willing to improve their environmental performance if they can improve their financial results by reducing their operating costs and increasing the volume and margins of their green product sales.

In other words, it is possible to purchase green components of a product, as well as to create a new green product, and thus satisfy environmental narratives and requirements, but this will be done if there is demand for such a product and the corresponding costs are recouped. Accordingly, there is a problem of balancing environmental and financial efficiency, only a successful combination of which, as S. Hart and M. Milstein [13] point out, can ensure an increase in shareholder wealth, which they define as the creation of sustainable value. At the same time, according to I. Miroshnichenko, R. Barontini, and F. Testa [14, p. 340], internal environmental practices (pollution prevention and green supply chain management) are the main environmental factors affecting financial performance, while external environmental practices (green product development) play a secondary role in determining financial performance. They also doubt that the implementation of the international standard ISO 14001, which defines general requirements for environmental management systems, has a positive impact on financial performance. This skepticism, however, can be partly explained by the fact that, as noted by P. Arozena, R. Orcos, and F. Zuagi, "the economic benefits of ISO 14001 are most significant for large companies in countries with a high level of environmental awareness" [15], which points to the importance of contextual variables.

The attitude of companies towards the transportation of raw materials, components, and finished products by shipping companies, whose activities, as part of the global transport business, contribute significantly to atmospheric pollution, is indicative. In 2022, 82% of corporate customers of maritime transport expressed their willingness to pay a 3% premium for zero-carbon transport, which corresponds to \$ 10–20 billion in addition-

¹⁵ Can OEMs Catch the Next Wave of EV Adopters? Boston Consulting Group. March 2024. 12 p. (2). URL: <https://www.bcg.com/publications/2024/can-oems-catch-the-next-wave-of-ev-adopters> (accessed on 21.10.2024).

al income for shipowners. However, this amount is not enough to cover all the costs of decarbonizing such transportation, which requires a premium of 10–15%. It is noteworthy that the key motivation for customers to pay for zero-carbon transportation in 2022 was pressure from regulators (such as EU Regulation 2023/1805 on the use of renewable and low-carbon fuels in maritime transport¹⁶) — 47% of all possible answers, 34% of answers related to the corresponding requirements of the customers' product buyers, 16% to the requirements of banks financing the customers' activities, and only 3% to the customers' ability to cover these costs at the expense of buyers. However, more than half of international transport customers believe that even more expensive transportation will help them win the competition in the market for their finished products due to a smaller carbon footprint.¹⁷ A similar situation regarding willingness to pay a premium for decarbonization is observed in the production of electric cars and washing machines, as well as in relation to its sufficiency to cover the corresponding costs and improve competitive position.¹⁸

Based on the above, it can be concluded that the willingness of both individual and corporate consumers to purchase environmentally friendly goods and services is shaped by two key conditions: affordability and (or) the material benefits of using them. Thus, economic feasibility remains the decisive factor determining consumer choice in favor of green alternatives.

On the other hand, the policy of economic de-globalization pursued mainly by the governments

of developed countries makes it difficult for many retail and corporate consumers to access the most environmentally efficient solutions, thus undermining the very idea of free competition and open markets in the context of the movement towards a cleaner environment worldwide.

3. Corporate behavior and incentives

Currently, environmental issues do not take precedence over social and corporate governance issues in any region of the world in terms of ESG (environmental, social, governance) compliance. However, environmental protection receives slightly more attention in the EU, as well as in international companies with annual revenues exceeding \$ 1 billion, compared to smaller organizations.¹⁹

A global survey of companies in various industries conducted by BCG in 2024 showed that only 9% of them report on Scope 1, 2, and 3 emissions, only 16% set targets for these indicators,²⁰ and less than 10% of companies have reduced their emissions by more than 4%.²¹ K. Jansson points out [15, p. 93] that this largely depends on the choice of environmental strategy. If a reactive approach is chosen, the main focus will be on compliance with environmental standards and emission control, leaving the original production process untouched. If a reactive approach is chosen, the focus will be on compliance with environmental regulations and emission control, leaving the original production process untouched. When choosing a proactive approach, the goal is to improve the efficiency of the production process by investing in new technologies that reduce costs and prevent pollution, leading to a significant reduction in environmental risk.

¹⁶ Regulation (EU) 2023/1804 of the European Parliament and of the Council of 13 September 2023 on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU; Regulation (EU) 2023/1805 of the European Parliament and of the Council of 13 September 2023 on the use of renewable and low-carbon fuels in maritime transport, and amending Directive 2009/16/EC. Official Journal of the European Union. L 234. English edition. Vol. 66 Legislation 22 September 2023. 211p. URL: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2023:234:FULL> (accessed on 22.10.2024).

¹⁷ Customers' willingness to pay can turn the tide toward decarbonized shipping. Boston Consulting Group. 2022. 12 p. (2, 5, 6). URL: <https://www.bcg.com/publications/2022/customers-willingness-to-pay-to-decarbonize-shipping> (accessed on 22.10.2024).

¹⁸ Green Awakening: Are consumers open to paying more for decarbonized products? Boston Consulting Group. December 2023. 15 p. URL: <https://web-assets.bcg.com/fa/44/8abcfccf430ca039a3a1417ac690/green-awakening-are-consumers-open-to-paying-more-for-decarbonized-products.pdf> (accessed on 22.10.2024).

¹⁹ ESG momentum: Seven reported traits that set organizations apart. McKinsey & Company. May 26, 2023. 17 p. (4, 13). URL: <https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/esg-momentum-seven-reported-traits-that-set-organizations-apart> (accessed on 22.10.2024).

²⁰ Boosting your bottom line through decarbonization carbon emissions. Survey Report 2024. Boston Consulting Group. September 2024. 15 p. URL: <https://web-assets.bcg.com/09/68/8b0f9c5c4dea8c37f757b87705f3/why-climate-leaders-are-seeing-bottom-line-results-sep-2024-edit-04.pdf> (accessed on 17.10.2024).

²¹ To inspire action on net zero, set a price for carbon. Boston Consulting Group. November 03, 2023. 10 p. (3). URL: <https://www.bcg.com/publications/2023/benefits-of-carbon-pricing-to-inspire-net-zero> (accessed on 17.10.2024).

Companies that do not take a proactive approach to green manufacturing may end up complicating their financial situation. According to BCG, most electric vehicle manufacturers in developed countries are currently losing around \$6,000 on each vehicle they sell for \$50,000, after taking into account tax incentives for customers. At the same time, they can only close half of this cost gap by making the right technology choices and economies of scale. But we must also take into account competition from Chinese imports, which (in the case of open markets and free competition promoted by Western countries over the past 50 years — authors) will likely drive market prices down even further, exacerbating the profitability problem. At some point, it will become unprofitable for such manufacturers to lose money on every car they sell.²² It is highly likely that they will abandon the production of electric vehicles or demand strict protection of the domestic market, as is the case in the US, where electric vehicles from China are effectively banned, or state subsidies. But in any case, strategically, they may lose out to new manufacturers of these new means of mobility. The implementation of the relevant European regulations poses significant challenges for traditional industries. By the deadline initially set by the regulator, only a limited number of companies had achieved the target share of new vehicles with a minimal carbon footprint. The other market participants, who form its core, failed to meet the requirements at the end of the reporting period. In the long term, this could have significant financial consequences for a number of large industrial groups.²³ According to expert estimates, the potential total amount of possible sanctions for the sector could be in the tens of billions of euros, with a significant portion theoretically attributable to the leading market players.

One can hardly challenge the view of McKinsey's industrial and sustainability practice ex-

perts, who argue²⁴ that “the single most effective way for companies to scale climate technologies is to strive for cost parity with carbon-intensive alternatives.” And the CEO of British energy major BP has stated outright that “we want to expect the same level of returns from our energy transition projects as we have from our historical businesses”.²⁵

High production costs encourage many companies involved in climate technology to add a “green premium” to the price of their products, which can deter many potential buyers. At the same time, non-price factors that are important to consumers who prefer environmentally friendly products can help increase sales, which in most cases account for a smaller share of sales in the relevant product class.

Many countries would like to switch to cleaner energy sources, but their high cost makes projects involving their use financially unviable. The IEA points out²⁶ that developed and developing economies importing liquefied gas generally need prices of around \$3–5 per MMBtu (million British thermal units) to make gas attractive as a large-scale alternative to coal, but for liquefied natural gas producers in most new export projects, an average price of around \$8/MMBtu is acceptable to cover investment and operating costs.

It is evident that the untested nature of many green technologies and products, combined with their high cost, creates increased business risks, which generally hinders the rapid return on investment of such projects, despite their anticipated long-term financial efficiency. At the same time, green goods and services are in demand among retail consumers motivated by environmental awareness, as well as corporate buyers seeking to reduce the carbon footprint of their production in the context of tightening government regulatory requirements. The combined

²² Can OEMs Catch the Next Wave of EV Adopters? Boston Consulting Group. March 2024. 12 p. (3). URL: <https://www.bcg.com/publications/2024/can-oems-catch-the-next-wave-of-ev-adopters> (accessed on 21.10.2024).

²³ Europe's carmakers discount EVs, hike petrol car prices as new emissions rules loom. Reuters. December 17, 2024. URL: <https://www.reuters.com/business/autos-transportation/europes-carmakers-discount-evs-hike-petrol-car-prices-new-emissions-rules-loom-2024-12-17/> (accessed on 11.01.2025).

²⁴ A radical approach to cost reduction at climate tech companies. McKinsey & Company. June 18, 2024. 9 p. (1). URL: <https://www.mckinsey.com/capabilities/sustainability/our-insights/a-radical-approach-to-cost-reduction-at-climate-tech-companies> (accessed on 21.12.2024).

²⁵ European oil giants step back from renewables path. Reuters. November 18, 2024. URL: <https://www.reuters.com/business/energy/european-oil-giants-step-back-renewables-path-2024-11-18/> (accessed on 21.12.2024).

²⁶ World Energy Outlook 2024. International Energy Agency. 2024. 398 p. (19). URL: <https://iea.blob.core.windows.net/assets/5e9122fc-9d5b-4f18-8438-dac8b39b702a/WorldEnergyOutlook2024.pdf> (accessed on 21.10.2024).

effect of these factors can have a mixed impact on companies' operating costs while creating potential for revenue growth through a shift in market share in favor of green producers at the expense of suppliers of conventional alternatives. M. Sato, T. Kruse, J. Burke, M. Mohnen, and P. Pope [17] conclude that the high operating margins of green goods production are combined with low asset turnover and accounting profits due to increased innovation costs, which negatively affects return on investment. In other words, achieving the desired financial results requires significant investment in working capital and continuous innovation in order to increase operational efficiency and gain a competitive edge in the product market.

Private sector financing of green projects is influenced by conflicting factors. On the one hand, their appeal is reinforced by the dominant environmental discourse, government support in the form of incentives, and growing consumer demand, including the willingness of a segment of the market to pay a "green" premium. On the other hand, many green products remain fundamentally uncompetitive in the mass market without ongoing government subsidies and regulatory restrictions on traditional counterparts, creating high risks and uncertainty regarding the financial returns on projects.

In terms of capital sources, equity financing for such projects is often motivated by investors' long-term ESG expectations, while debt financing is driven by lenders' desire to diversify and "green" their portfolios by reducing the concentration of assets with a high carbon footprint. However, financial institutions (both commercial and investment banks) simultaneously perceive green projects as risky ones due to the immaturity of technologies and the volatility of the regulatory environment and fear conflicts of interest that may arise when refusing to finance traditional "brown" clients. In 2025, this attitude was reflected in the withdrawal of the world's largest banks from the Net Zero Banking Alliance. Among them were Britain's HSBC, America's Goldman Sachs and JPMorgan Chase, and Japan's Mitsubishi UFJ Financial Group Inc.²⁷ In January 2025, the large-

est investment fund, Black Rock, withdrew from a similar alliance of asset managers.²⁸

The above analysis shows that, despite growing social and regulatory demand for environmentally friendly products, companies remain skeptical about their financial effectiveness. This position is due to a number of constraints:

- Uncertainty and volatility of government support: Government incentives (subsidies, tax breaks) and regulatory pressure (bans, quotas) are unstable. The lack of long-term guarantees in this area creates significant risks for the profitability of green projects that require long investment horizons.

- Limited effective demand: High price sensitivity among consumers (both retail and corporate), despite growing demand, makes the premium price of environmentally friendly goods the main barrier to their mass distribution, even with subsidies.

- Increased discount rate: Taking into account increased technological, market, and regulatory risks forces companies to apply a higher discount rate to green projects, which directly reduces their estimated net present value (NPV) and investment attractiveness.

- Inconstancy of monopoly rents: Pioneer companies can temporarily extract excess profits from their monopoly on new green technologies. However, with the emergence and growth of competition, these monopoly rents quickly disappear, leveling out the exceptional profitability for the industry as a whole.

- Tendency toward symbolic compliance: In conditions of high uncertainty, many companies choose a risk minimization strategy, limiting themselves to formal compliance with regulatory requirements or shifting the focus toward less capital-intensive components of the ESG agenda (social policy, corporate governance) at the expense of real environmental investments.

Despite these circumstances, objective reality shows that the climatic conditions in which companies operate are changing, and quite rapidly. Therefore, the conclusion by T. Noordewier and M. Lucas that "economic activity can no longer be separated from the realities of the biophysi-

²⁷ HSBC exits banks' climate coalition abandoned by Wall Street. Bloomberg. July 11, 2025. URL: <https://www.bloomberg.com/news/articles/2025-07-11/hsbc-exits-bankers-climate-coalition-abandoned-by-wall-street> (accessed on 22.08.2025).

²⁸ BlackRock quits climate change group in latest green climb-down. Financial Times. January 10, 2025. URL: <https://www.ft.com/content/f0fb9841-db1d-442e-a757-1a1327497fb1> (accessed on 22.08.2025).

cal environment” [18, p. 11] requires investment in reducing environmental pollution, creating products with zero carbon footprint, or giving traditional products new environmentally friendly properties.

4. Internal carbon pricing as a strategic tool

4.1. The concept of internal carbon pricing

Given the inevitable tightening of environmental regulations in various forms, as well as the instability of potential government support on both the demand and supply sides, companies should primarily rely on their own strategic capabilities to develop competitive products.

For the purposes of this study, key concepts are defined as follows:

- Internal carbon price (ICP) is a management parameter voluntarily set by a company for strategic planning and investment assessment purposes. It is a monetary valuation of a ton of CO₂ equivalent emissions used to model future costs associated with carbon regulation and to incentivize internal operational efficiency.

- The effectiveness of green investments is the achievement of financial return targets (such as net present value or internal rate of return) while meeting strategic goals of reducing the carbon footprint and improving the environmental performance of a product or process. In the context of this work, effectiveness is assessed primarily through the prism of achieving price parity with traditional analogs as a condition for entering the mass market.

- A corporate climate strategy is a comprehensive action plan that integrates decarbonization goals into a company’s business model with a focus on creating long-term value. Under the proposed approach, such a strategy is transformed from a defensive one (risk minimization) to a proactive one, where instruments such as ICP are used to finance innovation and capture new market segments.

In this context, the internal carbon price is a key tool for managing environmental risks. This voluntary mechanism allows companies to model and internalize carbon costs at the planning stage, thereby assessing the economic feasibility of producing a green product given its higher cost relative to its traditional counterpart. If the carbon footprint is successfully

reduced and the cost is equalized, the use of ICP can directly improve the financial performance of the project. The use of ICP is a relatively new phenomenon, the types and examples of which are given in [19, p. 35, 36].

Theoretical ideas about ICP and its relationship with environmental regulations external to companies are quite diverse.

I. Dao, T. Ronkalli, and R. Semet note [20, p. 6, 35–37] that in 2024, external regulation of carbon emissions by companies was distributed worldwide as follows: exchange-traded carbon credit and certificate schemes accounted for 38% of all programs, including 8% in the implementation phase, while carbon taxes accounted for 62%, of which 26% are still only planned. Internal corporate carbon regulation programs were dominated by shadow pricing schemes (68%), with implicit pricing and internal commission schemes each accounting for 13% (these figures are confirmed in a study by M. Desjardins, J. Gianfrate, M. Gitti, and B. Sinclair-Desgagne [21]).

The factors determining the level of internal carbon pricing are compliance with emissions trading schemes or carbon tax systems (35% and 26%, respectively), as well as the cost of achieving emission reduction targets and the cost of voluntary carbon offsets (approximately 20% each). The results of the study by these authors show that domestic carbon pricing mainly covers Scope 1 and 2 emissions, while the focus on reducing Scope 3 emissions through carbon pricing in the production and distribution stages is significantly lower.

The motivation of companies to voluntarily implement ICP is linked, as W. Ben-Amar, M. Gomez, H. Khurseed, and S. Marsat [22] find, primarily to their exposure to external regulatory risks related to carbon emissions, but not to physical shocks related to climate change. C. Lyu, P. Yang, and C. Zhang argue [19, p. 5] that the implementation of ESG may indicate companies’ desire to reduce their carbon footprint, thereby enhancing their credibility and appeal to customers, investors, and other stakeholders who are increasingly aware of environmental issues.

Scientists’ opinions on the consequences of using internal carbon pricing vary. P. Demirel and E. Kesidou indicate [23] that companies that use voluntary self-regulation are more likely to

participate in environmental innovation. J. Ma and J. Kuo believe [24] that the use of internal carbon pricing can increase the return on assets by 1.1%. Companies that use ICP are more likely to reduce the cost of goods sold, which can lead to increased profitability.

Empirical data study of global companies made by A. Trinks, M. Mulder, and B. Scholtens shows [25] that the impact of external carbon pricing systems increases the likelihood of using ICP by 10–13 percentage points but did not find a significant impact of factors related to government environmental policy on internal carbon pricing levels, the use of which is closely and positively related to company size and carbon emissions. ICPs may exceed external carbon prices, reflecting companies' concerns about future carbon emission restrictions. Accordingly, the spread of ICP programs in large, high-emission, and capital-intensive companies, especially in multinational enterprises (MNEs), with the aim of accelerating investment in low-carbon projects is determined by the significance of future carbon costs. B. Zhu, C. Xu, P. Wang, and L. Zhang believe [26] that ICP programs can be as effective in reducing emissions as external constraints. In sectors with low carbon dependence, which are typically end-user-oriented, there is great potential for green innovation, to which buyers of finished products are highly sensitive.

The assessments by C. Lyu, W. Xin, and C. Zhang are less positive [27]. Using data on the adoption of science-based targets by companies and their direct carbon emissions within a study of corporate carbon transition risks, they found limited evidence of its influence on the relationship between internal carbon pricing and corporate performance. In their view, the implementation of ICP is associated with a future decline in companies' financial performance, manifested by a decrease in net profit of 1.1% in the following year. At the same time, the price level of ICP does not have a significant impact on firms' future profitability. They also did not find that the adoption or price level of ICP substantially affects future risk-adjusted stock returns, but they observed significant variations in the relationship between ICP and performance across different industries and countries. Furthermore, the adoption of ICP reduces the growth rate of carbon

emissions over the next two years, although the overall effect on emission abatement remains ambiguous.

M. Desjardins, J. Gianfrate, M. Gitti, and B. Sinclair-Desgagné observe [21] that by integrating the elevated cost of carbon emissions into their cost structures, companies prepare for stricter regulatory requirements, thereby mitigating the risk of future shocks. Companies such as ExxonMobil exemplify the use of an internal carbon price set above the market rate. Microsoft, Renault, and Danone, in turn, use ICP to manage their capital expenditures, primarily directing investments toward sustainable projects.

An analysis of the existing research on ICP implementation reveals its predominant focus on issues of environmental regulation and on mitigating risks associated with the volatility of government policy. At the same time, the question of this instrument's direct impact on increasing corporate profitability remains understudied. However, if the analytical framework is expanded to include not only regulatory pressure but also the emerging consumer demand for green products (provided they are price-competitive), the focus of the problem shifts. In this context, a company's key task becomes developing solutions in procurement and production processes aimed at achieving target cost indicators that meet market expectations. It is quite plausible that the margin on green goods will lag behind that of conventional alternatives due to high R&D and new technology implementation costs. Nevertheless, a shift in market demand towards eco-friendly alternatives could lead to an increase in sales volume sufficient for the absolute profit figure to exceed that achievable through the production of conventional goods. In other words, with increased production costs for green products and their sale at the price of a conventional equivalent, the total profit of their manufacturer may be higher than that of sellers of traditional goods due to a shift in demand toward environmentally friendly products and a loss of consumer interest in traditional ones. A graphical comparison of these parameters and outcomes is presented in *Figure*. Moreover, with further growth in sales, the cost of green products will decrease due to the distribution of fixed costs and innovation expenses across a larger number of goods manufactured.

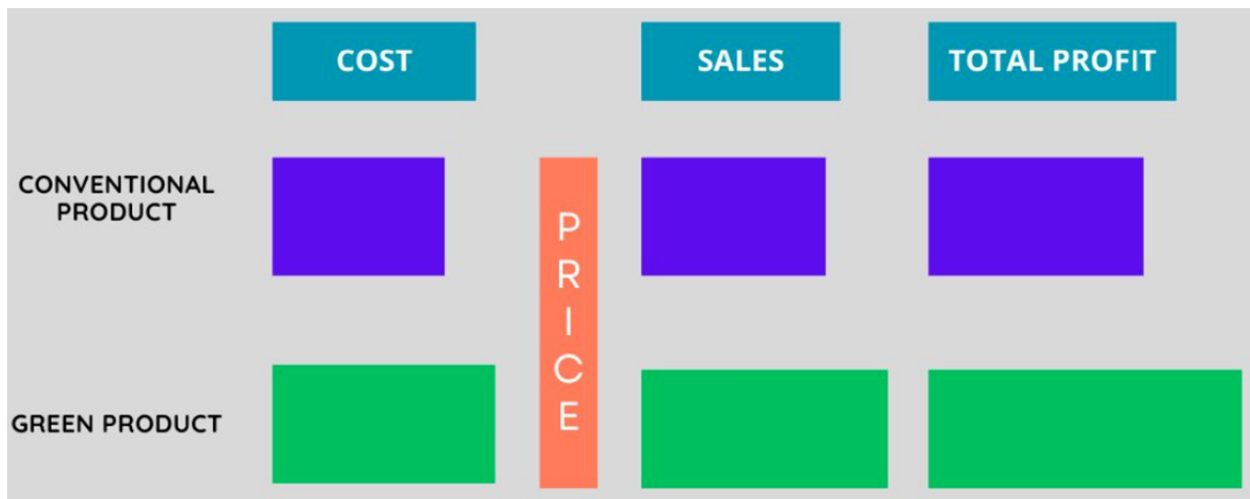


Fig. Financial performance of green and conventional product manufacturing and sales

Source: Compiled by the authors.

4.2. A strategic model for the proactive management of carbon risks and opportunities

From a practical standpoint, applying a financial approach entails integrating all associated costs into the green project's planned performance model. These include expenses related to the use of eco-friendly raw materials and supplies, renewable energy sources, and low-carbon production technologies. Given the difficulty in calculating these costs directly, it is advisable to employ simulation modeling. This involves adding a forecasted internal carbon price, relevant to the target markets and accounting for its potential increase, to the cost of a conventional product. In this model, government subsidies may be intentionally excluded to ensure a conservative assessment, thereby fostering a proactive design stance independent of the prevailing tax regime or demand-side support measures.

The rationale for this approach lies in the a priori inclusion in financial projections of future expenditures related to:

1. Reducing the carbon footprint.
2. Hedging financial risks arising from the tightening of carbon regulations.
3. Ensuring competitive readiness for entering markets with stringent environmental legislation.

Consequently, the company develops an internal motivation to seek innovative solutions aimed not only at regulatory compliance but also at enhancing operational efficiency. The virtual reserve (or "phantom" costs) formed in this way creates a funding source for future environmental

innovations. Thus, at the planning stage, a more realistic assessment of the project's economic viability from the standpoint of its market acceptability is achieved. The allocated reserves are either directed towards financing "greening" initiatives or, if unused, directly increase the final product's margin.

Furthermore, by adhering to the requirement of price parity with conventional alternatives (which is key for the mass consumer), the manufacturer can reasonably project a significant increase in sales volumes. This, in turn, even with a reduced margin, can lead to growth in the absolute amount of profit due to the economies of scale effect.

In this context, the need to artificially inflate the discount rate becomes redundant, as the carbon price embedded in the model itself serves to quantify climate risks while simultaneously incentivizing the selection of the most cost-effective technologies within the project. Demonstrating serious environmental commitment, as case studies (e.g., Tesla) show, also positively impacts market capitalization and facilitates equity financing, which can, in turn, improve the terms for debt financing. A consistent transition from demand by green enthusiasts to the mass market, driven by achieving price parity, initiates a positive feedback loop. Subsequently, increased production volumes lead to a reduction in unit cost through the distribution of fixed costs, which further strengthens the price advantage and, ultimately, the producer's financial performance.

Given that the company's strategic objective is value maximization, the described proactive approach appears more promising compared to defensive environmental strategies. The growing demand for competitive green products and improved financial metrics directly translates into an increase in market capitalization. Conversely, ignoring the "greening" trend entails significant strategic risks. Insufficient investment in developing environmentally friendly products can lead to the erosion of demand for traditional counterparts and long-term financial difficulties, as illustrated by the ongoing transformation of the European automotive industry. As noted in the literature, "inaction on climate change may prove far more costly, as investments in adaptation... can 'pay for themselves' five- to sixfold through avoided losses".²⁹

Thus, although government environmental incentives should be taken into account, relying on their permanence to achieve corporate financial objectives is not rational, as their priorities may not align with the goals of profit and value maximization. The financial success of green products is based on mass-market demand, which, in most cases, is triggered by reaching price parity with conventional alternatives. This target is achieved primarily through the producer's internal operational efficiency.

Over the 30 years since the publication of M. Porter and C. van der Linde's then-revolutionary idea about the benefits for companies of considering well-balanced government environmental regulations, subsequent research has confirmed the correctness of their hypothesis that stricter regulation leads to a greater number of innovations. However, as noted by S. Ambec, M. Cohen, S. Elgie, and P. Lanoie [28, p. 16], their assumption that stricter regulation enhances business efficiency is far from always being corroborated in practice.

The implementation of the proposed strategic mechanism based on internal carbon pricing could provide Russia with a foundation to re-emerge on the global stage with a fundamentally new competitive advantage. Rather than remaining a passive object of extraterritorial regulation,

Russian businesses can use this instrument for proactive transformation. Systematically incorporating carbon costs into product pricing at the design stage will stimulate technological modernization, optimization of value chains, and investment in low-carbon innovations.

Consequently, when achieving carbon neutrality becomes a mandatory condition for access to key markets, Russian companies will find themselves not as laggards forced to bear high adaptation costs, but as prepared players offering products that are already competitive both in price and environmental parameters. This will enable Russia to reposition itself from a supplier of raw materials and energy-intensive goods into a supplier of high-tech solutions and industrial products with a low carbon footprint, thereby reclaiming the strategic initiative and establishing a long-term foundation for economic sovereignty in the new climate reality.

5. Discussion

The analysis presented in this work reveals a profound dichotomy between the declared objectives of the green transition and the economic logic of corporate behavior. Despite increasing regulatory pressure and the growing environmental sensitivity of a segment of consumers, the primary deterrent for companies remains the uncertainty regarding the financial return on environmental investments. In this context, the proposed concept of applying an internal carbon price transcends the role of a mere accounting tool, evolving into a strategic management system.

The findings of the study suggest that the key value of ICP lies in its dual nature. First, it formalizes and materializes uncertainties associated with the future tightening of carbon regulations, the volatility of government support, and shifting consumer preferences, thereby allowing for the advance allocation of funds and the adaptation of the business model. Simultaneously, by advocating for the integration of "phantom" carbon costs into the cost structure, ICP creates an internal economic signal that shifts the focus of managerial decisions from mere compliance to the pursuit of the most cost-effective pathways for decarbonization.

It is important to emphasize a methodological feature of this study. It is conceptual and analytical in nature and does not employ econometric

²⁹ The Cost of Inaction: A CEO Guide to Navigating Climate Risk. World Economic Forum. Annual report. December 2024. 58 p. (4). URL: <https://www.weforum.org/publications/the-cost-of-inaction-a-ceo-guide-to-navigating-climate-risk/> (accessed on 25.01.2025).

modeling. This choice is driven by the practice-oriented objective of the work: to propose a management tool applicable in real-world business conditions. The key data required for in-depth quantitative analysis, such as detailed cost structures, specific technological and logistics chains, and internal rates of return, constitute trade secrets and are unavailable from public sources. Moreover, significant variations in these parameters across companies and industries render a universal econometric model less relevant than a qualitative conceptual framework that can be adapted to specific circumstances.

The conclusion that the financial success of green products hinges on achieving mass-market demand through price parity, rather than a green premium, calls into question the effectiveness of purely defensive strategies. The proposed proactive approach, centered on ICP, enables the transformation of an environmental constraint into a driver of operational excellence.

6. Conclusion

The conducted analysis reveals a systemic imbalance between the climate agenda and the economic logic of business. Despite growing pressure from regulators and consumers, companies face high financial uncertainty. Traditional government instruments often fail to create lasting incentives for deep technological transformation. The key to the solution lies in a proactive strategy that shifts the focus from external enforcement to internal efficiency. The widespread adoption of green products requires achieving price parity with conventional counterparts.

The proposed strategic model for applying an internal carbon price serves as the foundation for this transformation. Its value lies in utilizing this instrument not only for risk assessment but also as a mechanism for financing innovation. By incorporating the projected cost of the carbon footprint into the product cost structure at the design stage, a company establishes a clear managerial benchmark. This stimulates the search for the most economical decarbonization solutions and leads to the creation of a competitive product. Consequently, the proposed approach enables the conversion of environmental challenges into drivers of operational excellence, thereby aligning environmental responsibility with the objective of increasing corporate value.

This study contributes to the scientific literature on the role of economic agents in environmental preservation through the following key propositions:

- To our knowledge, this study is the first in the literature to emphasize the importance of mass-producing green goods for improving environmental pollution.
- Companies need to account for existing government environmental incentives, but relying on them in long-term business plans is difficult due to their volatility.
- Both corporate and retail consumers are not averse to purchasing green goods and services under two conditions: if they are financially affordable and/or if their application or use yields tangible benefits.
- One method of managing the risks associated with the tightening of government environmental policies and competition from firms already producing green goods is for a manufacturer to incorporate the cost of the carbon emissions of its products into its planned financial performance calculations, even when not mandated by law.
- Import restrictions on environmentally friendly goods imposed by developed countries hinder the diffusion of effective green technologies and their related products.

7. Limitations

The conceptual nature of this study entails a number of limitations that define promising avenues for future research. First, the proposed model is normative in nature and outlines an optimal decision-making logic. Its practical implementation and effectiveness will depend on specific contextual factors, such as industry characteristics, company size, and prevailing corporate culture. Second, the analysis is primarily focused on the microeconomic perspective of an individual firm, whereas macroeconomic factors, including shifts in the labor market, cross-border carbon regulation, and the geopolitical landscape, can significantly influence the final outcomes. Finally, the absence of empirical testing on extensive data prevents a quantitative measurement of the relationship between ICP adoption and specific firms' financial or operational metrics, leaving this task for future empirical studies.

REFERENCES

1. Black S., Parry I., Zhunussova K. Is the Paris agreement working? A stocktake of global climate mitigation. IMF Staff Climate Note 2023/002, International Monetary Fund, Washington, DC. 44 p. ISBN: 979-8-40025-797-1
2. Porter M.E., van der Linde C. Toward a new conception of the environment-competitiveness relationship. *Journal of economic perspectives*. 1995;9(4):97-118
3. Zhang J., Wang Z., Zhao H. The impact of consumer subsidy on green technology innovations for vehicles and environmental impact. *International Journal of Environmental Research and Public Health*. 2020;17(20):7518. DOI: org/10.3390/ijerph17207518
4. Bian J., Zhang G., Zhou G. Manufacturer vs. consumer subsidy with green technology investment and environmental concern. *European Journal of Operational Research*. 2020;287(3):832-843. URL: <https://doi.org/10.1016/j.ejor.2020.05.014>
5. Saha S., Majumder S., Nielsen I.E. Is It a Strategic Move to Subsidized Consumers Instead of the Manufacturer? *IEEE Access*. 2019;7:169807-169824. DOI: 10.1109/ACCESS.2019.2954376
6. Yi Yo., Wang Ya., Fu Ch., Li Yu. Taxes or subsidies to promote investment in green technologies for a supply chain considering consumer preferences for green products. *Computers and Industrial Engineering*. 2022;171:108371. URL: <https://doi.org/10.1016/j.cie.2022.108371>
7. Frondel M., Sommer S., Vance C. The burden of Germany's energy transition: An empirical analysis of distributional effects. *Economic Analysis and Policy*. 2015;45:89-99. URL: <http://dx.doi.org/10.1016/j.eap.2015.01.004>
8. Scott W.A. Cost and carbon-intensity reducing innovation in biofuels for road transportation. *Energy Policy*. 2025;197(114416). URL: <https://doi.org/10.1016/j.enpol.2024.114416>
9. D'Angelo V., Cappa F., Peruffo E. Green manufacturing for sustainable development: The positive effects of green activities, green investments, and non-green products on economic performance. *Business strategy and the environment*. 2023;32:1900-1913. DOI: 10.1002/bse.3226
10. Wang J., Shen M., Chu M. Why is green consumption easier said than done? Exploring the green consumption attitude-intention gap in China with behavioral reasoning theory. *Cleaner and Responsible Consumption*. 2021;(100015). URL: <https://doi.org/10.1016/j.clrc.2021.100015>
11. Lorenzoni I., Hulme M. Believing is seeing: Laypeople's views of future socio-economic and climate change in England and in Italy. *Public Understanding of Science*. 2009;18(4):383-400. DOI: 10.1177/0963662508089540
12. Sommer S., Mattauch L., Pahle M. Supporting carbon taxes: The role of fairness. *Ecological Economics*. 2022;(195):107359. URL: <https://doi.org/10.1016/j.ecolecon.2022.107359>
13. Hart S.L., Milstein M.B. Creating sustainable value. *Academy of Management Perspectives*. 2003;17(2):56-67. URL: <http://dx.doi.org/10.5465/AME.2003.10025194>
14. Miroshnichenko I., Barontini R., Testa F. Green practices and financial performance: A global outlook. *Journal of Cleaner Production*. 2017;(147):340-351. URL: <http://dx.doi.org/10.1016/j.jclepro.2017.01.058>
15. Arocena P., Orcos R., Zouaghi F. The impact of ISO 14001 on firm environmental and economic performance: The moderating role of size and environmental awareness. *Business Strategy and the Environment*. 2021;30(2):955-967. DOI: 10.1002/bse.2663
16. Jansson C. Can green producers achieve strong profitability without engaging in high-risk activities? *Management Decision*. 2022;60(13):92-104. URL: <http://DOI 10.1108/MD-08-2021-1090>
17. Sato M., Kruse T., Burke J., Mohnen M., Pope P. Does it pay for firms to go green? London: Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy, London School of Economics and Political Science. 2020. URL: https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2020/06/GRI_policy-report_Does-it-pay-for-firms-to-go-green-1.pdf
18. Noordewier T., Lucas M. On being green and profitable: Does industry context matter? *International Journal of Production Economics*. 2020;223:107528. URL: <https://doi.org/10.1016/j.ijpe.2019.107528>
19. Lyu Ch., Yang P., Zhang Ch. Corporate environmental governance: A Global study of internal carbon pricing. *SSRN Electronic Journal*. 2025. DOI: 10.2139/ssrn.5252571
20. Dao I., Roncalli T., Semet R. An introduction to carbon pricing: Carbon tax, cap and trade, ETS and internal carbon price. *SSRN Electronic Journal*. 2024. URL: <http://dx.doi.org/10.2139/ssrn.4940475>

21. Desjardins M., Gianfrate G., Ghitti M., Sinclair-Desgagne B. Internal carbon pricing — A price instrument to cope with organizational failure. *FEB-RN*. 2025. Research Paper No. 59/2025. 21 p. URL: <http://dx.doi.org/10.2139/ssrn.5014201>
22. Ben-Amar W., Gomes M., Khursheed H., Marsat S. Climate change exposure and internal carbon pricing adoption. *Business Strategy and the Environment*. 2022;31(7):2854-2870. URL: <https://doi.org/10.1002/bse.3051>
23. Demirel P., Kesidou E. Sustainability-oriented capabilities for eco-innovation: Meeting the regulatory, technology, and market demands. *Business Strategy and the Environment*. 2019;28(5):847-857. URL: <https://doi.org/10.1002/bse.2286>
24. Ma J., Kuo J. Environmental self-regulation for sustainable development: Can internal carbon pricing enhance financial performance? *Business Strategy and the Environment*. 2021;30(8):3517-3527. URL: <https://doi.org/10.1002/bse.2817>
25. Trinks A., Mulder M., Scholtens B. External carbon costs and internal carbon pricing. *Renewable and Sustainable Energy Reviews*. 2022;168(112780). URL: <https://doi.org/10.1016/j.rser.2022.112780>
26. Zhu B., Xu Ch., Wang P., Zhang L. How does internal carbon pricing affect corporate environmental performance? *Journal of Business Research*. 2022;145:65-77. URL: <https://doi.org/10.1016/j.jbusres.2022.02.071>
27. Lyu Ch., Xin W., Zhang Ch. Internal Carbon Price and Firm Performance. *SSRN Electronic Journal*. 2025. 47 p. URL: <http://dx.doi.org/10.2139/ssrn.5252987>
28. Ambec S., Cohen M., Elgie S., Lanoie P. The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness? Resources for the Future Discussion Paper. 2011;11-01. URL: <http://dx.doi.org/10.2139/ssrn.1754674>

ABOUT THE AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

Vladimir D. Smirnov — Cand. Sci. (Econ.), Associate Professor, Department of World Economy and International Finance, Faculty of International Economic Relations, Financial University under the Government of the Russian Federation, Moscow, Russian Federation

Владимир Дмитриевич Смирнов — кандидат экономических наук, доцент кафедры мировой экономики и мировых финансов факультета международных экономических отношений, Финансовый университет при Правительстве Российской Федерации, Москва, Российская Федерация

<https://orcid.org/0000-0002-1243-5349>

Corresponding Author / Автор для корреспонденции:

vdsmirnov@fa.ru

Irina D. Tyukhmeneva — Independent Economist, in 2025, obtained a Master's degree in Applied Economics, University of Padua, Padua, Italy

Ирина Дмитриевна Тюхменева — независимый экономист, в декабре 2025 г. окончила магистратуру по специальности «Прикладная экономика», Университет Падуи, Падуя, Италия

<https://orcid.org/0009-0009-1942-4579>

iratyukhmeneva@gmail.com

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The article was submitted on 27.08.2025, revised on 15.01.2026 and accepted for publication on 10.02.2026.

The authors read and approved the final version of the manuscript.

DOI: 10.26794/2308-944X-2026-14-1-37-55
UDC 338.1(045)
JEL G34, O31, O32, O33

The Shifting Influence of Digital Transformation on Breakthrough Innovation in China

T. Pu¹, A.H. Zulkafli²

¹ Guizhou University of Commerce, Guiyang, China;

² Universiti Sains Malaysia, Penang, Malaysia

ABSTRACT

The study investigates the relationship between digital transformation (Dt) and breakthrough innovation (Bi) in Chinese A-share listed companies. Specifically, the **subject** of the study is the influence of Dt on Bi, focusing on comparing its effects during normal periods and the global health crisis, with an emphasis on the differing impacts across state-owned enterprises (SOEs) and non-state-owned enterprises (non-SOEs). The **purpose** of the research is to explore how digitalization can enhance innovation under both stable conditions and during external disruptions, while examining the variations in its effects on different types of firms. The **relevance** lies in the increasing role of Dt in driving innovation in today's rapidly evolving global landscape, especially in light of the challenges posed by the COVID-19 crisis. This study provides important insights into how firms can adapt their digital strategies to maintain or accelerate innovation during periods of disruption. The **scientific novelty** lies in the analysis of the heterogeneous impact of Dt on innovation across firm types and external contexts, particularly the comparison between normal and crisis periods. The authors used the **methods** of machine learning-based text-mining techniques to construct indicators for Dt and fixed-effects regression models to estimate its impact on Bi. As part of the study, the author used panel data from Chinese listed companies spanning from 2014 to 2024, applying these advanced methods to uncover the effects of Dt on Bi under different periods and firm conditions. Based on the **results**, it was found that Dt significantly boosts Bi under normal circumstances but that this positive relationship is disrupted during crisis periods, especially in SOEs. Non-SOEs showed no significant impact from Dt in either normal or crisis periods. The author **concluded** that while digital transformation is a key driver of innovation, its effectiveness is contingent upon firm type and the external context, with global disruptions potentially limiting its full potential, particularly for SOEs.

Keywords: digital transformation; breakthrough innovation; machine learning; global health crisis; state-owned enterprises; non-state-owned enterprises; China

For citation: Pu T., Zulkafli A.H. The shifting influence of digital transformation on breakthrough innovation in China. *Review of Business and Economics Studies*. 2026;14(1):37-55. DOI: 10.26794/2308-944X-2026-14-1-37-55

ОРИГИНАЛЬНАЯ СТАТЬЯ

Изменение влияния цифровой трансформации на прорывные инновации в Китае

Т. Пу¹, А.Х. Зулкафли²

¹ Коммерческий университет Гуйчжоу, Гуйян, Китай;

² Университет Сайнс Малайзия, Пенанг, Малайзия

АННОТАЦИЯ

В данном исследовании изучается взаимосвязь между цифровой трансформацией (ЦТ) и прорывными инновациями (ПИ) в китайских компаниях, А-акции которых котируются на бирже. **Предметом** исследования является влияние ЦТ на ПИ. Проводится сравнение этого влияния в обычные периоды и в условиях глобального кризиса здравоохранения с учетом различного воздействия на государственные и негосударственные предприятия. **Цель исследования** — изучить, как цифровизация может способствовать инновациям в стабильных условиях и во время внешних потрясений, а также исследовать различия в ее влиянии на разные типы фирм. **Актуальность** исследования заключается в возрастающей

роли цифровой трансформации в стимулировании инноваций в современном быстро меняющемся глобальном ландшафте, особенно в свете вызовов, связанных с кризисом COVID-19. Данное исследование предоставляет важные сведения о том, как фирмы могут адаптировать свои цифровые стратегии для поддержания или ускорения инноваций в периоды потрясений. **Научная новизна** заключается в анализе неоднородного влияния цифровой трансформации на инновации в разных типах компаний и внешних условий, в частности, при сравнении периодов нормальных и кризисных ситуаций. Авторы использовали **методы** машинного обучения для анализа текста с целью построения индикаторов цифровой трансформации и регрессионные модели с фиксированными эффектами для оценки ее влияния на прорывные инновации. В рамках исследования авторы применяли панельные данные китайских компаний, котирующихся на бирже, за период 2014–2024 гг., реализуя эти передовые методы для выявления влияния цифровой трансформации на прорывные инновации в разные периоды и при различных условиях деятельности компаний. На основе полученных **результатов** было установлено, что ЦТ значительно повышает ПИ в нормальных условиях, но эта положительная взаимосвязь нарушается в кризисные периоды, особенно в госпредприятиях. В негосударственных предприятиях значительного влияния ЦТ ни в нормальные, ни в кризисные периоды не зафиксировано. Авторы пришли к **выводу**, что, хотя цифровая трансформация является ключевым фактором инноваций, ее эффективность зависит от типа компании и внешнего контекста, а глобальные потрясения ограничивают ее потенциал, особенно для государственных предприятий.

Ключевые слова: цифровая трансформация; прорывные инновации; машинное обучение; глобальный кризис здравоохранения; государственные предприятия; негосударственные предприятия; Китай

Для цитирования: Pu T., Zulkafli A.H. The shifting influence of digital transformation on breakthrough innovation in China. *Review of Business and Economics Studies*. 2026;14(1):37-55. DOI: 10.26794/2308-944X-2026-14-1-37-55

Introduction

The rapid advancement of technologies such as artificial intelligence, blockchain, cloud computing, and big data has led to a broad shift toward digital transformation (Dt) across multiple sectors [1–3]. Businesses increasingly recognize the transformative power of digitalization, which not only reshapes traditional business models but also redefines innovation processes [4–5]. Dt is widely regarded as a crucial force in enhancing operational efficiency and improving overall economic outcomes [6–9]. Given its broad impact, it is essential to deeply understand the relationship between Dt and breakthrough innovation (Bi).

Academic discussions on Dt often emphasize its potential to enhance innovation capabilities by facilitating more effective knowledge absorption and promoting value creation [10]. Additionally, the role of the internet in improving information access and dissemination has been shown to significantly influence product innovation, enabling firms to better meet customer needs through internet-based business models [11–15]. However, during the global COVID-19 pandemic (2020–2021), many firms experienced varying degrees of disruption to their innovation activities, particularly in the early stages [16]. As the pandemic persisted, it remained

unclear whether companies, through accelerated Dt, were able to uncover new pathways and opportunities for Bi.

This study aims to fill the gap in the literature by examining the impact of Dt on Bi, with a particular focus on comparing its effects during normal periods and crisis periods. By utilizing panel data from Chinese A-share listed firms spanning 2014 to 2024, this study constructs a Dt index using machine learning-based text-mining techniques. The analysis reveals that while Dt generally enhances Bi, this positive effect is significantly interrupted during crisis periods, highlighting the disruptive impact of external shocks on the relationship between Dt and innovation.

In addition, the study examines the heterogeneous effects of Dt on Bi across different types of firms. The results show that state-owned enterprises (SOEs) experience a stronger positive impact of Dt on Bi during normal periods compared to non-state-owned enterprises (non-SOEs). However, this effect is reversed for SOEs during crisis periods, while non-SOEs show no significant impact from Dt in either normal or crisis periods. These findings suggest that the relationship between Dt and Bi is not uniform across firm types, with SOEs benefiting more from Dt under normal conditions but facing greater challenges during crises, whereas non-

SOEs struggle to leverage Dt effectively in both contexts.

This research contributes in several ways. First, by comparing the effects of Dt on Bi during normal periods and crisis periods, it fills a gap in the existing literature on the dynamic relationship between digital transformation and innovation under external shocks. Second, the study employs machine learning-based text-mining techniques to construct a Dt index, providing an innovative methodological approach for researching corporate Dt and its impact on innovation. Third, it uncovers the heterogeneous effects of Dt on Bi under different firm types, offering new theoretical insights into the role of Dt during periods of economic and social turmoil.

The organization of this paper is structured as follows: Section 2 delves into the theoretical framework, providing a comprehensive discussion on the derivation and development of the research hypotheses. Section 3 outlines the methodological approach adopted in this study, detailing the techniques and processes employed. Section 4 presents the empirical findings and conducts a thorough analysis of their reliability and validity. Section 5 presents the heterogeneity analysis, focusing on the differences between state-owned and non-state-owned enterprises in the relationship between Dt and Bi. Lastly, Section 6 concludes by summarizing the key insights and implications derived from the study.

Theoretical foundations and hypothesis development

Agency theory

Agency theory (AT) serves as a potential theoretical framework for explaining the impact of Dt on Bi. At the heart of this theory is the inherent conflict of interests and the information asymmetry that exists between the owners, or shareholders, of the company and the managers tasked with its day-to-day operations [17]. These discrepancies can often result in managerial behaviors that prioritize personal goals over the long-term success of the company. The theory provides a lens through which the relationship between Dt and Bi can be dissected and understood, particularly through the following three key aspects:

First, reduction of information asymmetry. One of the most significant contributions of Dt is its ability to reduce information asymmetry, which has long been a barrier to effective governance in corporations. By integrating advanced information technologies, such as big data analytics, blockchain, and cloud computing, firms are now able to gather, process, and analyze massive datasets in real time [18]. This collection and processing of data substantially diminish the information gaps between managers and owners, making the flow of information far more transparent and accessible. For owners, this increased visibility into managerial actions enables enhanced monitoring of decisions, leading to more informed oversight. As a result, the typical risks associated with moral hazard and adverse selection — common in situations of incomplete information — are notably reduced. With these risks mitigated, owners are more capable of ensuring that managerial activities align with the firm's innovation agenda. Furthermore, the transparency introduced by Dt makes it harder for managers to pursue self-serving projects, as they are now held accountable for their actions in a more transparent environment. This shift encourages a more innovation-driven approach, with managers increasingly directed to invest in projects that foster corporate growth and competitiveness.

Second, innovation incentives. Dt also plays a pivotal role in the enhancement of innovation incentives within the firm. Advanced data analytics, made possible by Dt, allow companies to monitor the progress of innovation projects more accurately and in real time, ensuring that managers remain accountable for meeting both short-term milestones and long-term strategic objectives [19]. This capability creates a dynamic feedback loop, where managers are continuously assessed based on performance metrics linked directly to innovation outcomes. Transparent and precise reward systems, supported by data-driven insights, are designed to ensure that managerial behavior is aligned with the company's broader innovation goals. These incentive structures motivate managers to focus on projects that will have lasting impacts on the firm's innovative capabilities, rather than prioritizing short-term gains or personal interests. Furthermore, Dt enables more efficient performance

evaluations, thus refining the overall managerial incentive system, which, in turn, enhances a firm's ability to sustain and scale its innovation efforts [20].

Third, reduction of agency costs. Another critical aspect of AT is the reduction of agency costs, which represent the expenses incurred due to the conflict of interest between managers and owners. Dt significantly improves the efficiency of monitoring and controlling the execution of innovation projects. For example, cloud computing and blockchain technologies allow for a more transparent and verifiable documentation process regarding the progression of innovation initiatives [21]. This increased transparency not only accelerates the reporting process but also minimizes the need for extensive manual oversight, thereby cutting down on the traditional costs associated with supervisory efforts. As a result, firms can free up resources that would otherwise be used for monitoring and direct these resources toward higher-potential innovation projects. Ultimately, lower agency costs enable firms the flexibility to invest more aggressively in breakthrough innovations, which in turn can improve their competitive standing in an increasingly digitized economy. By streamlining project management and accountability, Dt empowers companies to achieve higher levels of innovation output with fewer internal inefficiencies.

Resource dependence theory

Resource dependence theory (RDT) provides a comprehensive and insightful framework for analyzing the relationship between Dt and innovation. According to RDT, organizations are inherently dependent on external resources for their long-term survival and success [22]. This external reliance not only influences an organization's operational behaviors and strategies but also affects its capacity to innovate. The interaction between Dt and Bi can be better understood through the following key perspectives:

First, expanding access to essential resources. Digital transformation significantly impacts innovation by broadening firms' ability to acquire vital external resources. In highly competitive markets, the capability to effectively gather, integrate, and utilize these resources

provides a substantial competitive edge. Leveraging cutting-edge technologies, including big data analytics, cloud computing, and blockchain, firms can systematically extract valuable insights from diverse external sources such as suppliers, markets, and business partners [23]. This improved capacity to process extensive datasets facilitates access to critical knowledge, technological innovations, and financial assets, which serve as fundamental drivers of innovation. By alleviating resource constraints, firms are better equipped to pursue groundbreaking innovations, advancing both technological and commercial frontiers.

Second, enhancing resource interdependencies. Dt also plays a fundamental role in fostering and strengthening the interdependencies between organizations and their external environment. Through the implementation of digital platforms, firms can build stronger, more interactive relationships with external stakeholders, including customers, suppliers, and strategic partners [24]. These digital platforms create opportunities for co-creation of value, where firms and their partners can collaboratively develop new products or services. Such interdependencies drive continuous innovation, as firms must keep up with or surpass the expectations of their external stakeholders to maintain their competitive edge. The collaborative nature of these interdependencies also facilitates faster and more efficient innovation cycles, enhancing a firm's overall innovation capability.

Third, reducing environmental uncertainty. A central tenet of RDT is the notion that firms innovate not just for growth but also to manage and mitigate the uncertainties present in their external environment. Environmental uncertainty, particularly concerning the availability and reliability of critical resources, can pose significant risks to a firm's innovation endeavors [25]. Dt, with its ability to process real-time data and deploy advanced predictive analytics, enables firms to monitor external conditions and anticipate potential challenges with greater accuracy. By reducing uncertainty about external factors, such as market demand or supply chain disruptions, firms are in a stronger position to make well-informed decisions regarding their innovation investments. This risk mitigation leads to more strategic and calculated inno-

vation activities, minimizing the potential for failure.

Fourth, strategic resource reconfiguration. Another way in which Dt impacts innovation is by empowering firms to reconfigure their resource base more effectively. Dt tools allow companies to optimize how they allocate resources across different innovation projects, making it easier to shift focus to high-potential opportunities while reducing investments in underperforming or obsolete initiatives [26]. This ability to adapt and reallocate resources in response to new digital opportunities enables firms to enhance their innovation outcomes. By continually reconfiguring resources to meet emerging challenges, firms ensure that they remain at the forefront of innovation, effectively navigating a rapidly changing digital landscape. This dynamic reallocation of resources is essential not only for maintaining operational efficiency but also for sustaining long-term innovation success.

Black swan theory

Black swan theory (BST), popularized by Nassim Nicholas Taleb, describes rare and unpredictable events with profound consequences [27]. These events are characterized by three main features: first, they are outliers. Black Swan events fall outside regular expectations and are not anticipated by historical data. They are so rare and unprecedented that past experiences do not indicate their likelihood or impact. Second, they have a massive impact. When such events occur, they have extensive and often transformative effects, disrupting normal processes and systems. The consequences are significant and can lead to systemic changes. Third, retrospective predictability is evident. After the event occurs, there is a tendency to create explanations that make it seem predictable or understandable, even though it was unforeseeable before it happened. This hindsight often overlooks the inherent unpredictability of the event.

The global COVID-19 pandemic can be considered a Black swan event. On the one hand, the pandemic emerged as an anomaly, far exceeding typical expectations and preparedness plans. Previous experiences and historical data on infectious diseases did not anticipate the scale and rapid spread of COVID-19, rendering

it an unforeseeable and unprecedented event. On the other hand, the pandemic had a massive impact globally, disrupting economies, health-care systems, and daily life. The shockwaves affected virtually every sector, including Dt and innovation processes [28]. The scale of the crisis surpassed the anticipations and preparations of most organizations and governments.

Subsequently, there has been a trend to rationalize the pandemic by citing various factors and warning signals that were supposedly evident but previously overlooked. This retrospective reasoning often disregards the inherent unpredictability and magnitude of the crisis. In the context of Dt and innovation, the COVID-19 pandemic underscores how Black swan events can undermine expected outcomes. Initially, it was anticipated that Dt would continuously drive innovation. However, the sudden outbreak and profound impact of the pandemic created conditions that disrupted these anticipated benefits.

Main effect hypothesis

Based on prior literature, this study predicts that Dt enhances Bi among Chinese listed firms.

From the perspective of AT, Dt alleviates information asymmetry between shareholders and managers, a critical issue in innovation activities. Due to the long-term and risky nature of innovation, managers responsible for the daily operations and financial disclosures related to R&D may prioritize their own short-term interests over those of shareholders. This misalignment can lead to agency conflicts and increased costs. Dt improves the transparency of innovation information, enhancing the timeliness and openness of R&D investment disclosures [29]. By reducing the risk of misinformation and lowering agency costs, Dt aligns managerial actions with shareholder interests. Furthermore, the automation of financial data processing through digital technologies further limits human intervention, thereby reducing agency costs associated with R&D investments [18, 30].

From the perspective of RDT, Dt substantially enhances innovation efficiency by transforming the allocation of internal resources and minimizing reliance on external entities. Advanced digital technologies, including artificial intelligence, blockchain, cloud computing, and big

data, diminish dependence on conventional and less effective systems, thereby improving the overall efficiency of innovation processes [31]. Additionally, these technologies facilitate better management of interactions within the innovation network, bridging knowledge gaps between firms and external partners [32]. This improved access and integration support the generation of innovative outcomes. Dt also enhances decision-making efficiency in innovation strategies and enables firms to establish strategic partnerships and alliances [1, 16]. By reducing dependence on single suppliers and fostering knowledge exchange and resource pooling, Dt contributes to more efficient innovation processes. Based on these considerations, we propose the following hypothesis:

H1: Under otherwise similar conditions, Dt has a positive impact on Bi.

Contextual effect hypothesis

From the perspective of the BST, Dt's typically positive influence on Bi may be disrupted during global health crises due to the extraordinary nature of such events. Black Swan events are characterized by their rarity, extreme impact, and the tendency for individuals to construct post hoc explanations that make these events appear predictable. The COVID-19 pandemic exemplifies a Black Swan event, representing an unprecedented disruption that exceeds the normal scope of organizational risk management and strategic planning [33]. During such crises, the traditional benefits of Dt — such as enhanced transparency, streamlined processes, and increased operational efficiency — can be severely compromised. The pandemic imposes substantial external shocks and operational constraints, leading organizations to prioritize immediate crisis response over long-term innovation efforts.

In this context, the usual mechanisms through which Dt supports Bi — such as improved data accessibility and resource optimization — may be undermined by the urgent need to adapt to rapidly changing and highly uncertain conditions. The crisis introduces a level of unpredictability and instability that disrupts normal innovation workflows and resource allocations. As organizations are forced to reallocate resources and shift focus to short-term survival,

the positive impact of Dt on Bi may be significantly attenuated. Thus, while Dt generally enhances innovation under stable conditions, its effectiveness in driving Bi is likely diminished during global health crises due to the amplified and unprecedented challenges posed by such events. In this way, Hypothesis 2 is presented.

H2: The positive impact of Dt on Bi is disrupted during global health crises.

Heterogeneity hypothesis

Building on the theoretical foundations of AT and RDT, we hypothesize that the impact of Dt on Bi will exhibit heterogeneity between SOEs and non-SOEs. Specifically, we propose that the positive impact of digital transformation on breakthrough innovation is stronger in SOEs during normal periods compared to non-SOEs, but this effect is likely to be disrupted during crises for SOEs.

From the perspective of AT, SOEs are typically characterized by a more structured governance framework with stronger oversight from government stakeholders [25]. This enhanced governance structure means that Dt can more effectively reduce information asymmetry and agency costs in SOEs, aligning managerial incentives with long-term innovation goals [27]. During normal periods, this alignment enables SOEs to leverage digital transformation to enhance their breakthrough innovation efforts. The availability of resources and government support further strengthens their capacity to implement digital technologies, which ultimately drives more significant innovation outcomes. However, during crises, SOEs are often subject to more rigid, government-driven constraints, which may lead to a more conservative approach that prioritizes stability over innovation [11]. In such circumstances, the impact of Dt on innovation is likely to be weaker or even reversed, as SOEs may focus more on risk mitigation and short-term survival, rather than leveraging Dt for long-term innovation.

In contrast, non-SOEs may not experience the same level of benefit from Dt during either normal or crisis periods. While they may face fewer government-imposed constraints compared to SOEs, their limited resources and less formalized governance structures may restrict their ability to adopt and implement digital technolo-

gies effectively [31]. This resource constraint, combined with potential organizational inertia, could lead to weaker or insignificant effects of Dt on innovation, regardless of the period. The negative relationship between Dt and breakthrough innovation for non-SOEs in crisis periods further supports this argument, indicating that these firms may not possess the resilience or adaptability to capitalize on digital transformation, even in times of uncertainty. Therefore, we hypothesize:

H3: Compared to non-SOEs, the positive impact of Dt on Bi is stronger in SOEs during normal periods, but this effect is likely to be disrupted during crises for SOEs.

Methodology

Sample and data

This study utilized a comprehensive and unique dataset covering all A-share listed firms in China from 2014 to 2024. Financial information for the analysis was derived from the reputable China Stock Market and Accounting Research Database, known for its detailed and reliable financial and accounting data on Chinese enterprises. Simultaneously, Dt-related terms were meticulously identified from corporate annual reports through text mining methodologies, enabling an in-depth assessment of Dt activities across firms. To measure innovation output, patent data were sourced from the Chinese Research Data Services Database, ensuring precise evaluation of firms' innovation capabilities.

Several rigorous preprocessing steps were applied to enhance the quality and robustness of the dataset. First, financial institutions were excluded from the sample. These firms operate under distinct governance structures and financial performance frameworks compared to non-financial companies, which could introduce bias into the analysis. By excluding financial firms, the study focuses on non-financial enterprises, where Dt and innovation dynamics are more comparable. Second, firms placed under "Special Treatment" (ST) status, meaning they experienced consecutive losses over two years and faced the risk of delisting, were removed. These companies tend to have abnormal financial behaviors, which could skew the results and lead to misinterpretation of the general trends observed in healthier firms.

In addition, data reliability was a key consideration. Therefore, firms with incomplete or missing financial, patent, or Dt-related data were systematically excluded from the analysis. This step ensured that the dataset used for empirical testing was as complete as possible, minimizing the impact of data gaps that could distort the findings. Moreover, to deal with potential biases arising from outliers in the financial data, all continuous variables were winsorized at the 1st and 99th percentiles.

Variable measurement and estimations techniques

Dependent variable

The dependent variable in this study is breakthrough innovation, which is measured using patent-related activities. Consistent with the approach of [34], Bi is quantified as the natural logarithm of one plus the total number of invention patents applied for by the firm each year. This method of measurement captures a firm's efforts to engage in innovative activities, particularly those aimed at developing new, groundbreaking technologies. Invention patents, as opposed to utility or design patents, provide a more stringent measure of innovation because they reflect higher levels of novelty and technological advancement. By taking the natural logarithm, we address potential skewness in the patent count data, ensuring that firms with very high or very low numbers of patent applications do not disproportionately influence the results.

Independent variable

The independent variable in this research is digital transformation (Dt). Since the text in annual reports reflects a firm's strategic orientation, examining these reports provides valuable insights into the firm's emphasis on digital transformation [35]. Following the methodology of Tu and He (2022) [36, 37], this study employs a Python-based crawler to develop the digital transformation metric. The process involves several stages: first, seed terms associated with Dt, such as "digital technology," "information technology," "big data," and "cloud computing," are selected. Python's Jieba and Re modules are then used to extract relevant text, which is subsequently cleaned, matched,

and analyzed for frequency. The corpus for this study is generated through word segmentation and the removal of stop words. Machine learning, specifically the word2vec model, is applied to this corpus to generate word vectors and calculate similarities between terms, thereby identifying semantically related words. Using a seed word dictionary, the frequency of these keywords is determined. Due to the typical right-skewed nature of this data, the keyword frequencies are log-transformed (LN) with an addition of one (LN (keyword frequency +1)) to evaluate the degree of Dt among Chinese A-share listed companies.

Control variables

To address potential confounding factors influencing breakthrough innovation, this study incorporates a comprehensive set of control variables. These variables are selected based on their relevance to innovation performance in prior literature. Firm Size (Fs), measured as the logarithm of total assets, accounts for the scale of a company and its potential to support innovation activities. Firm Age (Fa), calculated as the natural logarithm of the number of years since establishment plus one, reflects the maturity and experience of the firm. Financial Leverage (Lev), defined as the ratio of total debts to total assets, captures the firm's financial structure and risk profile. Return on Assets (Roa), represented by net income divided by total assets, provides insight into the firm's profitability and efficiency in utilizing resources. Sales Growth (Gr), measured by the year-over-year change in operating income, indicates the firm's market performance and growth trajectory. Board Size (Bs), expressed as the logarithm of the number of board directors, serves as a proxy for governance and decision-making capacity. Ownership Concentration (To), represented by the percentage of shares held by the largest shareholder, reflects the degree of control exerted by major stakeholders, which may influence strategic innovation decisions. Finally, Institutional Ownership (In), represented by the percentage of shares held by institutional investors, is included to account for the influence of institutional investors on a firm's innovation strategy and decision-making process.

Estimations techniques

The following equation is used to estimate H1 and H3:

$$Bi_{i,t} = \alpha_0 + \alpha_1 Dt_{i,t} + \alpha_2 Fs_{i,t} + \alpha_3 Fa_{i,t} + \alpha_4 Lev_{i,t} + \alpha_5 Roa_{i,t} + \alpha_6 Gr_{i,t} + \alpha_7 Bs_{i,t} + \alpha_8 To_{i,t} + \alpha_9 In_{i,t} + Year + Firm + \varepsilon. \quad (1)$$

In the model specification, α_0 represents the intercept term, while $\alpha_1 - \alpha_9$ denote the coefficients associated with the respective independent and control variables, which are to be estimated through regression analysis. This study incorporates dummy variables to control for both year and firm fixed effects, represented by Year and Firm, respectively. These fixed effects account for time-invariant characteristics specific to each firm and temporal factors that could influence the results across different years. The error term, ε , captures unobserved factors that may affect the dependent variable. The subscript *iii* refers to the cross-sectional dimension, indicating individual firms, while *t* denotes the time-series dimension, representing different periods over which the data are observed.

Findings

Descriptive statistics and correlation matrix

The descriptive statistics presented in *Table 1* provide a comprehensive overview of the key variables utilized in this study. The dataset comprises 39,440 observations, offering a broad range of data points across different variables.

Starting with the dependent variables, breakthrough innovation (*Bi* and *Bia*) both exhibit considerable variability. *Bi*, representing the natural logarithm of one plus the total number of invention patent applications, has a mean of 1.198, with a standard deviation of 1.353. The range of values for *Bi* spans from 0 to 5.609, reflecting substantial differences in patenting activities across firms. A similar pattern is seen for *Bia*, which represents the natural logarithm of one plus the total number of granted invention patents. The mean value of *Bia* is 0.851, with a standard deviation of 1.110, further illustrating the varied innovation outputs among firms. The discrepancy between *Bi* and *Bia* highlights the gap between innovation efforts (applications) and realized outcomes (grants), reinforcing

Table 1
Descriptive statistics

Variables	Count	Mean	Sd	Min	Max
Bi	39440	1.198	1.353	0.000	5.609
Bia	39440	0.851	1.110	0.000	4.970
Dt	39440	1.724	1.412	0.000	5.056
Fs	39440	22.259	1.309	19.630	26.452
Fa	39440	2.065	0.957	0.000	3.466
Lev	39440	0.410	0.205	0.049	0.935
Roa	39440	0.037	0.069	-0.375	0.255
Gr	39440	0.133	0.375	-0.654	3.808
Bs	39440	2.099	0.197	1.609	2.708
To	39440	0.332	0.147	0.074	0.757
In	39440	0.419	0.249	0.001	0.920

Source: Calculated by authors.

Table 2
Pearson correlation

Column number	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variables	Bi	Dt	Fs	Fa	Lev	Roa	Gr	Bs	To	In
(1)	1.000									
(2)	0.165***	1.000								
(3)	0.077***	0.026***	1.000							
(4)	-0.172***	-0.039***	0.465***	1.000						
(5)	-0.054***	-0.036***	0.489***	0.379***	1.000					
(6)	0.128***	-0.048***	0.005	-0.254***	-0.369***	1.000				
(7)	0.027***	-0.002	0.038***	-0.071***	0.026***	0.266***	1.000			
(8)	0.016***	-0.056***	0.271***	0.162***	0.139***	0.014***	0.006	1.000		
(9)	-0.015***	-0.117***	0.171***	-0.083***	0.015***	0.171***	0.004	0.010**	1.000	

Source: Calculated by authors.

Note: significance levels are represented by asterisks: *, **, and *** correspond to p-values less than 0.1, 0.05, and 0.01, respectively.

ing the need to analyze both dimensions of innovation.

Turning to the key independent variable, Dt, the data show significant heterogeneity in the adoption of digital technologies across firms. The mean value of Dt is 1.724, with a standard deviation of 1.412, indicating that while some firms have embraced digital technologies more extensively, others are still in the early stages of transformation. The values of Dt range from

0 to 5.056, suggesting varied digital strategies and capabilities among firms.

For the control variables, the firms in the sample exhibit an average firm size (Fs) of 22.259, measured as the natural logarithm of total assets, and an average firm age (Fa) of 2.065 years. The financial leverage (Lev) has a mean value of 0.410. The return on assets (Roa) shows a mean of 0.037, indicating relatively modest profitability across the sample. The growth rate

(Gr) has a mean of 0.133, suggesting that firms experience moderate growth. The board size (Bs) has an average value of 2.099, while ownership concentration (To) is on average 0.332. Additionally, the institutional ownership (In) variable, which represents the proportion of shares owned by institutional investors, has a mean of 0.419 and a standard deviation of 0.249.

The correlation matrix in *Table 2* shows the relationships between the key variables in this study. Notably, Bi and Dt are positively correlated (0.165***), suggesting that firms with higher digital transformation levels tend to engage in more breakthrough innovation. The correlation between Bi and Fs is also positive (0.077***), indicating that larger firms are more likely to engage in innovation activities. There is a negative relationship between Bi and Lev (−0.054***), implying that firms with higher leverage may invest less in breakthrough innovation. Dt is negatively correlated with Fa (−0.039***), suggesting that older firms might be slower to adopt digital transformation strategies. Moreover, the correlation between Dt and To is negative (−0.117***), suggesting that firms with higher ownership concentration may be less likely to embrace digital transformation. Overall, the coefficient values are all less than 0.5, indicating no concerns about multicollinearity in the model.

Analysis of benchmark regression

We begin our analysis by exploring the impact of Dt on Bi using a panel data model that incorporates two-way fixed effects. This methodological approach allows us to control for both firm-specific unobservable heterogeneity and time-specific macroeconomic shocks, thereby providing more reliable estimates of the relationship between Dt and Bi. The regression outcomes are summarized in *Table 3*.

In columns (1) and (2) of *Table 3*, we present models where Bi serves as the dependent variable. These columns reveal a significantly positive effect of Dt on Bi, regardless of whether control variables are included. Specifically, Dt has a coefficient of 0.019 in the model without control variables (column 1) and 0.012 in the model with control variables (column 2), both significant at the 1% and 5% levels, respectively.

From a theoretical perspective, these findings are consistent with the resource-based

view, which suggests that Dt enhances firms' ability to acquire, process, and utilize information resources, thereby improving innovation efficiency and supporting complex knowledge recombination processes required for Bi [38]. Digital technologies can reduce information asymmetry, enhance cross-functional collaboration, and improve the quality of R&D decisions, ultimately strengthening firms' long-term innovation capacity [39]. Therefore, the results provide empirical support for Hypothesis 1.

In columns (3) and (4), we extend our investigation to the non-crisis period to evaluate whether the positive influence of Dt on Bi persists under relatively stable external conditions. The results continue to show positive and statistically significant coefficients for Dt, with a coefficient of 0.016 in column (3) and 0.013 in column (4), both significant at the 5% and 10% levels, respectively.

These results further reinforce the theoretical argument that Dt serves as a strategic capability that enhances firms' ability to sense and exploit innovation opportunities when external environments are relatively stable. Under such conditions, firms are more willing to allocate digital resources toward exploratory innovation activities, which is consistent with the long-term innovation investment logic suggested by the innovation incentive [40].

However, when we shift focus to the sample period encompassing the global health crisis of 2020–2021 (In-Crisis, columns 5 and 6), the effect of Dt on Bi becomes statistically insignificant. The coefficients for Dt in columns (5) and (6) are −0.020 and −0.022, respectively, neither of which is statistically significant.

Importantly, these crisis-period results can also be interpreted within the theoretical framework of AT and RDT when combined with the logic of BST, rather than contradicting these core theoretical predictions. BST suggests that rare, extreme, and highly unpredictable events can fundamentally disrupt existing organizational decision-making patterns and resource allocation structures.

From an AT perspective, Black Swan-type crisis events significantly intensify short-term performance pressure and managerial risk aversion. Under such extreme uncertainty, managers

Table 3
Benchmark results

Column number	(1)	(2)	(3)	(4)	(5)	(6)
Type	Full	Full	No-Crisis	No-Crisis	In-Crisis	In-Crisis
Variables	Bi	Bi	Bi	Bi	Bi	Bi
Dt	0.019*** (0.01)	0.012** (0.01)	0.016** (0.01)	0.013* (0.01)	−0.020 (0.02)	−0.022 (0.02)
Fs		0.112*** (0.01)		0.114*** (0.01)		0.205*** (0.06)
Fa		−0.010 (0.01)		−0.025 (0.02)		0.064 (0.07)
Lev		−0.126*** (0.04)		−0.132*** (0.05)		−0.129 (0.16)
Roa		0.263*** (0.08)		0.312*** (0.09)		−0.031 (0.20)
Gr		−0.015 (0.01)		−0.015 (0.01)		−0.060** (0.02)
Bs		−0.061 (0.04)		−0.077* (0.05)		0.043 (0.11)
To		0.223*** (0.08)		0.252*** (0.09)		0.738** (0.33)
In		−0.098* (0.05)		−0.130** (0.06)		−0.092 (0.20)
_cons	1.165*** (0.01)	−1.154*** (0.28)	1.110*** (0.01)	−1.161*** (0.30)	1.336*** (0.04)	−3.617*** (1.34)
Year-FE	√	√	√	√	√	√
Firm-FE	√	√	√	√	√	√
N	39370	39370	26189	31237	7432	7432
adj. R ²	0.752	0.752	0.732	0.739	0.870	0.870

Source: Calculated by authors.

Note: robustness standard errors are displayed within brackets. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10%, respectively.

are more likely to prioritize liquidity preservation, operational continuity, and short-term survival over long-term exploratory innovation investment, even when Dt capabilities are already in place. In this context, although Dt enhances transparency and monitoring efficiency, the governance benefits of digital transparency

may not fully translate into increased Bi investment during systemic crisis periods.

From a RDT perspective, Black swan events drastically increase uncertainty regarding the availability, reliability, and continuity of critical external resources. Even when digital technologies improve internal coordination and infor-

Table 4
Robustness checks

Column number	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Type	Full	No-Crisis	In-Crisis	Full	No-Crisis	In-Crisis	Full	No-Crisis	In-Crisis
Variables	Bia	Bia	Bia	Bi	Bi	Bi	Bi	Bi	Bi
Dt	0.017***	0.021***	0.017	0.013**	0.013**	-0.020	0.012**	0.013**	-0.017
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year-FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Firm-FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	39370	31237	7432	39370	31237	7432	31258	24329	4918
adj. R ²	0.718	0.719	0.836	0.753	0.739	0.870			

Source: Calculated by authors.

Note: robustness standard errors are displayed within brackets. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10%, respectively.

mation processing capabilities, firms may still face severe constraints in accessing external financing, technological knowledge spillovers, and stable supply chain resources. This external resource disruption weakens firms' ability to effectively convert Dt investments into Bi outcomes.

Overall, our findings suggest that while Dt generally enhances Bi under stable conditions, its innovation effects are contingent upon external environmental stability. These findings extend the existing literature by demonstrating that Dt should be viewed as a context-dependent strategic capability rather than a universally innovation-enhancing factor. Consistent with Wu et., al (2024) [41], Dt improves innovation-related information transparency and investment disclosure efficiency, but our results further suggest that the realization of these benefits depends on macroeconomic and environmental stability.

Robustness tests

To ensure the robustness and reliability of our findings, we perform several robustness checks using alternative specifications and methodologies. The results, presented in Table 4, confirm the consistency of our primary findings under different model assumptions.

First, we replace the dependent variable in our analysis to test the robustness of the rela-

tionship between Dt and Bi. In columns (1), (2), and (3), we use the number of granted invention patents (Bia) instead of patent applications as the measure of innovation. Given that granted patents are considered a more authoritative indicator of innovation due to their validation in the patenting process, we find that the coefficients for Dt remain positive and statistically significant in columns (1) and (2). However, in column (3), the relationship becomes statistically insignificant during crisis periods. This variation in significance reinforces the robustness of our results across different measures of innovation.

Second, we introduce additional fixed effects to further control for potential confounding factors. In columns (4), (5), and (6), we include industry, province, and city fixed effects in addition to firm and year fixed effects. This specification controls for unobserved heterogeneity across industries, regions, and firms, and the results remain consistent with our main findings. The coefficients for Dt continue to demonstrate significance, further validating our initial results.

Third, we substitute our regression methodology with a Poisson count model to test the robustness of our results under a different estimation method. Columns (7), (8), and (9) present the results from this alternative approach, where the dependent variable is modeled as a count

Table 5

Digital transformation and breakthrough innovation: SOEs vs. non-SOEs in normal and crisis periods

Ownership	SOEs		non-SOEs	
Column number	(1)	(2)	(3)	(4)
Period	No-Crisis	In-Crisis	No-Crisis	In-Crisis
Variables	Bia	Bia	Bia	Bia
Dt	0.023***	−0.018	0.004	−0.023
	(0.01)	(0.03)	(0.01)	(0.02)
Controls	✓	✓	✓	✓
Year-FE	✓	✓	✓	✓
Firm-FE	✓	✓	✓	✓
N	20832	2270	27521	5162
adj. R ²	0.769	0.907	0.747	0.849

Source: Calculated by authors.

Note: robustness standard errors are displayed within brackets. Significance levels are denoted by ***, **, and * for 1%, 5%, and 10%, respectively.

variable. Even with this different estimation technique, the coefficients for Dt continue to show similar patterns, confirming the stability of the relationship between digital transformation and breakthrough innovation under varying model specifications.

Heterogeneity analysis

We explore the differential effects of Dt on Bi by comparing SOEs and non-SOEs. The results presented in *Table 5* reveal substantial differences in how Dt influences innovation across these two types of firms, particularly under normal and crisis conditions.

For SOEs, as shown in columns (1) and (2), Dt has a significant positive effect on Bi during normal periods (0.023***), suggesting that digital transformation boosts the innovation capabilities of SOEs. This positive relationship could stem from the fact that SOEs often have more stable access to resources and government support, which enables them to effectively adopt digital technologies and pursue innovation. However, during crisis periods, the effect reverses, with a negative and statistically insignificant coefficient (−0.018, column 2). This may indicate that the typical advantages of digital transformation, such as enhanced transparency and data-driven decision-making, are not as ef-

fectively utilized in times of crisis. One possible explanation is that the unique characteristics of SOEs, such as stronger government involvement and more conservative decision-making, could hinder their ability to adapt quickly in uncertain conditions. In crisis situations, SOEs may prioritize stability and risk-averse strategies over the potential for innovation, thus diminishing the positive impact of Dt on breakthrough innovation.

In contrast, for non-SOEs, the results in columns (3) and (4) show weaker and statistically insignificant relationships between Dt and Bi, both during normal periods (0.004) and crisis periods (−0.023). This suggests that non-SOEs may not fully leverage the benefits of digital transformation in driving innovation, regardless of the economic context. It is possible that non-SOEs face more constraints in terms of resources, access to advanced technologies, and expertise, which limits their ability to adopt and implement digital transformation effectively. Furthermore, the negative effect during the crisis suggests that non-SOEs may be more vulnerable to external shocks, as they often lack the financial buffers and institutional support that SOEs benefit from. In times of crisis, these firms may be forced to focus on short-term survival rather than long-term innovation, further

weakening the impact of Dt on breakthrough innovation.

These findings suggest that digital transformation has heterogeneous effects on breakthrough innovation depending on the type of firm and the economic context. SOEs benefit more from Dt during normal times, but their ability to innovate is reduced during crises, potentially due to their more conservative strategies and reliance on government support. In contrast, non-SOEs show a weaker response to Dt overall, possibly due to limited resources and adaptability, and are particularly vulnerable during crises.

Discussion

The results of this study underscore the transformative potential of Dt in promoting Bi within Chinese listed companies. Our analysis reveals that, under stable conditions, Dt enhances Bi significantly, validating the idea that digitalization can fundamentally improve innovation processes. By enabling better access to data, more efficient resource management, and improved decision-making processes, Dt helps firms increase their innovation output. This is in line with existing literature that highlights the role of digital tools in driving operational efficiencies and enhancing corporate innovation [41–51].

That said, the study also reveals a critical insight: during crisis periods, the positive relationship between Dt and Bi is disrupted. This disruption is particularly evident during the global health crisis, where the usual benefits of digital transformation were attenuated. Firms, especially those in the most affected sectors, struggled to effectively leverage digital technologies to sustain or accelerate their innovation activities. The findings suggest that while digital transformation is a crucial driver of innovation in stable environments, its effectiveness is contingent upon the external environment's stability. In times of crisis, firms often shift their priorities to focus on short-term survival, cutting back on innovation activities and reducing the strategic importance of digital transformation. This result aligns with the Black swan theory, which posits that rare and unpredictable events — such as global crises — can disrupt even the most well-established organizational processes, including innovation [52].

The heterogeneity analysis adds further complexity to our understanding of the digital transformation-innovation relationship. Our results indicate that, during normal periods, SOEs experience a significantly stronger positive impact from Dt on Bi. This can likely be attributed to the institutional advantages of SOEs, such as greater access to resources, stable government support, and more formalized governance structures. These factors enable SOEs to effectively harness digital technologies and apply them toward innovation [53, 54]. Additionally, the relatively rigid and bureaucratic nature of SOEs may also contribute to their ability to systematically implement and monitor digital strategies, ensuring that these technologies contribute meaningfully to breakthrough innovation [55–57].

On the other hand, during crisis periods, this advantage seems to diminish. The increased regulatory scrutiny, government intervention, and a more cautious decision-making approach often found in SOEs may hinder their ability to quickly pivot or adapt to external shocks [58–60]. In contrast, non-SOEs show no significant impact from Dt on breakthrough innovation, regardless of whether conditions are normal or crisis-driven. This suggests that non-SOEs face significant challenges in implementing digital transformation strategies effectively. Their limited access to resources, lack of institutional support, and lower digital adoption rates might prevent them from capitalizing on digital technologies to foster innovation. These findings are consistent with previous research, which argues that SOEs, due to their institutional backing and resource availability, are better positioned to implement successful digital strategies, while non-SOEs often lack the necessary infrastructure and governance to do so [60–63].

Conclusion and implications

Drawing on a comprehensive dataset of Chinese A-share listed companies spanning from 2014 to 2024, this study provides both theoretical and empirical insights into the relationship between digital transformation and breakthrough innovation. Our analysis reveals a positive correlation between Dt and Bi, confirming our initial hypothesis that, under normal circumstances, digital transformation significantly enhances firms' ability to achieve breakthrough innovation. However, our

results also indicate that this positive influence is notably reduced during times of crisis, such as the global health crisis. This attenuation suggests that while digital transformation generally fosters innovation, its effectiveness is contingent upon the broader external environment, and its benefits can be undermined by significant disruptions.

Moreover, our heterogeneity analysis highlights important differences in the effects of digital transformation on breakthrough innovation between SOEs and non-SOEs. The results show that Dt has a stronger positive impact on innovation in SOEs during normal periods compared to non-SOEs, emphasizing the role of governance structures and resource access in facilitating innovation. However, this effect is attenuated or even reversed for SOEs during crises, underscoring the vulnerability of even well-resourced and structured firms in the face of unexpected disruptions. In contrast, non-SOEs show less significant impacts from Dt in both normal and crisis periods, suggesting that they may face greater challenges in leveraging digital technologies for innovation due to resource constraints and structural limitations.

These findings have significant implications for both theoretical frameworks and practical applications. From a theoretical standpoint, the positive association between Dt and Bi supports Agency Theory and Resource Dependence Theory, illustrating how digital transformation can reduce information asymmetry and improve firms' access to and utilization of external resources, thereby enhancing their innovative capabilities. However, the diminished impact of Dt during the global health crisis, interpreted through Black Swan Theory, highlights the vulnerability of even robust digital strategies to unforeseen and disruptive events. The heterogeneity observed between SOEs and non-SOEs further suggests that the benefits of Dt are not uniform across different firm types, and that ownership structure plays a critical role in

determining the extent to which Dt can drive innovation.

On the practical front, these results underscore the importance for firms to develop resilient and adaptable digital strategies. While digital transformation should be harnessed to drive innovation, firms must also ensure their strategies are flexible enough to respond to unforeseen crises. The reduction in the effectiveness of Dt amid external shocks indicates that firms need to proactively anticipate potential resource constraints and shifts in priorities. Specifically, SOEs should focus on balancing government influence with innovation-driven strategies, while non-SOEs may need to address structural limitations and resource gaps to fully capitalize on digital transformation. By adjusting digital initiatives to address these challenges, firms can better navigate volatile environments and maintain their competitive edge.

Future research should examine how external shocks influence the relationship between digital transformation and innovation, and explore strategies that firms can adopt to mitigate these disruptions. While this study focuses on Chinese A-share listed companies, the applicability of the findings to other countries or regions with different institutional settings may be limited. The sample's specific focus on Chinese companies, particularly the emphasis on SOEs and their unique governance structures, may not fully capture the dynamics of digital transformation in firms from other markets. Understanding how companies in different countries or industries maintain innovation through digital transformation during crises will be crucial for sustaining a competitive edge in today's rapidly changing and uncertain business environment. Future studies could also explore how variations in institutional environments, regulatory frameworks, and market conditions might influence the effectiveness of digital transformation in fostering innovation across different geographical settings.

REFERENCES

1. He Q., Meadows M., Angwin D., Gomes E., Child J. strategic alliance research in the era of digital transformation: Perspectives on future research. *British Journal of Management*. 2020;31(3):589-617. URL: <https://doi.org/10.1111/1467-8551.12406>
2. Rakovic L., Maric S., Milutinovic L.D., Vukovic V., Bjekic R. The role of leadership in managing digital transformation: A systematic literature review. *E+M Ekonomie a Management*. 2024;27(2):87-107. URL: <https://doi.org/10.15240/tul/001/2024-2-006>

3. Stacho Z., Stachová K., Lukáč M., Kupec V., Petru N. Management reflections on innovations in digitalization, with an emphasis on degree of work autonomy. *E+M Ekonomie a Management*. 2023;26(1):78-93. URL: <https://doi.org/10.15240/tul/001/2023-1-005>
4. Vallušová A., Kuráková I., Lacová Ž. Digital inequality and usage gap in the V4 region. *E+M Ekonomie a Management*. 2022;25(4):164-179. URL: <https://doi.org/10.15240/tul/001/2022-4-011>
5. Pu T. The R&D gain of digital transformation: Evidence from China. *Global Economic Review*. 2025;54(4):439-65. URL: <https://doi.org/10.1080/1226508x.2025.2566643>
6. Petrikova T., Kocisova K. Digital payments as an indicator of financial inclusion in Euro Area countries. *E+M Ekonomie a Management*. 2024;27(2):162-182. URL: <https://doi.org/10.15240/tul/001/2024-5-004>
7. Szalavetz A. Digitalisation-induced performance improvement: Don't take it for granted! *Acta Oeconomica*. 2022;72(4):457-475. URL: <https://doi.org/10.1556/032.2022.00031>
8. Vodă A., Brătucu G., Tudor A. I.M., Brătucu R., Chițu I. B., Dovleac L., Tecău A. S., Trifan A. Can Central and Eastern European countries lead on digitalization? Using digi-index to analyse technological progress and potential. *Acta Oeconomica*. 2022;72(4):437-455. URL: <https://doi.org/10.1556/032.2022.00030>
9. Wang D., Shao X. Research on the impact of digital transformation on the production efficiency of manufacturing enterprises: Institution-based analysis of the threshold effect. *International Review of Economics and Finance*. 2024;91:883-897. URL: <https://doi.org/10.1016/j.iref.2024.01.046>
10. Peng Y., Tao C. Can digital transformation promote enterprise performance? – From the perspective of public policy and innovation. *Journal of Innovation and Knowledge*. 2022;7(3):100198. URL: <https://doi.org/10.1016/j.jik.2022.100198>
11. Bobek V., Weitgasser L., Horvat T. The innovation – financial development – economic growth nexus in Latin America. *Acta Oeconomica*. 2024;74(2):169-185. URL: <https://doi.org/10.1556/032.2024.00008>
12. Endres H., Auburger J., Helm R. Industrial innovation management in the age of digital transformation: The risk of too strong selling capabilities. *Industrial Marketing Management*. 2024;117:371-385. URL: <https://doi.org/10.1016/j.indmarman.2024.01.008>
13. Noskova M., Kutlak J. The influence of the COVID-19 pandemic on managerial functions: Theory verified by Delphi method. *E+M Ekonomie a Management*. 2024;27(1):53-69. URL: <https://doi.org/10.15240/tul/001/2024-5-003>
14. Phan D. M., Hoang S. D., Dao T. D., Pham T. P. Regional COVID-19 cases and Bitcoin volatility: Assessment through the Markov switching prism. *E+M Ekonomie a Management*. 2024;27(2):142-161. URL: <https://doi.org/10.15240/tul/001/2024-2-009>
15. Pu T., Zulkafli A. H. How does digital transformation affect innovation quality? *Economics and Management*. 2024;27(4):16-32. URL: <https://doi.org/10.15240/tul/001/2024-5-021>
16. Filho W. L., Salvia A. L., Beynaghi A., Fritzen B., Ulisses A., Avila L. V., Shulla K., Vasconcelos C. R. P., Moggi S., Mifsud M., Anholon R., Rampasso I. S., Kozlova V., Iliško D., Skouloudis A., Nikolaou I. Digital transformation and sustainable development in higher education in a post-pandemic world. *International Journal of Sustainable Development and World Ecology*. 2023;31(1):108-123. URL: <https://doi.org/10.1080/13504509.2023.2237933>
17. Pu T., Zulkafli A. H. Managerial ownership and corporate innovation: evidence of patenting activity from Chinese listed manufacturing firms. *Cogent Business and Management*. 2024;11(1). URL: <https://doi.org/10.1080/23311975.2023.2289202>
18. He J., Du X., Tu W. Can corporate digital transformation alleviate financing constraints? *Applied Economics*. 2023;56(20):2434-2450. URL: <https://doi.org/10.1080/00036846.2023.2187037>
19. Pu T. Does digital transformation propel innovation strategies? An empirical investigation based on machine learning and the dynamic GMM approach. *E+M Ekonomie a Management*. 2025;28(2):81-96. URL: <https://doi.org/10.15240/tul/001/2025-5-012>
20. Pu T. Bridging digitalization and environmental, social, and governance performance: the moderating effect of CEO duality and government linked corporations. *Humanities and Social Sciences Communications*. 2025;12(1). URL: <https://doi.org/10.1057/s41599-025-05773-0>
21. Zhang C., Wang Y. Is enterprise digital transformation beneficial to shareholders? Insights from the cost of equity capital. *International Review of Financial Analysis*. 2024;92:103104. URL: <https://doi.org/10.1016/j.irfa.2024.103104>

22. Hillman A. J., Withers M. C., Collins B. J. Resource Dependence Theory: A review. *Journal of Management*. 2009;35(6):1404-1427. URL: <https://doi.org/10.1177/0149206309343469>
23. Nie J., Jian X., Xu J., Xu N., Jiang T., Yu Y. The effect of corporate social responsibility practices on digital transformation in China: A resource-based view. *Economic Analysis and Policy*. 2024;82:1-15. URL: <https://doi.org/10.1016/j.eap.2024.02.027>
24. Civelek M., Krajčík V., Ključnikov A. The impacts of dynamic capabilities on SMEs' digital transformation process: The resource-based view perspective. *Oeconomia Copernicana*. 2023;14:1367-1392. URL: <https://doi.org/10.24136/oc.2023.019>
25. Chen H., Tian Z. Environmental uncertainty, resource orchestration and digital transformation: A fuzzy-set QCA approach. *Journal of Business Research*. 2022;139:184-193. URL: <https://doi.org/10.1016/j.jbusres.2021.09.048>
26. Pu T., Zulkafli A. H. State Ownership heterogeneity and corporate innovation: New evidence from a hierarchical perspective. *Journal of Corporate Finance Research*. 2024;18(1):20-36. URL: <https://doi.org/10.17323/j.jcfr.2073-0438.18.1.2024.20-36>
27. Heuer J., Merkle C., Weber M. Fooled by randomness: investor perception of fund manager skill. *Review of Finance*. 2016;21(2):605-635. URL: <https://doi.org/10.1093/rof/rfw011>
28. MacMillan C. Covid-19 and the problem of frustrated contracts. *King S Law Journal*. 2021;32(1):60-70. URL: <https://doi.org/10.1080/09615768.2021.1885328>
29. Jiang W., Li J. Digital transformation and its effect on resource allocation efficiency and productivity in Chinese corporations. *Technology in Society*. 2024;78:102638. URL: <https://doi.org/10.1016/j.techsoc.2024.102638>
30. Pu T., Li Y., Zulkafli A. H. Digital transformation and corporate innovation: Empirical discovery based on machine learning. *Asian Academy of Management of Accounting and Finance*. 2024;20(2):121-153. URL: <https://doi.org/10.21315/aamjaf2024.20.2.4>
31. Li S., Gao L., Han C., Gupta B., Alhalabi W., Almakdi S. Exploring the effect of digital transformation on firms' innovation performance. *Journal of Innovation and Knowledge*. 2023;8(1):100317. URL: <https://doi.org/10.1016/j.jik.2023.100317>
32. Van Meeteren M., Trincado-Munoz F., Rubin T. H., Vorley T. Rethinking the digital transformation in knowledge-intensive services: A technology space analysis. *Technological Forecasting and Social Change*. 2022;179:121631. URL: <https://doi.org/10.1016/j.techfore.2022.121631>
33. Gray G. L., Alles M. G. Measuring a business's grit and survivability when faced with "Black Swan" events like the coronavirus pandemic. *Journal of Emerging Technologies in Accounting*. 2021;18(1):195-204. URL: <https://doi.org/10.2308/jeta-2020-060>
34. Liu J., Chen Y., Liang F. H. The effects of digital economy on breakthrough innovations: Evidence from Chinese listed companies. *Technological Forecasting and Social Change*. 2023;196:122866. URL: <https://doi.org/10.1016/j.techfore.2023.122866>
35. Kindermann B., Beutel S., De Lomana G. G., Strese S., Bendig D., Brettel M. Digital orientation: Conceptualization and operationalization of a new strategic orientation. *European Management Journal*. 2021;39(5):645-657. URL: <https://doi.org/10.1016/j.emj.2020.10.009>
36. Tu W., He J. Can digital transformation facilitate firms' M&A: Empirical discovery based on machine learning. *Emerging Markets Finance and Trade*. 2022;59(1):113-128. URL: <https://doi.org/10.1080/1540496x.2022.2093105105>
37. Jiang L., Li B., Zhang M. The impact of digital transformation on the efficiency of corporate resource allocation: Internal mechanisms and external environment. *Technological Forecasting and Social Change*. 2025;215:124107. URL: <https://doi.org/10.1016/j.techfore.2025.124107>
38. Tang J., Li W., Hu J., Ren Y. Can government digital transformation improve corporate energy efficiency in resource-based cities? *Energy Economics*. 2024;141:108043. URL: <https://doi.org/10.1016/j.eneco.2024.108043>
39. Li X., Li X., Ding S. Digital transformation and innovation ambidexterity: perspectives on accumulation and resilience effects. *European Journal of Innovation Management*. 2024;28(4):1601-1624. URL: <https://doi.org/10.1108/ejim-07-2023-0526>

40. Chang C. H., Chen Y. S., Tseng C. W. Digital transformation anxiety: absorptive capacity, dynamic capability, and digital innovation performance. *Management Decision*. 2024;63(3):734-755. URL: <https://doi.org/10.1108/md-08-2023-1363>
41. Wu Z., Zhang M., Ji R., Dou W. How does enterprise digital transformation promote green innovation? Evidence from listed companies in China. *Applied Economics*. 2024;57(57):9807-22. URL: <https://doi.org/10.1080/00036846.2024.2423902>
42. Rubio-Andrés M., Linuesa-Langreo J., Gutiérrez-Broncano S., Sastre-Castillo M. Á. Tackling digital transformation strategy: how it affects firm innovation and organizational effectiveness. *The Journal of Technology Transfer*. 2024;50(5):1893-918. URL: <https://doi.org/10.1007/s10961-024-10164-9>
43. Qiao Y., Li X., Hu J. From digital to innovative: How does digital transformation affect corporate innovation? *Economics Letters*. 2025;247:112210. URL: <https://doi.org/10.1016/j.econlet.2025.112210>
44. Pu T. The Role of Digitalization in Enhancing Green Innovation Efficiency: Examination of Multiple Sub-Dimensions, transformation speed, and Heterogeneity. *SAGE Open*. 2025;15(2). URL: <https://doi.org/10.1177/21582440251335734>
45. Probojakti W., Utami H. N., Prasetya A., Riza M. F. Driving sustainable competitive advantage in banking: The role of transformational leadership and digital transformation in organizational agility and corporate resiliency. *Business Strategy and the Environment*. 2024;34(1):670-689. URL: <https://doi.org/10.1002/bse.4005>
46. Xue J., Li G., Ivanov D. Digital transformation in the blockchain era: Balancing efficiency and resilience in operations management. *International Journal of Production Economics*. 2025;282:109525. URL: <https://doi.org/10.1016/j.ijpe.2025.109525>
47. Yu Y., Zeng H., Zhang M. Digital transformation for supply chain collaborative innovation and market performance. *European Journal of Innovation Management*. 2024;28(6):2446-68. URL: <https://doi.org/10.1108/ejim-09-2023-0736>
48. Zhang J., Yu C. H., Zhao J., Lee C. C. How does corporate digital transformation affect green innovation? Evidence from China's enterprise data. *Energy Economics*. 2025;142:108217. URL: <https://doi.org/10.1016/j.eneco.2025.108217>
49. Qiao C., Chen S. Digital transformation, management efficiency and intra-firm common prosperity. *International Review of Economics and Finance*. 2025;98:103948. URL: <https://doi.org/10.1016/j.iref.2025.103948>
50. Pu T., E, S, and G, not just ESG: Exploring the digital transformation–environmental, social, and governance performance nexus through patent-based evidence. *SAGE Open*. 2025;15(4). URL: <https://doi.org/10.1177/21582440251384402>
51. Zhang G., Xie Q., Gao H., Lu J., Cucari N. Implementation of social responsibility in digital transformation: An opportunity or a challenge to corporate innovation performance. *Corporate Social Responsibility and Environmental Management*. 2024;32(1):1245-60. URL: <https://doi.org/10.1002/csr.2970>
52. Krupa J., Jones C. Black Swan Theory: Applications to energy market histories and technologies. *Energy Strategy Reviews*. 2013;1(4):286-90. URL: <https://doi.org/10.1016/j.esr.2013.02.004>
53. Okhmatovskiy I. Performance implications of ties to the government and SOES: A Political embeddedness perspective. *Journal of Management Studies*. 2009;47(6):1020-47. URL: <https://doi.org/10.1111/j.1467-6486.2009.00881.x>
54. Li S., Xia J. The roles and performance of state firms and non-state firms in China's economic transition. *World Development*. 2007;36(1):39-54. URL: <https://doi.org/10.1016/j.worlddev.2007.01.008>
55. Huang K. G., Jing R., Xia J., Zhang C. M., Zhong W., Zhu D. H. Coevolution of SOEs and the Chinese Economy: The Roles of SOE heterogeneity from the institutional, strategic, and organizational perspectives. *Management and Organization Review*. 2024;20(5):704-15. URL: <https://doi.org/10.1017/mor.2024.68>
56. Maqsood U. S., Wang S., Zahid R. M. A. Digital age imperatives and firm internal control quality: evidence from CEOs personal trait and type of state-owned enterprises. *Managerial Auditing Journal*. 2024;39(6):700-27. URL: <https://doi.org/10.1108/maj-10-2023-4071>
57. Chen Z., Cao Y., Liao K. How state-owned equity participation promotes the digital transformation of nonstate-owned enterprises: Evidence from China. *Finance Research Letters*. 2023;59:104818. URL: <https://doi.org/10.1016/j.frl.2023.104818>

58. Luke B. Examining accountability dimensions in state-owned enterprises. *Financial Accountability and Management*. 2010;26(2):134-62. URL: <https://doi.org/10.1111/j.1468-0408.2010.00496.x>
59. Jiang Y., Gao Y., Yu Y. The unintended effect of the accountability system of state-owned enterprises: Evidence from crash risk. *Corporate Governance and International Review*. 2025;34(1):128-53. URL: <https://doi.org/10.1111/corg.70007>
60. Anathole U., Limei C., Hamza F. Navigating Corporate greenwashing in the carbon era: synergizing internal carbon pricing, ESG governance, and regulatory stringency to advance environmental integrity. *Corporate Social Responsibility and Environmental Management*. 2026;33:1794-1814. URL: <https://doi.org/10.1002/csr.70256>
61. Zhang Z., Zheng X., Lv Q., Meng X. How institutional pressures influence corporate greenwashing strategies: Moderating effects of campaign-style environmental enforcement. *Journal of Environmental Management*. 2024;373:123914. URL: <https://doi.org/10.1016/j.jenvman.2024.123914>
62. Pu T. How digital transformation shapes corporate R&D expenditure: An exploration of multidimensional perspectives and innovation consequences. *SAGE Open*. 2025;15(3). URL: <https://doi.org/10.1177/21582440251349263>
63. Turturea R., Sauerwald S., Heugens P.P.M.A.R. Forging agents of the state? How political institutions impact CEO compensation in state-owned enterprises. *Journal of International Business Studies*. 2025;56(5):589-607. URL: <https://doi.org/10.1057/s41267-024-00765-9>

ABOUT THE AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

Tingqian Pu — PhD in Finance, Associate Professor of the School of Economics and Finance, Guizhou University of Commerce, Guiyang, China

Тинцянь Пу — PhD в области финансов, доцент Школы экономики и финансов, Коммерческий университет Гуйчжоу, Гуйян, Китай
<https://orcid.org/0000-0002-6618-5891>

Corresponding Author / Автор для корреспонденции:
tq_pu@outlook.com

Abdul Hadi Zulkafli — PhD in Finance, Associate Professor of the School of Management, Universiti Sains Malaysia (Malaysia Science University), Penang, Malaysia

Абдул Хади Зулкафли — PhD в области финансов, доцент Школы менеджмента, Университет Сайнс Малайзия, Пенанг, Малайзия
<https://orcid.org/0000-0001-6087-1746>
hadi_zml@usm.my

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The article was submitted on 19.01.2026; revised on 09.02.2026 and accepted for publication on 01.03.2026. The authors read and approved the final version of the manuscript.

DOI: 10.26794/2308-944X-2026-14-1-56-74
UDC 336(045)
JEL M41, M48, L25, Q56

The Role of Strategic Agility for Sustainable Business Performance: A Management Control and Accounting System Approach

E. Susana, E. Murwaningsari, Y.A. Sudibyo, S. Mayangsari
Trisakti University, Jakarta, Indonesia

ABSTRACT

The Purpose: The study examines the impact of sustainable management control systems and sustainable management accounting systems on sustainable business performance and analyses whether strategic agility moderates these relationships. The research addresses the problem of how internal sustainability mechanisms influence long-term business outcomes in dynamic environments. **Methods:** The study uses a quantitative approach with data collected via questionnaires from publicly listed companies on the Indonesia Stock Exchange (IDX). The sample consists of 265 issuers listed on IDX, representing various sectors with an emphasis on organisational practices related to sustainability and performance. The researchers employed structural equation modelling using the Statistical Package for the Social Sciences (SPSS) Analysis of Moment Structures (AMOS) 22 to test the hypotheses, along with sensitivity and expansion tests. The **results** indicate that both sustainable management control systems and sustainable management accounting systems significantly enhance sustainable business performance. However, strategic agility does not moderate these relationships. **Limitations:** The findings are limited to IDX-listed companies and thus may not be generalisable to non-listed firms. The study also did not account for the adoption of specific international sustainability standards, limiting insights into innovation-driven sustainability practices. **Contribution:** This study contributes to the literature by integrating strategic agility into the sustainability-performance framework and highlighting the roles of internal control and accounting systems. It offers empirical evidence from an emerging market context, emphasising structural over strategic drivers of sustainable business performance.

Keywords: sustainable business performance; strategic agility; sustainable management control system; sustainable management accounting system; Indonesia stock exchange; contingency theory

For citation: Susana E., Murwaningsari E., Sudibyo Y.A., Mayangsari S. The role of strategic agility for sustainable business performance: A management control and accounting system approach. *Review of Business and Economics Studies*. 2026;14(1):56-74. DOI: 10.26794/2308-944X-2026-14-1-56-74

ОРИГИНАЛЬНАЯ СТАТЬЯ

Роль стратегической гибкости в обеспечении устойчивой эффективности бизнеса: системный подход к управленческому контролю и бухгалтерскому учету

Э. Сусана, Э. Мурванингсари, И.А. Судибйо, С. Майангсари
Университет Трисакти, Джакарта, Индонезия

АННОТАЦИЯ

Цель: в исследовании изучается влияние систем устойчивого управленческого контроля и систем устойчивого управленческого учета на устойчивые показатели бизнеса и анализируется, оказывает ли стратегическая гибкость на эти взаимосвязи. Исследование рассматривает проблему обусловленности внутренних

механизмов устойчивого развития и долгосрочных результатов бизнеса в динамичной среде. **Методы:** в исследовании применен количественный подход с использованием данных, собранных с помощью анкетирования компаний, котирующихся на Индонезийской фондовой бирже (IDX). В выборку вошли 265 эмитентов, котирующихся на IDX и представляющих различные сектора с акцентом на организационные практики, связанные с устойчивостью и эффективностью. Исследователи использовали моделирование структурных уравнений с помощью статистического пакета для социальных наук (SPSS) с анализом моментных структур (AMOS 22) для проверки гипотез, а также тесты чувствительности и расширения. **Результаты** показывают, что как системы устойчивого управленческого контроля, так и системы устойчивого управленческого учета значительно повышают показатели устойчивого развития бизнеса. Однако стратегическая гибкость не является модератором этих взаимосвязей. **Ограничения:** результаты исследования ограничены компаниями, котирующимися на Индонезийской фондовой бирже, и поэтому могут быть неприменимы к компаниям, не котирующимся на бирже. В исследовании также не учитывалось внедрение конкретных международных стандартов устойчивого развития, что ограничивает понимание инновационно ориентированных практик устойчивого развития. **Вклад:** данное исследование вносит вклад в литературу, интегрируя стратегическую гибкость в концепцию устойчивого развития и подчеркивая роль систем внутреннего контроля и бухгалтерского учета. В нем представлены эмпирические данные в контексте развивающихся рынков, и особое внимание уделяется структурным, а не стратегическим факторам устойчивого развития бизнеса.

Ключевые слова: устойчивое развитие бизнеса; стратегическая гибкость; система устойчивого управленческого контроля; система устойчивого управленческого учета; Индонезийская фондовая биржа; теория ситуационного подхода

Для цитирования: Susana E., Murwaningsari E., Sudibyo Y.A., Mayangsari S. The role of strategic agility for sustainable business performance: A management control and accounting system approach. *Review of Business and Economics Studies*. 2026;14(1):56-74. DOI: 10.26794/2308-944X-2026-14-1-56-74

1. Introduction

The current global business environment underscores the growing demand from shareholders to address environmental, social, and governance (ESG) issues more comprehensively, considering this from an international perspective driven by pressure from public interest institutions [1]. Socially responsible investing (SRI) is about making a positive impact on society and the world. Sustainability and sustainable development are concepts that have gained global recognition and are used to address the complex demands of increasing stakeholder concerns about environmental and social issues. The term 'sustainable development' was popularized in 1987 by the Brundtland report, which included the 'classic' definition of sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs [2]. The presence of these sustainability standards can impact a company's financial standing. These initiatives often require a commitment of financial resources for the procurement of environmentally friendly equipment, the launch of high-quality standards for products, and the development of safety programmes [3].

The Indonesian government, through the Ministry of Environment and Forestry (Ministry of Environment and Forestry of the Republic of Indonesia, hereinafter abbreviated KLHK), has the authority to impose administrative, civil, and criminal sanctions on any environmental pollution violators. Most recently, in June 2024, the KLHK Air Pollution Control Task Force halted the operational activities of three companies suspected of causing air pollution. The energy crisis is also a significant environmental issue. Indonesia is vulnerable to an energy crisis due to its large dependence on fossil fuels. Measuring sustainable performance is an important issue to enable effective sustainability management [4, 5], as it can provide sustainable performance indicators for planning actions [6], assessing sustainability practices, conducting audits and internal control [7].

Maximum sustainable performance can be achieved when management accounting practices are implemented effectively. Therefore, management accounting practices are a determinant factor of sustainable performance. One of the management accounting practices that can affect sustainable performance is the sustainable management control system. Sustainable management control systems are a relatively

new construct and tend to be a largely neglected area of research [8]. Herremans and Nazari [9] emphasised that sustainable management control systems can ensure that sustainability principles are integrated into business operational practices. This will help organisations monitor and manage their business activities, as well as ensure compliance with environmental and social standards [10]. By implementing sustainable practices, such as responsible sourcing, efficient distribution, and waste reduction, organisations can enhance business performance and mitigate environmental impacts [11]. The empirical evidence shows that sustainable management control systems have a positive and significant effect on sustainable performance [12, 13].

Another management accounting practice that affects sustainable performance is the sustainable management accounting system. One of the sustainability practices that involves organisational activities is the implementation of a sustainable management accounting system, which provides environmental information to mitigate environmental problems and enhance performance and sustainability. In this case, the implementation of a sustainable management accounting system can enhance management accounting practices by providing valuable environmental information and supporting organisations in managing and improving their performance [14, 15].

The implementation of sustainable management accounting systems enables companies to derive positive benefits for the environment by reducing environmental impacts and enhancing environmental programmes and management, ultimately leading to improved company performance [16]. Empirical evidence shows that sustainable management accounting systems have a positive and significant effect on sustainable performance [17].

Various previous studies have empirically proven the role of an intermediary (mediation or moderation) of agility in the relationship between management control systems and management accounting systems on firm performance, namely, the relationship between management control systems and firm performance moderated by agility [18] and mediated by agility [19, 20]. Meanwhile, the relationship between management accounting systems and

firm performance, mediated or moderated by agility, remains unclear.

This study aims to examine the effect of the Sustainable Management Control System and Sustainable Management Accounting System on Sustainable Business Performance moderated by Strategic Agility. The novelty of this study is the development of management control system measurements derived, which consists of 4 (four) dimensions, namely, diagnostic control, interactive control, boundary systems, and belief systems adopted from Simons' Levers of Controls (LoC) Framework and often known as traditional management control systems. Measurement development is carried out on the dimensions and aspects of the indicator variable. The development of measurements will focus on two additional dimensions: eco-performance measurement and eco-budgeting.

2. Literature review

2.1. Contingency theory

Contingency theory employs a situational and context-oriented approach that seeks to identify and develop functional relationships between environmental variables, management, and performance [21]. There is no single accounting system that is suitable or the "best" management control system for all organisations under all circumstances; its design must depend on the circumstances [22–24]. Related to this research, contingency theory can provide an appropriate framework for examining the relationship between the implementation of sustainable management control systems and sustainable management accounting systems, as well as their impact on sustainable performance.

2.2. Sustainable business performance

Sustainable business performance is a measure of company performance that encompasses economic, environmental, and social objectives in the implementation of its business strategies to protect and preserve the environment and society while maximising market capitalisation [25]. Economic growth is a top priority for most organisations and can be achieved through effective inter-organisational information systems, which lead to increased company capabilities. Economic performance helps build an ecosystem for business process opera-

tions and provides space to meet stakeholder expectations [26].

2.3. Sustainable management control system

A sustainable management control system enables top management to achieve strategic sustainability goals by identifying and managing threats and opportunities related to corporate social responsibility strategies, as well as establishing risk management practices [27]. This approach has a positive impact on sustainable business performance [28]. Similar to the sustainable management accounting system, better information about environmental conditions can help make more effective management decisions, which in turn improve company performance.

2.4. Sustainable management accounting system

A sustainable management accounting system was developed as a corrective innovation to address the limitations of conventional management accounting systems, which do not provide accurate information on environmental cost management. Through the adoption of a sustainable management accounting system, companies can measure financial and non-financial environmental information beyond the usual perspective that tends to combine environmental costs into overhead costs [29]. A measurement of sustainable management accounting systems was developed by Fuzi et al., which consists of five dimensions: environmental costs, environmental regulations, environmental safety, management commitments, and customer focus.

2.5. Strategic agility

Strategic agility can be understood as a form of dynamic capabilities [30] because it describes a company's ability to bring the right product or service to the market at the right time, in the right place, and at the right price [31]. Organisations that demonstrate agility will be better able to adapt to external changes and create value as a result [32]. Strategic agility can enhance a company's competitive quality and responsiveness to environmental changes, ultimately improving its overall performance [33].

2.6. Hypotheses development

A management control system is a system that collects and uses information to evaluate the performance of various organisational resources — human, physical, financial, and the organisation as a whole — by considering the organisation's strategy. The implementation of sustainable management control system practices can ensure the integration of sustainability principles into supply chain management (SCM) practices, which will help organisations monitor and manage their business activities, ensuring compliance with environmental and social standards. Several previous studies, including [34], empirically demonstrate that a sustainable management control system has a positive impact on sustainable business performance. Based on these various explanations, the formulation of the hypothesis that can be built is:

H1: Sustainable Management Control System has a positive effect on Sustainable Business Performance.

A sustainable management accounting system is a new and innovative concept that extends the conventional management accounting system. A sustainable management accounting system can be defined as the identification, allocation, creation, and use of physical and monetary information to support business decision-making that drives sustainable business development [36]. Various previous studies, such as [35–37], empirically demonstrate that a sustainable management accounting system has a positive impact on sustainable business performance. Based on the various explanations provided, the following hypothesis can be formulated:

H2: Sustainable Management Accounting System has a positive effect on Sustainable Business Performance.

Strategic agility is defined as an organization's ability to swiftly and effectively respond to changes in the external environment by realigning its internal resources and capabilities. This dynamic capability enables firms to enhance market share, improve financial performance, and increase overall productivity. Empirical evidence from [34] confirms the positive impact of strategic agility on firm performance. Concurrently, the implementation of sustainable management control systems (SMCS) has been shown

to contribute positively to sustainable business performance [38]. Building upon these findings, it is hypothesised that strategic agility may play a moderating role in the relationship between SMCS and sustainable business performance. Based on these various explanations, the formulation of the hypothesis that can be built is:

H3: Strategic agility strengthens the influence of sustainable management control systems on sustainable business performance.

The Sustainable Management Accounting System (SMAS) plays a critical role in enhancing resource efficiency, reducing environmental impact, and mitigating risks to support improved managerial performance. Given the rapidly changing business environment, organizations must develop strategic agility to adapt effectively. This capability allows firms to align SMAS implementation with internal conditions and optimize resource use, thereby increasing operational efficiency. Empirical studies confirm that strategic agility positively influences firm performance. Accordingly, effective SMAS adoption is expected to improve sustainable business performance, particularly when moderated by high levels of strategic agility. This is consistent with prior research demonstrating the positive impact of SMAS on sustainable business outcomes [39]. Based on these various explanations, the formulation of the hypothesis that can be built is:

H4: Strategic agility strengthens the influence of sustainable management accounting systems on sustainable business performance.

3. Research methodology

The data analysis technique employed in this study utilises covariance-based structural equation modelling (CB-SEM) analysis conducted using the AMOS program. Moderated regression analysis (MRA) was employed to test the hypothesis estimated by the SEM method. The primary data used in this study was obtained through a questionnaire instrument. This questionnaire was distributed and completed by business actors engaged in various types of companies listed on the Indonesia Stock Exchange (IDX) across different regions and sectors in Indonesia. The calculation of the minimum number of samples is 10 times the number of the largest indicators of each variable (construct), whereas, for the maximum likelihood estimation technique,

the range of the number of samples is 100–200 samples [40, 41]. This study used a sample of 265 respondents from various types of companies listed on the Indonesia Stock Exchange (IDX) across different regions and sectors in Indonesia. In addition, this analysis employs descriptive statistics, which are useful tools for analysing data using existing samples without the intention of drawing generally applicable conclusions or making broad generalisations. The design for this study employs a quantitative approach, a research method grounded in the philosophy of positivism, which involves collecting data using research instruments and analysing quantitative data to test the established hypothesis [42]. Meanwhile, the type of research conducted in this study is causal associative research, which aims to analyse the relationship between one or several variables and other variables or how a variable (independent variable) affects another variable (dependent variable). The regression model equation formed is as follows:

$$SBP = \alpha + \beta_1 DC + \beta_2 IC + \beta_3 BoS + \beta_4 BeS + \beta_5 EPM + \beta_6 EB + \beta_7 CSR + \beta_8 OC + \beta_9 OL + \epsilon.$$

Description:

DC — Diagnostic control;

IC — Interactive control;

BoS — Boundary systems;

BeS — Belief systems;

EPM — Eco-performance measurement;

EB — Eco-budgeting;

SBP — Sustainable Business Performance.

Variable Control:

CSR — Corporate Social Responsibility;

OC — Organisation culture;

OL — Organisation learning.

3.1. Operationalisation of variables

Operational variable tables are used to define research variables concretely and measurably, thus facilitating the data collection process. In *Table 1*, each variable is broken down into indicators, sub-indicators, measuring instruments, and measurement scales.

Measuring variables in a sustainable management control system (SMCS) requires a multi-dimensional approach that focuses not only on financial aspects but also integrates sustainability principles into the core of the control process.

Table 1
Measurement of sustainable management control system variables

Dimension	Indicator
Diagnostic control (DC) [18]	The company has identified critical (important) performance variables for the company (DC1)
	The company has set targets for performance variables that are critical (important) for the company (DC2)
	The company monitors progress in achieving critical (important) performance targets for the company (DC3)
	The company corrects deviations from the company's established critical performance targets (DC4)
	The company always reviews important areas of the company's critical performance that have been determined (DC5)
Interactive control (IC)	Companies often provide recurring agendas for top management and subordinate activities (IC1)
	Companies often provide recurring agendas for subordinate activities (IC2)
	Companies often provide a means for debating the underlying data, assumptions, and action plans (IC3)
	The company's attention is focused on strategies with uncertain environmental conditions (IC4)
	The company encourages and facilitates dialogue and information sharing with subordinates (IC5)
Boundary systems (BOS)	The company has a code of ethics to define appropriate and inappropriate behaviour (BOS1)
	The company already has guidelines that define specific areas for, or boundaries for, opportunity seeking and experimentation (BOS2)
	The company always actively communicates regarding risks and activities to avoid (BOS3)
	The company imposes sanctions if involved in risks and activities outside the organization's guidelines (BOS4)
Belief systems (BES)	The company has formulated values, goals and directions in a formal document (BES1)
	The company always actively communicates about core values (BES2)
	The company has made a formal statement to create a commitment to the long-term vision (BES3)
	The company has made a formal statement of core values to motivate and guide subordinates in seeking new opportunities (BES4)
Eco-performance measurement (EPM). ISO 14001 (Novelty)* [43]	The company monitors internal compliance with environmental policies and regulations (EPM1)
	The company provides environmental performance data for internal decision-making (EPM2)
	Management motivates all employees for continuous improvement of environmental performance (EPM3)
	The company provides environmental performance data for external reporting (EPM4)
	The company carries out environmental responsibilities by providing training to employees ISO 14001 (EPM5)
	The company carries out periodic environmental audits related to the Environmental Management System ISO 14001 (EPM6)
Eco-budgeting (EB). ISO 50001 (Novelty)**	Corporate budgeting details environmental costs (costs related to managing environmental impacts, such as waste treatment costs, emission reductions, and environmental impact remediation) (EB1)
	Company budgeting includes investment in environmentally friendly technologies (EB2)
	Company budgeting includes revenue from recycled waste or residual materials (EB3)
	Company budgeting includes energy savings ISO 50001 (EB4)

Source: Developed by the authors.

* ISO 14001. Environmental management systems. 2015. ** ISO 50001. Energy management. 2018.

Table 2
Measurement of sustainable management accounting system variables

Dimension	Indicator
Environmental cost	Management allocates environmental-related costs to production processes (SMAS 1)
	Management improves environmental cost management (SMAS 2)
Environmental regulation	Management complies with environmental regulations (SMAS 3)
	Management is committed to environmental regulations (SMAS 4)
Environmental safety	Management complies with procedures for creating environmental safety (SMAS 5)
	Management provides environmental safety requirements (SMAS 6)
Management commitment	Management is committed to supporting environmental management (SMAS 7)
	Management is committed to involving environmental decision-making (SMAS 8)
Customer focus	Management encourages environmentally friendly practices to customers (SMAS 9)
	Management is committed to providing value to customers (SMAS 10)

Source: Developed by the authors.

This framework can be described through four key elements, namely: Diagnostic Control that monitors environmental performance against established targets to ensure accountability; Boundary Systems that establish clear limits, rules, and codes of conduct to prevent environmentally and socially detrimental practices; Belief Systems that establish and communicate the company's core values related to sustainability commitments to inspire and direct organizational behavior; and specific instruments such as Eco-performance Measurement and Eco-budgeting that technically allocate resources (budgets) and evaluate performance results based on measurable environmental indicators. Thus, these four pillars complement each other to create a dynamic control system, capable of driving strategic initiatives while ensuring the company's operations remain within the corridor of economic, social, and environmental responsibility.

Table 2 shows the sustainable management accounting system indicator based on previous research which will be included in the questionnaire.

Table 3 shows the Strategic Agility (SA) indicator based on previous research which will be included in the questionnaire.

Table 4 shows the Sustainable Business Performance indicator based on previous research which will be included in the questionnaire.

4. Results

4.1. Descriptive statistics

The purpose of descriptive statistics is to present, summarise, and describe a set of data. This allows the main characteristics of the data to be easily understood without drawing conclusions that go beyond the data itself. Table 5 shows the descriptive statistics for this study.

According to the results shown in Table 5 of descriptive statistical testing, it is evident that the average value for all variables falls within the agreed category. The standard deviation value of all variables is below the average value, which means that the data is normally distributed.

Validity testing is used to measure the accuracy and precision of a research instrument in measuring what it is supposed to measure. Meanwhile, reliability testing is used to assess the consistency and stability of the instrument, so that the measurement results can be trusted and reliable when repeated under the same conditions. Table 6 shows the results of the validity and reliability tests for this study.

The validity testing shown in Table 6 indicates that the loading factor meets all the requirements, as it is above 0.4. Likewise, construct reliability should be above 0.7 and variance extracted should be above 0.5. The test results show a value of 0.850. It means that a sustainable management control system, a sustainable

Table 3
Strategic agility variable measurement

Dimension	Indicator
Sensing agility	The company can detect changes in customer preferences (SA 1)
	The company can detect changes in competitor movements (SA 2)
	The company can detect technological changes (SA 3)
Decision making agility	The company can create action plans to meet customer needs (SA 4)
	The company can create action plans to react to competitors' strategic moves (SA 5)
	The company can make action plans related to the use of new technology (SA 6)
Acting agility	The company can modify/restructure the production process in a timely manner (SA 7)
	The company can introduce new products at the right time (SA 8)
	The company can adopt new technologies at the right time (SA 9)

Source: Developed by the authors.

Table 4
Measurement of sustainable business performance variables

Dimension	Indicator
Economic performance [44]	The company has experienced annual profit growth since the implementation of the sustainability program (SBP 1)
	The company has experienced an increase in market share and reputation since the implementation of the sustainability program (SBP 2)
	Companies reduce energy usage costs (SBP 3)
Environmental performance [45]	Companies reduce the risk of environmental accidents (SBP 4)
	The company produces little waste and emissions (SBP 5)
	The intensity of company activities to protect the natural environment is increasing (such as nature conservation activities, tree planting, etc.) (SBP 6)
Social performance	The company carries out community economic development activities (SBP 7)
	Companies improve community health and safety (SBP 8)
	Companies are encouraged to involve the local workforce (SBP 9)

Source: Developed by the authors.

management accounting system, strategic agility, and strategic agility moderation have an 85% effect on sustainable business performance, while other factors influence the remaining factors.

Hypothesis testing is used to verify the validity of a statement or tentative assumption (hypothesis) regarding a population based on sample data. This allows researchers to objectively decide whether to accept or reject a hypothesis based on statistical evidence. Table 7 shows the results of the hypothesis testing calculated using the equation:

$$SBP = \beta_1 SMCS + \beta_2 SMAS + \beta_3 SMCS \times SA + \beta_4 SMAS \times SA + \beta_5 OC + \beta_6 OL.$$

The results of the hypothesis testing in Table 7 show that the sustainable management control system has a positive effect on sustainable business performance, the sustainable management accounting system has a positive effect on sustainable business performance, the moderation of strategic agility and the sustainable management control system is proven not to moderate, and the moderation of strategic agility and the

Table 5
Descriptive statistics

Stats.	SMCS	SMAS	SA	SBP	OC	OL
Mean	4.951	5.178	4.925	4.888	4.793	4.837
Stdev	0.700	0.755	0.870	0.815	0.937	1.125
Min	1.708	1.200	1.111	1.667	1.333	1.000
Max	6.000	6.000	6.000	6.000	6.000	6.000

Source: Developed by the authors.

sustainable management accounting system is proven not to moderate.

Sensitivity tests are used to measure the extent to which the results of a model or analysis change when key assumptions or input variables are changed. The goal is to assess the robustness of research findings and identify which parameters most influence the final results. *Table 8* shows the results of the sensitivity test calculated using the equation:

$$SBP = \beta_1 SMCS + \beta_2 SMAS + \beta_3 SMCS * SA + \beta_4 SMAS \times SA + \beta_5 OC + \beta_6 OL.$$

The results of the sensitivity test show that the coefficient of determination is 84.9%, which is lower than that of the first model, at 85%. It means that the model using novelty provides better results.

Table 9 presents the results of the expansion test using path analysis to examine the effects of eight predictor variables on Systolic Blood Pressure (SBP). The results show that the model explains a substantial proportion of the variance in SBP, with an R^2 value of 0.693, indicating that 69.3% of the variability in SBP is jointly explained by the predictor variables included in the model. This suggests that the model has strong explanatory and predictive power.

As shown in *Table 9*, only two variables demonstrate statistically significant effects on SBP at the 5% significance level. Economic Budget (Eco_Budg) has a positive and significant effect on SBP ($\beta = 0.263$, $p = 0.006$), indicating that higher economic budget allocation is associated with an increase in SBP. Similarly, Organisational Commitment (OC) also shows a significant positive effect on SBP ($\beta = 0.201$, $p = 0.012$), suggesting that stronger organizational commitment contributes to higher SBP levels.

Table 6
Validity and reliability test results

Variable	Indicator	Std Loading	Construct Reliability	Variance Extracted
SMCS	SMCS1	0.790	0.920	0.660
	SMCS2	0.728		
	SMCS3	0.857		
	SMCS4	0.890		
	SMCS5	0.893		
	SMCS6	0.693		
SMAS	SMAS.1	0.761	0.938	0.751
	SMAS.2	0.873		
	SMAS.3	0.906		
	SMAS.4	0.920		
	SMAS.5	0.864		
SBP	SBP.1	0.781	0.887	0.723
	SBP.2	0.895		
	SBP.3	0.871		
SA	SA.1	0.905	0.941	0.841
	SA.2	0.950		
	SA.3	0.895		
OC	OC1	0.864	0.839	0.636
	OC2	0.826		
	OC3	0.693		
OL	OL1	0.882	0.912	0.776
	OL2	0.836		
	OL3	0.922		

Source: Developed by the authors.

The Diagnostic Control (Diag_Control) variable exhibits a marginal effect on SBP ($\beta = 0.164$, $p = 0.067$), indicating a tendency toward significance, although it does not meet the conventional 0.05 threshold. In contrast, the remaining variables — Internal Control (Int_Control), Boundary System (Bound_Sys), Belief System (Belief_Sys), Economic Performance Measurement (Eco_PM),

Table 7
Hypothesis test results

Variable	Used in	Indicator	Estimate	S.E.	C.R.	P (1-tailed)	Results
SBP	<--	SMCS	0.296	0.136	2.179	0.015	Accepted
SBP	<--	SMAS	0.464	0.094	4.940	0.000	Accepted
SBP	<--	SA	0.268	0.085	3.161	0.001	
SBP	<--	OC	-0.016	0.107	-0.154	0.439	
SBP	<--	OL	0.025	0.062	0.402	0.344	
SBP	<--	SMCS × SA	0.000	0.001	0.746	0.228	Reject
SBP	<--	SMAS × SA	0.001	0.001	0.911	0.181	Reject

Description: SBP (Sustainable Business Performance), SA (Strategic Agility), SMCS (Sustainable Management Control Systems), SMAS (Sustainable Management Accounting System), OC (Organization Culture), OL (Organization Learning).

Source: Developed by the authors.

Note: *, **, *** significant at 10%, 5%, and 1%, respectively.

Table 8
Sensitivity test results

Influence of Variables			Model 1 (Novelty)		Model 2 (Without Novelty)	
			Estimate	P (1-tailed)	Estimate	P (1-tailed)
SBP	<--	SA	0,268	0,001***	0,251	0,002***
SBP	<--	SMCS	0,296	0,015**	0,187	0,051*
SBP	<--	SMAS	0,464	0,000***	0,536	0,000***
SBP	<--	SA×SMCS	0,000	0,228	0,001	0,123
SBP	<--	SA×SMAS	0,001	0,181	0,001	0,031*
SBP	<--	OC	-0,016	0,439	-0,033	0,381
SBP	<--	OL	0,025	0,344	0,041	0,252
R ²			0.850		0.849	

Description: SBP (Sustainable Business Performance), SA (Strategic Agility), SMCS (Sustainable Management Control Systems), SMAS (Sustainable Management Accounting System), OC (Organization Culture), OL (Organization Learning).

Source: Developed by the authors.

Note: *, **, *** significant at 10%, 5%, and 1%, respectively.

and Organizational Learning (OL) — do not show statistically significant effects, as their p-values exceed 0.05. This indicates that, within this model, these variables do not significantly predict SBP.

Based on the breakdown of the dimensions of the sustainable management control system variables, the test results indicate that diagnostic control has a positive impact on sustainable business performance, followed by the Eco Budgeting dimension, which is a notable novelty in this study. With a determination coefficient value of 69.3%, this shows a strong influence.

5. Discussion

5.1. The influence of sustainable management control systems on sustainable business performance

The results of this study empirically show that the sustainable management control system (SMCS) has a positive effect on sustainable business performance (SBP). This finding provides evidence that the implementation of a management control system that integrates sustainability principles plays a crucial role in driving sustainable business performance. Integrating

Table 9
Expansion test results

Variable	Used in	Indicator	Estimate	S.E.	C.R.	P	Results
SBP	<--	Diag_Control	0.164	0.109	1.503	0.067	Accepted
SBP	<--	Int_Control	-0.095	0.18	-0.528	0.299	Reject
SBP	<--	Bound_Sys	-0.127	0.309	-0.412	0.340	Reject
SBP	<--	Belief_Sys	0.336	0.335	1.002	0.158	Reject
SBP	<--	Eco_PM	0.234	0.259	0.900	0.184	Reject
SBP	<--	Eco_Budg	0.263	0.105	2.507	0.006	Accepted
SBP	<--	OC	0.201	0.089	2.251	0.012	
SBP	<--	OL	0.069	0.065	1.067	0.143	
		R ²	0.693				

Source: Developed by the authors.

sustainability dimensions into the management control system, especially through belief systems and interactive controls, can increase an organisation's effectiveness in responding to sustainability issues. They highlight that an interactive control system approach can encourage higher managerial involvement and create alignment between strategic and operational objectives. Likewise, found that SMCS, which aligns with sustainability values, contributes positively to company performance, including the reduction of manipulative practices such as real earnings management. In the context of the manufacturing sector, it also demonstrated that management control that emphasises non-financial aspects and sustainability dynamics can significantly enhance process efficiency and reduce environmental impacts [46, 47].

Theoretically, these results align with the management control systems (MCS) framework proposed by Florencio et al., where SMCS functions not only as a monitoring tool but also as a strategic instrument that influences organisational behaviour to align with long-term goals, including sustainability. [21] further emphasised that the use of interactive control systems through open communication, organisational learning, and innovation is a crucial element in the context of a complex and dynamic business environment, such as sustainability [48]. From the Resource-Based View (RBV) perspective [49], SMCS can be viewed as a strategic resource that has the characteristics of being valuable,

rare, inimitable, and non-substitutable. When implemented effectively and integrated into a company's sustainability strategy, SMCS can become a competitive advantage that is difficult for competitors to imitate. These findings indicate that integrating sustainability values into the control system plays a crucial role in reconciling control structures with sustainable business performance outcomes. That also distinguishes the results of this study from those of [50], which show that SMCS has no significant impact on performance unless it is accompanied by the integration of sustainability culture into business processes.

From the perspective of contingency theory, the effectiveness of a control system is highly dependent on the suitability of the system's characteristics in the internal and external context of the organisation. In this study, the effectiveness of SMCS is reflected in its ability to align with the company's organisational structure, strategy, and values. Research supports this finding, emphasising that the success of implementing a sustainability control system is highly dependent on top management involvement, organisational cultural support, and cross-functional participation in decision-making processes.

However, it is important to note that, in this model, organisational culture and organisational learning, which are hypothesised as control variables, do not show a significant influence on strengthening the relationship between SMCS and SBP. It can be explained by the findings of

[51], which show that limitations in the culture of knowledge-seeking and cross-functional participation can hinder the organisational learning process, thereby weakening the effectiveness of the control system. In addition, a study also shows that the role of organisational culture as a moderator of the influence of management accounting systems and sustainability strategies on performance is not always significant, depending on the depth of sustainability values internalised within the organisation. Thus, this finding implies that the success of SMCS in driving sustainable performance is not only determined by the existence of organisational culture and learning mechanisms alone but is also highly dependent on how the system is strategically integrated and supported by managerial commitment and relevant institutional incentives to drive the achievement of sustainable business performance significantly.

5.2. The influence of sustainable management accounting systems on sustainable business performance

Sustainable management accounting system (SMAS) is a management accounting system that integrates sustainability aspects into business planning, control, and decision-making. Sustainable management accounting system not only focuses on traditional financial reports but also includes environmental and social performance reporting to support sustainable business practices. The results of the hypothesis test show that the SMAS has a positive effect on sustainable business performance (SBP). The implementation of sustainable management accounting can enhance relationships with stakeholders, including investors, consumers, and other relevant parties, by providing more transparent information about the company's environmental and social impact. The application of sustainability principles in management accounting can also help companies identify cost-saving opportunities through more efficient resource utilisation, reduced waste, and increased productivity, which in turn can improve their sustainability performance [52]. With a more integrated accounting system, companies can optimize their long-term performance and reduce the risks associated with non-compliance with environmental and social regulations.

However, the results of this study contradict those of [53], which showed that the effect of SMAS on SBP is not always significant, especially in industries that do not prioritise sustainability or where the integration of sustainability into the accounting system is still limited. That could be due to differences in the level of implementation of sustainability in various industrial sectors or the obstacles companies face in adapting their accounting systems to sustainability principles [54].

A sustainable management accounting system provides more complete information about the environmental and social impacts of business activities. This transparency fosters greater trust among investors, consumers, and other stakeholders. With better monitoring of resource use, companies can reduce waste and operational costs. For example, the implementation of environmental accounting enables companies to identify more effective ways to conserve energy and raw materials.

A sustainable management accounting system helps companies meet increasingly stringent sustainability standards and regulations. This compliance reduces the risk of fines and legal sanctions and increases the company's competitiveness. The data generated by the sustainable management accounting system helps management make more informed decisions in managing environmental and social risks. Companies can develop long-term business strategies that are more sustainable and oriented towards shared value.

Companies that implement Sustainable management accounting systems are more trusted by consumers and business partners. A good reputation in sustainability can differentiate in the market and increase customer loyalty. By managing environmental and social risks more effectively, companies can avoid unexpected costs that arise from environmental disasters or social conflicts. Investment in sustainability can increase profitability in the long term through efficiency and innovation. Overall, the results of this study support the idea that sustainable management accounting systems play a crucial role in driving companies toward sustainable business performance. By providing more transparent information on environmental and social impacts, as well as

helping companies comply with regulations and plan sustainable long-term strategies, SMAS serves as a strategic tool to achieve sustainable business performance. The implementation of a more sustainability-based accounting system will provide greater added value for companies, both in terms of reputation, operational efficiency, and competitiveness in a market that increasingly demands concern for sustainability.

5.3. Strategic agility moderates the effect of a sustainable management control system on sustainable business performance

Strategic agility refers to a company's ability to adapt quickly to changes in the business environment, including sustainability-related challenges and opportunities. The dynamic capabilities theory, introduced by [55], stated that dynamic capabilities enable companies to adapt, innovate, and respond effectively to changes in the external environment. In this context, strategic agility is a form of dynamic capability that enables companies to quickly identify and respond to changes in markets, technology, and regulations related to sustainability. The results of the study indicate that strategic agility cannot strengthen the influence of the sustainable management control system (SMCS) on sustainable business performance (SBP) by increasing flexibility, innovation, and responsiveness in implementing sustainability strategies. This moderation is a predictor moderation where strategic agility has a positive effect on sustainable business performance but not on the sustainable management control system. This finding is not in line with the research of [56], which indicate that strategic agility can enhance sustainability-oriented management control systems by increasing responsiveness to external changes. Companies with strategic agility can adapt SMCS policies and systems more quickly in response to regulatory changes or technological developments relevant to sustainability. This speed in adapting enables companies to be more responsive to challenges and opportunities related to sustainability issues, which in turn improves sustainable business performance (SBP).

Strategic agility does not always strengthen the relationship between SMCS and SBP. Strategic agility does not have a significant effect on the implementation of sustainability management control systems, perhaps due to structural barriers or organizational culture that does not support sustainability. In addition, [57] notes that the effect of strategic agility on SMCS can be limited, depending on the stage of sustainability adoption within the company, especially in more traditional industries and those less involved in sustainability practices.

Resource-based view theory (RBV) emphasises the importance of unique internal resources and capabilities in creating a sustainable competitive advantage. In this case, strategic agility cannot yet be viewed as a capability that enables companies to utilise and integrate SMCS more effectively, thereby creating long-term value in the context of sustainability.

5.4. Strategic agility moderates the effect of a sustainable management accounting system on sustainable business performance

Hypothesis testing on the role of strategic agility (SA) in strengthening the relationship between the sustainable management accounting system (SMAS) and sustainable business performance (SBP) reveals that SA moderation does not enhance the relationship between SMAS and SBP. This finding indicates that although strategic agility has a positive effect on SBP, there is no significant strengthening of the influence of SMAS on SBP. In other words, although Strategic Agility can contribute to rapid adaptation to external changes, it does not strengthen the performance of SMAS in achieving sustainable business performance. This moderation is a predictor moderation because strategic agility has a positive effect on sustainable business performance but does not have a positive effect on sustainable management accounting systems.

Dynamic capabilities theory explains that companies need to have the ability to develop new skills and rearrange existing skills [58]. In relation to the results of this study, the company does not yet possess new skills and needs

to effectively reconfigure existing ones. Strategic agility requires companies to adjust their strategies quickly in response to changes in the business environment. Sustainable management accounting systems, on the other hand, focus on accurate and consistent sustainability recording and reporting, which often require strict procedures. Suppose a company is too flexible in changing its strategy. In that case, the quality and accuracy of the sustainability data collected by the sustainable management accounting system can be compromised, reducing its effectiveness in increasing sustainable business performance (SBP).

The sustainable management accounting system operates by collecting and analyzing environmental, social, and economic data to inform long-term strategic decisions. If a company frequently changes strategy due to agility factors, the accounting system may not have enough time to adapt, resulting in mismatches in recording and reporting [59, 60]. That can cause sustainability information to become less relevant or even inaccurate, reducing its impact on sustainable business performance.

The sustainable management accounting system aims to help companies achieve their long-term sustainability goals, such as reducing carbon emissions or improving resource efficiency. In contrast, strategic agility encourages faster changes in business operations and strategies to adapt to market trends. Focusing on short-term changes can hinder the achievement of long-term sustainability goals, as measured by the sustainable management accounting system. Consequently, strategic agility does not strengthen the relationship between the sustainable management accounting system and sustainable business performance.

A sustainable management accounting system requires stability in measurement and reporting, allowing sustainability data to be compared over time [61]. Suppose a company constantly changes its sustainability strategies and priorities due to strategic agility. In that case, the metrics used in the sustainable management accounting system may not remain consistent, making it difficult to assess their impact on sustainable business performance (SBP).

Strategic agility encourages rapid decisions based on market and technology changes. How-

ever, a sustainable management accounting system requires a more systematic process for collecting and analysing sustainability data before decisions are made. This imbalance can cause information from the Sustainable management accounting system not to be utilised optimally in decision-making, thereby weakening the impact of strategic agility on SBP. Although strategic agility provides a competitive advantage in terms of rapid response to change, SMAS requires a more stable system to produce reliable and consistent information related to sustainability impacts. Therefore, in the context of this study, strategic agility failed to strengthen the relationship between SMAS and SBP due to a mismatch in time focus and strategy between the two, resulting in an inability to optimally utilize sustainability information generated by SMAS in improving sustainable business performance.

6. Conclusions

The results of the study indicate that the sustainable management control system (SMCS) has a positive effect on sustainable business performance (SBP), the sustainable management accounting system has a positive effect on sustainable business performance, strategic agility does not moderate the effect of the sustainable management control system on sustainable business performance, and strategic agility does not moderate the effect of the sustainable management accounting system on sustainable business performance.

6.1. Implication

This study provides an important contribution to the development of the theory and practice of sustainability-based management control systems. Theoretically, this study confirms that conventional management control systems are no longer adequate to support the achievement of sustainable business performance. Only approaches that contain elements of novelty — such as the integration of eco-budgeting — have been proven to have a positive impact on corporate sustainability performance. That highlights the importance of developing both contextual and strategic sustainability dimensions. From a managerial perspective, these findings emphasise the need for transforma-

tion of control systems to be more adaptive and proactive in responding to sustainability challenges. The application of eco-budgeting as a strategic tool in resource allocation has been demonstrated to enhance the quality of long-term decisions and reinforce sustainability commitments.

On the other hand, these results also provide a strong basis for regulators to encourage companies to adopt sustainability measurement systems through incentive policies and budgeting obligations for environmentally friendly activities. Practically, companies are expected to adopt innovations in their internal control systems, particularly by explicitly incorporating environmental and social indicators into planning, reporting, and performance evaluation. This comprehensive integration will ensure that sustainability strategies align with the company's primary business strategy.

6.2. Limitations

This study focuses on companies listed on the Indonesia Stock Exchange (IDX), excluding those in the financial sector. Therefore, the generalisation of the findings is only relevant to the context of public companies in the non-financial sector in Indonesia. This scope implies that the study's results cannot be generalised to companies not listed on the IDX, such as private companies or other business entities with

different characteristics and organisational structures.

Another limitation lies in the research instrument, particularly in the questionnaire, which does not include items to identify the implementation of international sustainability management standards, such as ISO 14001 (environmental management) and ISO 50001 (energy management). The novelty aspect in the sustainable management control system variable has a close conceptual relationship with the adoption and implementation of these standards. The absence of this information limits the scope of the analysis, resulting in a less optimal understanding of the context for implementing sustainability innovation within each company. Additionally, this has implications for reducing the interpretative power in explaining the relationship between the novelty dimension and sustainable business performance.

Future research should expand the study by incorporating the stakeholder-governed environmental control dimension, which emphasizes the role of external stakeholders, including regulators, non-governmental organizations (NGOs), ESG-based investors, and local communities, in a company's management control system. Given the increasing external pressure on sustainable business practices, it is imperative to consider how external sustainability expectations and standards can be integrated into SMCS.

REFERENCES

1. Velte P. Environmental performance, carbon performance and earnings management: Empirical evidence for the European capital market. *Corporate Social Responsibility and Environmental Management*. 2021;28(1):42-53. URL: <https://doi.org/10.1002/csr.2030>
2. Abdul Aris N., Madah Marzuki M., Othman R., Abdul Rahman S., Hj Ismail N. Designing indicators for cooperative sustainability: The Malaysian perspective. *Social Responsibility Journal*. 2018;14(1):226-248. URL: <https://doi.org/10.1108/SRJ-01-2017-0015>
3. Park S., Song S., Lee S. Corporate social responsibility and systematic risk of restaurant firms: The moderating role of geographical diversification. *Tourism Management*. 2017;59:610-620. URL: <https://doi.org/10.1016/j.tourman.2016.09.016>
4. Perotto E., Canziani R., Marchesi R., Butelli P. Environmental performance, indicators and measurement uncertainty in EMS context: A case study. *Journal of Cleaner Production*. 2008;16(4):517-530. URL: <https://doi.org/10.1016/j.jclepro.2007.01.004>
5. Tam V.W.Y., Tam C.M., Zeng S.X., Chan K.K. Environmental performance measurement indicators in construction. *Building and Environment*. 2006;41(2):164-173. URL: <https://doi.org/10.1016/j.buildenv.2005.01.009>
6. De Burgos-Jiménez J., Cano-Guillén C.J., Céspedes-Lorente J.J. Planning and control of environmental performance in hotels. *Journal of Sustainable Tourism*. 2002;10(3):207-221. URL: <https://doi.org/10.1080/09669580208667163>

7. Jung E. J., Kim J. S., Rhee S. K. The measurement of corporate environmental performance and its application to the analysis of efficiency in oil industry. *Journal of Cleaner Production*. 2001;9(6):551-563. URL: [https://doi.org/10.1016/S0959-6526\(01\)00011-7](https://doi.org/10.1016/S0959-6526(01)00011-7)
8. Rehman S. U., Bhatti A., Kraus S., Ferreira J. J. M. The role of environmental management control systems for ecological sustainability and sustainable performance. *Management Decision*. 2021;59(9):2217-2237. URL: <https://doi.org/10.1108/MD-06-2020-0800>
9. Herremans I. M., Nazari J. A. Sustainability reporting driving forces and management control systems. *Journal of Management Accounting Research*. 2016;28(2):103-124. URL: <https://doi.org/10.2308/jmar-51470>
10. Laguir L., Laguir I., Tchemeni E. Implementing CSR activities through management control systems: A formal and informal control perspective. *Accounting, Auditing and Accountability Journal*. 2019;32(2):531-555. URL: <https://doi.org/10.1108/AAAJ-05-2016-2566>
11. Chin T. A., Tat H. H., Sulaiman Z. Green supply chain management, environmental collaboration and sustainability performance. *Procedia CIRP*. 2015;26:695-699. URL: <https://doi.org/10.1016/j.procir.2014.07.035>
12. Dharmayanti N., Ismail T., Hanifah I. A., Taqi M. Exploring sustainability management control system and eco-innovation matter sustainable financial performance: The role of supply chain management and digital adaptability in Indonesian context. *Journal of Open Innovation: Technology, Market, and Complexity*. 2023;9(3):100119. URL: <https://doi.org/10.1016/j.joitmc.2023.100119>
13. Petera P., Wagner J., Pakšiová R. The influence of environmental strategy, environmental reporting and environmental management control system on environmental and economic performance. *Energies*. 2021;14(15):4637. URL: <https://doi.org/10.3390/en14154637>
14. Gunarathne A. D. N., Alahakoon Y. Environmental management accounting practices and their diffusion: The Sri Lankan experience. *NSBM Journal of Management*. 2016;2(1):1-26. URL: <https://doi.org/10.4038/nsbmjm.v2i1.18>
15. Gunarathne N., Lee K. H. Environmental management accounting (EMA) for environmental management and organizational change: An eco-control approach. *Journal of Accounting and Organizational Change*. 2015;11(3):362-383. URL: <https://doi.org/10.1108/JAOC-10-2013-0078>
16. Zyznarska-Dworczak B. The development perspectives of sustainable management accounting in Central and Eastern European countries. *Sustainability*. 2018;10(5):1445. URL: <https://doi.org/10.3390/su10051445>
17. Fuzi N. M., Adam S., Ramdan M. R., Ong S. Y. Y., Osman J., Kolandan S. Sustainability management accounting and organizational performance: The mediating role of environmental management system. *Sustainability*. 2022;14(21):14290. URL: <https://doi.org/10.3390/su142114290>
18. Lill P. A., Wald A. The agility-control-nexus: A levers of control approach on the consequences of agility in innovation projects. *Technovation*. 2021;107:102276. URL: <https://doi.org/10.1016/j.technovation.2021.102276>
19. Oyadomari J. C., Chen Y. T., Dutra-de-Lima R. G., Mendonça O. R. Exploring the influences of cybernetic and dynamic controls on flexibility and performance. *Brazilian Administration Review*. 2023;20(3): e220170. URL: <https://doi.org/10.1590/1807-7692bar2023220170>
20. Lee S., Lee D., Kim S., Lee G. The role of agility in the relationship between use of management control systems and organizational performance: Evidence from Korea and Japan. *Journal of Applied Business Research*. 2017;33(3). URL: <https://journals.klalliance.org/index.php/JABR/article/view/405>
21. Henri J. F., Journeault M. Eco-control: The influence of management control systems on environmental and economic performance. *Accounting, Organizations and Society*. 2010;35(1):63-80. URL: <https://doi.org/10.1016/j.aos.2009.02.001>
22. Laguir I., Stekelorum R., Beysül A., Mouadili O., Segbotangni E. A. Eco-control systems and firm performance: Understanding the mediating role of circular economy practices and the moderating role of environmental uncertainty. *Journal of Cleaner Production*. 2024;450:141894. URL: <https://doi.org/10.1016/j.jclepro.2024.141894>
23. Luthans F., Stewart T. I. A general contingency theory of management. *Academy of Management Review*. 1977;2(2):181-195. URL: <https://doi.org/10.2307/257902>
24. Otley D. T. The contingency theory of management accounting: Achievement and prognosis. *Readings in Accounting for Management Control*. 1980:83-106. URL: https://doi.org/10.1007/978-1-4899-7138-8_5

25. Islam J., Hu H. A review of literature on contingency theory in managerial accounting. *African Journal of Business Management*. 2012;6(15):5159-5164. URL: <https://doi.org/10.5897/AJBM11.2764>
26. Elkington J. Partnerships from cannibals with forks: The triple bottom line of 21st-century business. *Environmental Quality Management*. 1998;8(1):37-51. URL: <https://doi.org/10.1002/tqem.3310080106>
27. Gupta S., Meissonier R., Drave V.A., Roubaud D. Examining the impact of Cloud ERP on sustainable performance: A dynamic capability view. *International Journal of Information Management*. 2020;51:102028. URL: <https://doi.org/10.1016/j.ijinfomgt.2019.10.013>
28. Arjaliès D.L., Mundy J. The use of management control systems to manage CSR strategy: A levers of control perspective. *Management Accounting Research*. 2013;24(4):284-300. URL: <https://doi.org/10.1016/j.mar.2013.06.003>
29. Wijethilake C. Proactive sustainability strategy and corporate sustainability performance: The mediating effect of sustainability control systems. *Journal of Environmental Management*. 2017;196:569-582. URL: <https://doi.org/10.1016/j.jenvman.2017.03.057>
30. Mat Yusoh N.N.A., Tuan Mat T.Z., Abdullah A. Environmental management accounting system adoption and sustainability performance: Triple bottom line approach. *Management Accounting Review*. 2023;22(1):233-267. URL: <https://doi.org/10.24191/MAR.V22i01-10>
31. Khan H. Is marketing agility important for emerging market firms in advanced markets? *International Business Review*. 2020;29(5):101733. URL: <https://doi.org/10.1016/j.ibusrev.2020.101733>
32. Roth A.V. Achieving strategic agility through economies of knowledge. *Planning Review*. 1996;24(2):30-36. URL: <https://doi.org/10.1108/eb054550>
33. Correia R.J., Dias J.G., Teixeira M.S. Dynamic capabilities and competitive advantages as mediator variables between market orientation and business performance. *Journal of Strategy and Management*. 2021;14(2):187-206. URL: <https://doi.org/10.1108/JSMA-12-2019-0223>
34. Tufan C., Mert I.S. The sequential effect of absorptive capacity, strategic agility, and sustainable competitive advantage on sustainable business performance of SMEs. *Environmental Science and Pollution Research*. 2023;30(19):55958-55973. URL: <https://doi.org/10.1007/s11356-023-26207-x>
35. Ruiz-Palomo D., Diéguez-Soto J., Duréndez A., Santos J.A.C. Family management and firm performance in family SMEs: The mediating roles of management control systems and technological innovation. *Sustainability*. 2019;11(14):3805. URL: <https://doi.org/10.3390/su11143805>
36. Fuadah L.L., Kalsum U., Arisman A. Determinants factor influence environmental management accounting and corporate environmental performance: Evidence in Indonesia. *Journal of Southwest Jiaotong University*. 2021;56(3):582-601. URL: <https://doi.org/10.35741/issn.0258-2724.56.3.49>
37. Saputra K.A.K., Subroto B., Rahman A.F., Saraswati E. Mediation role of environmental management accounting on the effect of green competitive advantage on sustainable performance. *Journal of Sustainability Science and Management*. 2023;18(2):103-115. URL: <https://doi.org/10.46754/jssm.2023.02.008>
38. Somjai S., Fongtanakit R., Laosillapacharoen K. Impact of environmental commitment, environmental management accounting and green innovation on firm performance: An empirical investigation. *International Journal of Energy Economics and Policy*. 2020;10(3):204-210. URL: <https://doi.org/10.32479/ijeep.9174>
39. Sari R.N., Pratadina A., Anugerah R., Kamaliah K., Sanusi Z.M. Effect of environmental management accounting practices on organizational performance: Role of process innovation as a mediating variable. *Business Process Management Journal*. 2021;27(4):1296-1314. URL: <https://doi.org/10.1108/BPMJ-06-2020-0264>
40. Osma B.G., Gómez-Conde J., López-Valeiras E. Management control systems and real earnings management: Effects on firm performance. *Management Accounting Research*. 2022;55:100781. URL: <https://doi.org/10.1016/j.mar.2021.100781>
41. Hair J.F., Black W.C., Babin B.J., Anderson R.E., Tatham R.L. Multivariate data analysis. *Cengage Learning*. 2019.
42. Sugiarto I. Metodologi penelitian bisnis. *Penerbit Andi*. 2022. URL: https://books.google.ru/books?hl=en&lr=&id=qTpcEAAAQBAJ&oi=fnd&pg=PP1&dq=Sugiarto+I.+Metodologi+penelitian+bisnis.+Penerbit+Andi.+2022.&ots=YNIn8wbWWL&sig=jlho4uCPjsO_zXflBzWViWmvefU&redir_esc=y#v=onepage&q=Sugiarto%20I.%20Metodologi%20penelitian%20bisnis.%20Penerbit%20Andi.%202022.&f=false

43. Battour M., Barahma M., Al-Awlaqi M. The relationship between HRM strategies and sustainable competitive advantage: Testing the mediating role of strategic agility. *Sustainability*. 2021;13(9):5315. URL: <https://doi.org/10.3390/su13095315>
44. Mousa S.K., Othman M. The impact of green human resource management practices on sustainable performance in healthcare organisations: A conceptual framework. *Journal of Cleaner Production*. 2020;243:118595. URL: <https://doi.org/10.1016/j.jclepro.2019.118595>
45. Jassem S., Azmi A., Zakaria Z. Impact of sustainability balanced scorecard types on environmental investment decision-making. *Sustainability*. 2018;10(2):541. URL: <https://doi.org/10.3390/su10020541>
46. Chandra T., Renaldo N., Chandra S., Ng M. Blue management accounting: Water footprint, cost, efficiency, and internal control at WKP Corporation headquarters. *Journal of Environmental Accounting and Management*. 2024;12(2):185-200. URL: <https://doi.org/10.5890/JEAM.2024.06.006>
47. Henri J.F. Management control systems and strategy: A resource-based perspective. *Accounting, Organizations and Society*. 2006;31(6):529-558. URL: <https://doi.org/10.1016/j.aos.2005.07.001>
48. Zulkifli Z., Purwati A.A., Renaldo N., Hamzah Z., Hamzah M.L. Employee performance of Sharia Bank in Indonesia: The mediation of organizational innovation and knowledge sharing. *Cogent Business and Management*. 2023;10(3):2273609. URL: <https://doi.org/10.1080/23311975.2023.2273609>
49. Barney J. Firm resources and sustained competitive advantage. *Journal of Management*. 1991;17(1):99-120. URL: <https://doi.org/10.1177/014920639101700108>
50. Asiaei K., Bontis N., Barani O., Jusoh R. Corporate social responsibility and sustainability performance measurement systems: Implications for organizational performance. *Journal of Management Control*. 2021;32(1):85-126. URL: <https://doi.org/10.1007/s00187-021-00317-4>
51. Shurafa R., Mohamed R. Management control system under the pressure of strategic uncertainty: The case of the Arab World. *Australian Journal of Basic and Applied Sciences*. 2016;10(7):130-134.
52. Burns J, Vaivio J. Management accounting change. *Management Accounting Research*. 2001;12(4):389-402. URL: <https://doi.org/10.1006/mare.2001.0178>
53. Putri H., Handajani L., Lenap I.P. Pengaruh green accounting, environmental performance, dan material flow cost accounting (MFCA) terhadap sustainable development. *Performance: Jurnal Bisnis dan Akuntansi*. 2024;14(1):317-329. URL: <https://doi.org/10.24929/feb.v14i1.2873>
54. Porter M.E., Kramer M.R. Creating shared value: How to reinvent capitalism — and unleash a wave of innovation and growth. In: *Managing Sustainable Business*. Springer. 2018:323-346. URL: https://doi.org/10.1007/978-94-024-1144-7_16
55. Teece D.J., Pisano G., Shuen A. Dynamic capabilities and strategic management. *Strategic Management Journal*. 1997;18(7):509-533. URL: [https://doi.org/10.1002/\(SICI\)1097-0266\(199708\)18:7<509::AID-SMJ882>3.0.CO;2-Z](https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z)
56. Alamsjah F., Asrol M. The impacts of middle managers' ambidexterity, continuous improvement, and organizational agility on business performance: A knowledge-based view. *Journal of Industrial Engineering and Management*. 2023;16(1):27-53. URL: <https://doi.org/10.3926/jiem.4610>
57. Alkandi I., Helmi M.A. The impact of strategic agility on organizational performance: The mediating role of market orientation and innovation capabilities in emerging industrial sector. *Cogent Business & Management*. 2024;11(1):2396528. URL: <https://doi.org/10.1080/23311975.2024.2396528>
58. Jin X., Yang D., Rhee M. How do dynamic capabilities enable a firm to convert external pressures into environmental innovation? A process-based study using structural equation modeling. *Systems*. 2024;12(12):561. URL: <https://doi.org/10.3390/systems12120561>
59. Deliu D., Olariu A. The role of artificial intelligence and big data analytics in shaping the future of professions in Industry 6.0: Perspectives from an emerging market. *Electronics*. 2024;13(24):4983. URL: <https://doi.org/10.3390/electronics13244983>
60. Baldivia M., Chowdhury S. Adapting business models in the age of omnichannel transformation: Evidence from small retail businesses in Australia. *Journal of Theoretical and Applied Electronic Commerce Research*. 2024;20(1):1. URL: <https://doi.org/10.3390/jtaer20010001>
61. Sitompul H., Saifi M., Hutahayan B., Sunarti. Use of renewable energy to enhance firm performance: A systematic review. *Sustainability*. 2024;16(21):9157. URL: <https://doi.org/10.3390/su16219157>

ABOUT THE AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

Efendi Susana — PhD Candidate in Accounting and Management, Lecturer, Faculty of Economics and Business, Trisakti University, Jakarta, Indonesia

Эфенди Сусана — аспирант в области бухгалтерского учета и менеджмента, преподаватель, факультет экономики и бизнеса, Университет Трисакти, Джакарта, Индонезия
<https://orcid.org/0009-0006-5336-1581>
efendisusanaefn@gmail.com

Etty Murwaningsari — PhD in Accounting and Management, Professor, Faculty of Economics and Business, Trisakti University, Jakarta, Indonesia

Этти Мурванингсари — PhD в области бухгалтерского учета и менеджмента, профессор, факультет экономики и бизнеса, Университет Трисакти, Джакарта, Индонезия
<https://orcid.org/0009-0005-8393-9623>
Corresponding Author / Автор для корреспонденции:
ettymurwaningsarisa@gmail.com

Yvonne Augustine Sudibyo — PhD in Accounting and Management, Lecturer, Faculty of Economics and Business, Trisakti University, Jakarta, Indonesia

Ивонн Августин Судибйо — PhD в области бухгалтерского учета и менеджмента, преподаватель, факультет экономики и бизнеса, Университет Трисакти, Джакарта, Индонезия
<https://orcid.org/0009-0007-4776-375X>
yvonneaugustinesudi13@gmail.com

Sekar Mayangsari — PhD in Accounting and Management, Lecturer, Faculty of Economics and Business, Trisakti University, Jakarta, Indonesia

Секар Майангсари — PhD в области бухгалтерского учета и менеджмента, преподаватель, факультет экономики и бизнеса, Университет Трисакти, Джакарта, Индонезия
<https://orcid.org/0000-0002-0787-5323>
sekarmayangsarisa3@gmail.com

Authors' declared contribution:

E. Susana — critical analysis of literature, methodology, results presentation in the form of tables, and data analysis.

E. Murwaningsari — introduction and findings.

Y.A. Sudibyo — survey and data interpretation.

S. Mayangsari — data validation and manuscript refinement.

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The article was submitted on 01.08.2025; revised on 26.02.2026 and accepted for publication on 05.03.2026.

The authors read and approved the final version of the manuscript.

DOI: 10.26794/2308-944X-2026-14-1-75-90
UDC 338.24:334.012.2:004.94(045)
JEL L26, Q01, R11

Determinants Affecting the Sustainable Development of Small and Medium-Sized Enterprises in a Developing Economy: A Cognitive Modeling Case Study of Cameroon

E.A. Fomina¹, Yu.V. Khodkovskaya²

¹ Financial University under the Government of the Russian Federation, Moscow, Russian Federation;

² Ufa State Petroleum Technological University, Ufa, Russian Federation

ABSTRACT

The recent revolutionary shifts in the global economy have generated new prospects for the growth and development of national economies through technological innovation while also exacerbating issues of macroeconomic instability, social inequality, and poverty. At present, small and medium-sized enterprises (SMEs) have catalyzed the advancement of the majority of national economies. **The subject** of the study is the conditions and determinants affecting the sustainable development of SMEs in Cameroon. **The purpose** of this research is to identify the key factors of development and suggest a comprehensive model of the sustainable development of the SME sector in Cameroon, taking into account the structural features of the national economy. **The relevance** is determined by modern trends of globalization and technological innovations affecting national economies, especially developing countries such as Cameroon, along with its vital economic and social problems. **The scientific novelty** involves developing a cognitive model that examines the cross-impact of factors influencing the development of SMEs, based on the theory of fuzzy sets, and substantiating practical mechanisms to enhance the effectiveness of government policies supporting SMEs. The authors used **methods** of systems approach, expert assessment method, fuzzy set theory, cognitive modeling, comparative analysis, and statistical methods of data verification. **The authors concluded** that there is structural dualism in Cameroon's economy in the disproportion between the high-tech financial sector and archaic forms of entrepreneurship. A fuzzy cognitive map has been developed, indicating seven important influential factors with maximum centrality, including the level of production infrastructure development and the success of anti-corruption strategy, among others. The necessity for a program-targeted strategy has been substantiated, focusing on the establishment of a sustainable investment climate, the development of public-private partnerships, and the enhancement of the financial culture within the business environment. The existence of systemic contradictions has been proven, namely regarding the exclusion of SMEs from investment growth in infrastructure.

Keywords: small and medium-sized enterprises; SME; Republic of Cameroon; factor analysis; fuzzy set theory; cognitive modeling; government economic policy

For citation: Fomina E.A., Khodkovskaya Yu.V. Determinants affecting the sustainable development of small and medium-sized enterprises in a developing economy: A cognitive modeling case study of Cameroon. *Review of Business and Economics Studies*. 2026;14(1):75-90. DOI: 10.26794/2308-944X-2026-14-1-75-90

Факторы, влияющие на устойчивое развитие малых и средних предприятий в развивающейся экономике: когнитивное моделирование на примере Камеруна

Е.А. Фомина¹, Ю.В. Ходковская²

¹ Уфимский филиал Финансового университета при Правительстве Российской Федерации, Уфа, Российская Федерация;

² Уфимский государственный нефтяной технический университет, Уфа, Российская Федерация

АННОТАЦИЯ

Революционные преобразования мировой экономики последних лет открыли новые перспективы для роста и развития национальных экономик благодаря технологическим инновациям, одновременно усугубив проблемы макроэкономической нестабильности, социального неравенства и бедности. В настоящее время малые и средние предприятия (МСП) являются катализатором развития большинства национальных экономик. **Предметом** исследования являются условия и факторы, влияющие на устойчивое развитие МСП в Республике Камерун. **Цель** данного исследования – выявить ключевые факторы развития и предложить комплексную модель устойчивого развития сектора МСП в Камеруне, учитывающую структурные особенности национальной экономики. **Актуальность** определяется современными тенденциями глобализации и технологическими инновациями, влияющими на национальные экономики, особенно развивающиеся страны, такие как Камерун, где наблюдаются серьезные экономические и социальные проблемы. **Научная новизна** состоит в разработке когнитивной модели взаимовлияния факторов развития МСП, основанной на теории нечетких множеств, а также предложенных практических механизмах улучшения государственной политики поддержки малых предприятий. Авторы использовали **метод** системного подхода, метод экспертной оценки, теорию нечетких множеств, когнитивное моделирование, сравнительный анализ и статистические методы верификации данных. Авторы пришли к **выводу** о наличии структурного дуализма в экономике Камеруна, проявляющегося в диспропорции между высокотехнологичным финансовым сектором и архаичными формами предпринимательства. Была разработана нечеткая когнитивная карта, указывающая на семь важных факторов влияния с максимальной центральностью, включая уровень развития производственной инфраструктуры и эффективность антикоррупционной стратегии. Обоснована необходимость программно ориентированной стратегии, направленной на создание устойчивого инвестиционного климата, развитие государственно-частного партнерства и повышение финансовой культуры в деловой среде. Доказано наличие системных противоречий, в частности, в отношении исключения МСП из инвестиционного роста в инфраструктуру.

Ключевые слова: малые и средние предприятия; МСП; Республика Камерун; факторный анализ; теория нечетких множеств; когнитивное моделирование; государственная экономическая политика

Для цитирования: Fomina E.A., Khodkovskaya Yu.V. Determinants affecting the sustainable development of small and medium-sized enterprises in a developing economy: A cognitive modeling case study of Cameroon. *Review of Business and Economics Studies*. 2026;14(1):75-90. DOI: 10.26794/2308-944X-2026-14-1-75-90

Introduction

The increased scientific interest in the small and medium-sized enterprises (SMEs) sector, both globally and specifically in Cameroon, is driven by their significant contribution to addressing key socio-economic issues, such as generating employment for the population and promoting income growth at both the regional and national levels.

Cameroon's economy has one of the most dynamic development paths among Central African

countries, demonstrating robust gross domestic product (GDP) growth rates that significantly outpace the regional average. According to the World Bank, Cameroon's average annual GDP growth rate was 3.8% in 2021, 3.74% in 2022 and 3.25% in 2023, exceeding the Central African average rates by 2.7%, 3.54%, and 2.38%, respectively.¹

¹ World Bank. Countries and Economies. URL: <https://data.worldbank.org/country> (accessed on 07.18.2024).

The structural analysis of Cameroon's economy reveals the dominance of the services sector (50.2% of GDP), where primarily large corporations operate, including transnational ones (telecommunication, finance, logistics companies), while the industry sector (mining industries) accounts for 25.5% and the agricultural sector, with the SMEs' predominance, comprises 17.3%.²

In the context of the social organization of the economy, SMEs play a system-forming role, providing employment for over 50% of the population and accounting for over 90% of the business sector.³ However, in terms of GDP and added value, the large, predominantly foreign capital, concentrated in the raw materials and financial sectors, plays a dominant role. It creates a dualistic economic model in which the SMEs with their critical social function demonstrate a limited contribution to the macroeconomic value indicators due to low productivity and concentration in low-margin activities.

This structural imbalance greatly explains the low rate of GDP per capita growth and the persistent low living standards of the population as a consequence. According to the analytical estimates, the Quality of Life Index in Cameroon over a period of 2021–2023 was recorded at 3.6 points out of 10,⁴ corresponding to 78th place in the global ranking.

Insufficient infrastructure advancement significantly restricts the development of entrepreneurship. By the end of 2023 approximately 30% of the country's population lacked access to the electricity grid, and by 2024 approximately 60% of the residents lacked reliable Internet access. These infrastructure deficiencies cause the systemic problems at all stages of the value-added creation limiting the inflow and effective use of investment resources, which is reflected in Cameroon's low ranking (123rd out of 141) in the 2024 Global Competitiveness Index.⁵

Despite Cameroon's rich natural resource base (oil, bauxite, timber, iron ore, gold, diamonds and coffee), its investment structure lacks a clear national focus. The capital from China, India and France dominates the primary industries and banking sector. Gaps in the legal regulation of entrepreneurship foster the spread of unauthorized and illegal business practices accompanied by high levels of corruption (140th place in the 2023 Transparency International Corruption Perceptions Index).⁶

The established duty rates at 10, 20, and 30% provide great opportunities for subjective decisions and corruption development, which further hinders the formation of a nationally oriented business community and the legalization of economic activity, including the SME sector.

Thus, despite the implementation of economic reforms, the adoption of Cameroon's Vision 2030, and the intensification of scientific and technical cooperation with industrialized countries, there remains an urgent need to foster conditions for enhancing the real competitiveness of small and medium-sized businesses. The purpose of this study is to identify the key factors for the SME's growth that best correspond to the current state and strategic development objectives of this sector.⁷

Literature review

The theoretical basis for studying the key trends in SME development is provided by the works of the leading economic scholars, who interpret the role and importance of SMEs in the economy in different ways. Thus, within the framework of the neoclassical paradigm, SMEs are an essential element of the competitive environment, which facilitates the efficient use of resources and is highly adaptable to market conditions [1]. The institutional school (T. Veblen, J.K. Galbraith, R. Coase, and others) emphasizes the dependence of SME development on the quality of institutions, including informal ones, the availability of infrastructure and government support tools [2]. In the countries of the European Union, for

² Economic and political overview in Cameroon. Montrouge: Groupe Credit Agricole. 2019. URL: <https://international.groupecreditagricole.com/en/international-support/cameroon/economic-overview>

³ Institut National de la Statistique du Cameroun. INS Cameroon. Yaoundé-Cameroun: Institut National de la Statistique. 2025. URL: <https://ins-cameroun.cm/en/>

⁴ USnews.com. URL: <https://www.usnews.com/> (accessed on 02.12.2025).

⁵ Global Competitiveness Index. URL: <https://gtmarket.ru/ratings/global-competitiveness-index?ysclid=m5i9pk9fj0693230570> (accessed on 15.02.2025).

⁶ To AmerunplaceVratingcorruption. URL: <https://cbonds.ru/indexes/29333/?ysclid=m5i8siuo7302607084> (accessed on 12.08.2024).

⁷ Cameroon Country Strategic Plan 2021–2030. URL: <https://www.effectivecooperation.org/content/cameroon-national-development-strategy-2020-2030> (accessed on 19.10.2024).

example, a developed infrastructure supporting SMEs (business incubators, guarantee funds) advances their growth [3].

Keynesian economists argue for the need for active government support for the SMEs through subsidies and public procurement, the fact of which is justified with the experience of small businesses in Russia under the sanctions in 2022, when the Bank of Russia's credit holiday measures⁸ helped preserve businesses and jobs [3]. Thus, scientific literature acknowledges the significant potential impact of government support measures for SMEs as a key tool for economic stabilization, particularly during times of crisis.

Complex econometric models have been employed in several studies to analyze the growth determinants of SMEs, including the classical study by Akinboade O.A. [4], which identified key factors such as access to financing, personnel qualifications, and infrastructure quality. However, this study analyzes the factors without considering their systemic interactions and synergistic effects. The implemented linear model does not reveal nonlinear relationships, which results in its methodological limitation.

The key trends of the SMEs' development in Cameroon are determined by the state economic policy, resource potential and degree of integration into the regional and global markets. SMEs are essential to Cameroon's economy, playing a key role in reducing unemployment and ensuring social stabilization [5]. The research on identifying the SMEs' growth factors [6], assessing the effectiveness of the government support⁹ [7], forecasting structural shifts in the economy,¹⁰ barriers and risks analysis, as well as identifying the growth opportunities, emphasizes the need for a systematic study of the SMEs' development trends for their effective management.¹¹

⁸ Analytical Center for the Government of the Russian Federation. Small and medium-sized businesses under sanctions.

⁹ World Bank. Cameroon Economic Update: Private Sector Growth and AfCFTA Integration. Washington, DC: World Bank Group; 2024. URL: <https://www.worldbank.org> (accessed on 02.02.2025).

¹⁰ INS Cameroon. 2024. Agro-Industrial Potential of Cameroon: 2024 Statistical Review. Yaoundé: Institut National de la Statistique. URL: <https://www.ins-cameroun.org> UNCTAD. Green Energy Adoption in African SMEs: Case Studies from Cameroon. Geneva: United Nations; 2025.

¹¹ GICAM. Digital Transformation in Cameroonian SMEs: Trends and Barriers. Douala: Groupement Interpatronal du Cameroun; 2024. URL: <https://www.gicam.org> (accessed on

The analysis of the SMEs' development trends in Cameroon allows the assessment of potential opportunities and risks in various industries and identification of patterns for predicting crises, growth, or market transformation. For example, modeling the impact of tax imposition tools on Cameroon's economic development allows us to predict¹²: 1) acceleration of the GDP growth to 4.5% on average over 2025–2027 in case of the reforms in the energy sector and government funding [7]; 2) reduction of the inflation to 3% by 2027 due to the stabilization of the budget deficit (~1% of the GDP)¹³ [8]; 3) a social effect in the form of increasing the coverage of education and health-care services in rural areas through budget funds redistribution [8].

The representatives of the evolutionary school (the innovative approach) emphasize the nonlinear nature of development and the importance of knowledge and institutions in shaping the long-term competitiveness of the SMEs as well as their role in the generation and diffusion of innovations through the network interactions [9]. The digital transformation of business and the implementation of technological innovations receive significant attention. There has been a study of the integration of digital platforms into the SMEs' supply chains: it has been proved that the use of blockchain tracking can reduce the carbon dioxide emission by 15–20% (using the example of the water footprint in agriculture monitored by Vestigia), which increases the investment attractiveness of the business.¹⁴

The digital transformation of the SMEs in Cameroon faces a number of challenges that slow down the adoption of modern technologies. The key obstacles include: insufficient digital infra-

02.02.2025); African Development Bank. FinTech Solutions for SMEs in CEMAC Region. Abidjan: AfDB; 2025.

¹² World Bank. Cameroon's Fiscal Policy Scenarios: 2025–2035. World Development Report. 2024;12(4):33–50. DOI: 10.1596/978-1-4648-2024-1

¹³ International Monetary Fund. African Dept. Central African Economic and Monetary Community (CEMAC): Press Release; Staff Report; and Statement by the Executive Director. IMF Staff Country Reports. 2025;064:1–87. DOI: 10.5089/9798229003711.002; International Monetary Fund. African Dept. Central African Economic and Monetary Community: Common Policies in Support of Member Countries Reform Programs. IMF Staff Country Reports. 2024;193:1–59. DOI: 10.5089/9798400280054.002

¹⁴ European Commission. Blockchain for SME Supply Chains: EU Pilot Projects. Sustainability. 2025;17(3):112–130. DOI: 10.3390/su17030112.

structure (low internet penetration, especially in rural areas, high costs of the Internet connection, unstable communications, shortage of the adapted IT solutions) [10]; financial restrictions (lack of investment in digital technologies, limited access to crediting, insufficient government support) [11]; digital skills deficit (low digital literacy of entrepreneurs and employees, shortage of qualified IT specialists) [12, 13]; cultural and organizational barriers (conservative business models, resistance to change, insufficient awareness of the benefits of digital tools) [13, 14]; legal and regulation challenges (underdeveloped regulation framework for the digital economy, cyber security issues) [15].

The Cameroonian SMEs identify the conflict between traditional management models and digital transformation requirements as a key barrier [16]. The traditional hierarchical structures and cultural stereotypes hinder the implementation of agile approaches. The level of SMEs' digitalization in Cameroon is 23% lower than in Kenya and Nigeria, with less dominant traditional structures. To overcome these barriers, it is proposed to use the adapted training for managers, pilot projects and digital platforms (e.g., electronic data interchange systems for supply chains), the effectiveness of which has been proven within the framework of the EU Horizon 2020 INNOSUP and BlockStart programs.¹⁵ An additional barrier is the digital gender gap mentioned in the World Bank reports.

Targeted government funding stimulates the "green transition" and sustainable development of SMEs. The research shows that the long-term effects of government support for "green innovation" continue to positively impact the financial performance of SMEs even after funding is cancelled, with a lag effect of 3–5 years [17]. The subsidies are proposed to be stratified. There is "green start-ups" grant support for microenterprises and R&D tax credits for medium-sized enterprises. Such programs as the UN's "Green To Compete" program help the SMEs implement "green" technologies, reducing costs and increasing competitiveness, which confirms the effectiveness of a growth model based on the triad of "digitizing, cooperation, and government support" [18, 19].

The cluster model is considered to be a long-range management technology for the SMEs'

growth based on the geographic concentration of interconnected enterprises, organizations and institutions. Interaction within clusters facilitates the exchange of knowledge and resources, accelerating the development and implementation of innovations. The collaboration allows the SMEs to experiment, analyze successful practices and reduce barriers to accessing information and technologies [19–21].

The sustainable development paradigm views SMEs as the key agents of change, particularly in developing countries. Cameroon collaborates with such international organizations¹⁶ as the Climate and Clean Air Coalition (CCAC)¹⁷ to develop methodologies for assessing the SMEs' impact on the environment. There are implemented projects that are aimed at reducing emissions in the livestock industry (use of feed additives that reduce methane emissions by 15–20%). The share of «green» enterprises is forecasted to increase to 25% by 2030.

The scientific studies of the SMEs' contribution to the economy rest on qualitative and quantitative analytical methods [22–26]. However, there remains a relevant trend to study cause-effect relationships between the development of the SMEs as an institution and socioeconomic development indicators, as well as the consideration of associated effects [27]. Such an approach allows us to predict risks and opportunities as well as develop appropriate management decisions.

Materials and methods

A system approach was chosen as the main research method due to the need for providing the sustainable development of the SMEs based on the principles of economic, environmental and social justice [28].

Based on a review of articles on the problems of the SMEs' sustainable development management in the digital economy, external determinants were grouped into the key perspectives in accordance with the UN Sustainable Development Framework: economic, social, and environmental. There was also an institutional perspective, as the creation of a highly effective business requires the corresponding institution's performance.

¹⁵ European DIGITAL SME Alliance. Blockchain. 2024, May 7. URL: <https://www.digitalsme.eu/blockchain/>

¹⁶ UNDP. Cameroon Country Report 2024. URL: <https://www.unfpa.org>

¹⁷ CCAC. Agriculture Sector Report. URL: <https://www.ccacoalition.org>

The analysis of the current conditions of the SMEs in Cameroon over the past five years and revealing institutional and infrastructural challenges and weaknesses were carried out using quantitative and qualitative analytical methods.

The qualitative analysis served as a methodological approach to identify the specific features of doing business by the SMEs in foreign countries. A number of authors indicate such issues as the company's age, industry, size, level of innovative activity, growth potential, etc., as the key indicators of sustainable and regular growth. According to international practices, the achievement of the sustainable and regular growth key indicators relies on the national support of the SMEs, including systematic, holistic, and functional (thematic) approaches to selecting the SMEs subjects whose government support can create a synergistic effect both for an individual economic entity and for society as a whole [29]. The most common programs within the holistic approach are aimed at searching for (often on an application basis) companies with high competitive potential in the international market in order to create a relatively small pool of high-growth companies (HGCs) deserving government support [30, 31].

An expert assessment method was used to identify and rank challenges and prioritize the SMEs development in Cameroon. We used data from the World Bank, the Strategy Document for Growth and Employment (DSCE), the Vision 2035 Development Strategy, and the General Plan for Industrialization (PDI). Statistical analysis was used to verify the expert assessments.

Market and industry analyses were used to assess the SMEs' business activity through the processes of concentration and deconcentration: 1) market concentration according to the "grow or go" principle leads to the consolidation of business structures and the displacement of less efficient SMEs [32]; 2) deconcentration causes an increase in the number of companies in high-income segments, increasing competition and distributing growth potential, which can lead to a decrease in the number of SMEs. Industry analysis emphasizes that different business areas are at different stages of the life cycle [33] and have different growth potentials.

The forms and mechanisms of the SMEs' state subsidies were studied, taking into account the theoretical principles of market models of

subsidies, problems of information asymmetry and appropriate mechanisms (E. Gurvits, E. Maskin, R. Myerson, B. Goodwin, G. Kramer, and others) [34].

To identify and systematize the problems of the SMEs, the materials from the International Organization of Standardization (ISO) and the World Economic Forum (WEF) were used, as well as the empirical observations in the regions of Cameroon over the past five years. The targets of Cameroon's Vision 2030 have set a focus on researching the SMEs' growth issues as well as developing the tools for providing their sustainable growth.

The identification of numerous problems in the functioning of the SMEs in Cameroon, which increase their impact on the effectiveness and sustainability of the SMEs, made it essential to assess the degree of their importance in key areas for developing the unified organizational and methodological tools of the SMEs' sustainable growth — modeling the conditions for the SME development, based on the theory of fuzzy sets.

Using fuzzy set theory as a mathematical tool and the construction of a fuzzy economic model

Table 1
Diagnostic map of SME problems in Cameroon

Prospects	Key operational issues and development of SMEs
Economic	High financial isolation of SMEs; poorly diversified industry structure of SMEs; low investment activity limited access to energy and Internet resources for SMEs
Social	low literacy rate of the population, including financial literacy of SMEs insufficient supply of qualified personnel
Ecological	failure to adhere to environmental standards of SMEs limited implementation of state environmental monitoring measures
Institutional	high differentiation in the development of Cameroon's regions lack of institutions of territorial development poor infrastructure provision in the districts

Source: Compiled by the authors.

Table 2
Cameroon SME development matrix

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
									3												
3				3		2											-1				
	3		2																		
				3		2															
									3												
1				3																	
							3														
				3														3			
							3			1								1			
					3						-3				1						2
									3						1						
1		-3		-3					-3												
	2					2							3				-2				3
						3					-2								1		
								3													
					2	2													-2	1	
	3																				
		2							-2												
			2								-3			3		3					3
	1								-3						1						-3
								2				3								1	
				3	2												-2				

Source: Compiled by the authors.

for the SMEs' development in Cameroon stems from the fact that observational data on the SMEs' activity in the country is not homogeneous and lacks a clearly defined statistical nature. The experts have also noted the lack of clearly structured databases characterizing the SMEs in Cameroon and the unsystematic record of statistical data. The demand to account for nonlinear relationships between the factors also influenced the choice of this mathematical tool. It limits the application of the traditional econometric models.

Using the expert assessment method with the involvement of 47 experts that represent the SME entities, selected according to the criteria of expertise and experience in the SME sector (at least 5 years) and knowledge of national specifics, the problems have been ranked and the influence strength between them assessed, using the scale from – (maximum negative impact) to +1 (maximum positive impact).

The results of the expert assessment made it possible to group the identified problems into 4 prospects and draw a diagnostic map of the SMEs problems: (Table 1). The diagnostic map of

the SMEs problems in Cameroon has showed that assessing the problems requires the coordinated processing of both quantitative and qualitative indicators to obtain reliable research results. To improve the reliability and validity of the study results, the Cameroon National Institute of Statistics database for 2020–2024 was used.¹⁸

The experts have identified the most significant indicators (concepts) characterizing the presence or absence of the problems in the development of the SMEs, which were assessed by the experts in quartiles: “1” — low level, “2” — average level, “3” — high level: 1. Density of transport routes; 2. Level of the e-commerce development; 3. Density of the banking network in the country's regions; 4. Availability of banking products; 5. Adherence to environmental standards by SMEs; 6. Number of the Internet users; 7. Volumes of real investment; 8. Level of industrial infrastructure development; 9. Budget expenditures for the SMEs support; 10. Wage rate of the population; 11. Literacy rate of the

¹⁸ National Institute of Statistics of Cameroon. URL: <https://ins-cameroun.cm/en/> (accessed on 01.11.2025).

population; 12. Level of financial literacy of SMEs; 13. Level of the business social responsibility; 14. Tax burden on business; 15. Level of corporate culture development; 16. Development of local self-government; 17. Effectiveness of anti-corruption policy; 18. Negative impact of business on the environment; 19. Level of public-private partnerships development; 20. Density of SMEs; 21. Administration simplicity; 22. Contribution of SMEs to GDP.

At the stage of modeling the conditions for the SMEs development, the level of codified relationships between the indicators (concepts) was assessed with the use of the scale: 1.0; 0.75; 0.5; 0.25; 0; -0.25; -0.5; -0.75; -1.0, (in quartiles: 4, 3, 2, 1, 0, -1, -2, -3, -4).

As a result, a matrix (cognitive map) of the SME development in Cameroon was drawn (*Table 2*).

To verify the expert assessments and minimize the bias, we conducted the statistical analysis of the opinion consistency. The calculated dissonance index showed an average level of 26%, indicating acceptable consistency. The largest discrepancies were recorded for the indicators “negative impact of business on the environment” (65%) and “contribution of SMEs to GDP” (62%), reflecting the ambiguity of their perceptions.

The quality and acceptable confidence level in the indicators selected for the analysis is confirmed by a consonance level of over 90%.

Based on Cameroon’s SME development matrix, the most important indicators that demonstrate a high level of trust and intensity of influence on SMEs have been established, including the volume of real investment, the level of industrial infrastructure development, budget expenditures on SME support, the level of financial literacy of SMEs, the level of corporate culture development, the level of public-private partnerships development, and the effectiveness of anti-corruption policies.

The above-mentioned indicators can be grouped according to the trends that have developed in Cameroonian SMEs:

1) formation of a sustainable investment climate:

- volumes of real investment;
- level of industrial infrastructure development;

2) interaction between the state and business, promotion of the GR management technologies:

- budget expenditures on the SMEs support;
- level of corporate culture development;

- level of public-private partnerships development;

3) formation of financial culture in the business environment and the society as a whole:

- level of financial literacy of the SMEs;
- effectiveness of anti-corruption policy.

The research, based on the fuzzy cognitive mapping (FCM) method, emphasizes modeling the factors’ systemic interactions and synergies rather than examining the role of each factor in isolation. For example, this model demonstrates that even a significant improvement of one factor (“availability of banking products”), coupled with a low level of another (“financial literacy”), may not produce the expected positive effect on “actual investment volumes” (see *Table 2* of the impact matrix). Thus, the suggested method complements existing quantitative research methods by offering a qualitative systemic perspective.

The performed calculations have revealed the structure-forming factors and outlined the direction of further research in order to develop relevant organizational and methodological tools for providing the sustainable growth of the SMEs.

Results

The modeling performed enabled us to identify seven critical elements with the highest potential impact on the development of SMEs in Cameroon and categorize them into strategic clusters:

1. Formation of a sustainable investment climate

A foresight analysis of Cameroon’s SMEs’ economic activity revealed that the key factor in achieving socioeconomic benefits is the adoption of innovative technologies, which is impossible without significant investment. In recent years, Cameroon has experienced active digitization of its agricultural and banking sectors, the development of which is recognized as strategically important in the context of the global trends.

The agricultural sector, which includes crop production, livestock farming, forestry, and related activities (processing, marketing, and distribution), has a systemic impact on all aspects of Cameroon’s population. This sector plays a key role in the country’s economy, serving as a potential growth area as it provides employment for a significant part of the population (over 40% in 2023). It also facilitates the development of the related indus-

tries and provides a means of living for most small businesses. Its contribution to Cameroon's GDP remains significant, amounting to 16.7% in 2023.

The effectiveness of modern agribusiness models, which include not only production but also logistics (setting up logistics hubs and industrial parks mainly oriented to SMEs), processing, and marketing, directly depends on the development of road, transport, and digital infrastructure. In a developing economy, government institutions play a key role in shaping the national investment market, while achieving economic sovereignty is difficult without their active participation.

The pace of modernization of Cameroon's agricultural sector depends directly on the volume of investment attracted. The banking sector, which is the main source of financing for the SMEs, is primarily represented by the subsidiaries of foreign financial groups (e.g., Societe Generale Cameroon, UBA Cameroon, AccessBank). Although the presence of international capital provides access to a wide range of banking products, the task of strategic development, within the framework of the stated course to build a digital economy by 2035, requires intensified investment activity and technology transfer from research centers to the real sector. Thus, increased financial integration creates preconditions for economic and social development, stimulates savings and capital accumulation, and helps optimize the distribution and availability of financial resources for businesses [35].

The model demonstrated a strong positive correlation between the volume of real investment and the level of industrial infrastructure development. However, a contradiction has been revealed: increased investment in infrastructure can indirectly contribute to the market monopolization and displacement of SMEs by attracting large amounts of foreign capital. This underscores the need for the state to specifically invest in infrastructure that caters to the needs of SMEs, such as logistics hubs and industrial parks.

2. Limited access to investment resources for SMEs in Cameroon

The availability of investment resources for SMEs in Cameroon remains a limiting factor in their progressive development. This problem is fundamentally structural in nature, exacerbated by the dominance of agricultural and rural micro-

enterprises (over 80%) in the SME sector, which are characterized by chronic financial exclusion. In this context, differentiating both investment types (based on the target function) and institutional funding sources is methodologically justified.

A large number of the SMEs, being an indicator of significant entrepreneurial potential, correlates with the prevalence of micro-entrepreneurship, which is largely capitalized on through the reinvestment of personal savings or family pools. However, such financial injections are characterized as compensatory "subsistence investments," rather than strategic "growth investments," which objectively limits the potential for scaling business models and their transition to sustainable development.

There arises a systemic paradox: despite the nominal presence of formal credit products in the financial market (produced primarily by the subsidiaries of international banking groups), their actual accessibility for the vast majority of SMEs remains minimal. This imbalance is determined by the financial institutions' excessive requirements for collateral, credit history and the level of business formalization. Thus, there is a fundamental gap between the institutional supply of financial services and the practical approval of these services by the SMEs, caused by the dissonance between the standardized credit products and the specific risk profile of local enterprises.

This combination of factors highlights the need for government institutions to develop and implement comprehensive investment programs aimed at reducing the identified gap through the creation of specialized financial mechanisms adapted to the structural characteristics of the SME sector.

These circumstances make it necessary to develop and implement comprehensive government investment programs aimed at reducing this gap.

3. Interaction between the government and business: institutional aspect and implementation of the government relations (GR) management technologies

The institutional framework of Cameroon's state support system for small and medium-sized enterprises demonstrates formal structural integrity. The key actors in this system are:

- The Ministry of Small and Medium Enterprises, Social Economy and Handicrafts (MINP-

MEESA), which performs a coordinating and regulatory function.

- Agency of the SMEs Promotion (APME) that is responsible for the operational implementation of the support programs.
- Specialized development financial institutions: National Credit Council for Agriculture (CNCA CreditAgricole) and Bank of Small and Medium Enterprises (Banquedes PME).

The effectiveness of these institutions is ambivalent. The effectiveness of these institutions is significantly limited by administrative barriers, persistent underfunding, and weak interdepartmental coordination, in addition to certain incentive measures, such as reducing the corporate tax rate for SMEs from 28% to 25% in 2023. This creates an institutional trap whereby program initiatives fail to reach a significant portion of target groups, particularly SMEs in the informal sector and remote regions.

In the paradigm of the modern economic theory, consolidated interaction between the state and business is considered to be a key determinant of the formation of sustainable synergies aimed at socioeconomic development. The state acts as a system-forming stakeholder interested in the diversified development of the business sector. Legal and effective economic activity by the SMEs is possible only in an environment of institutionalized public-private dialogue within a clear legal framework, which is a prerequisite for building a competitive economy.

In Cameroon, elements of such collaboration are partially incorporated into the Kribi, Douala and Limbe free economic zones (FEZs), where the SMEs receive comprehensive support (administrative, fiscal, and advisory). However, this model is characterized by spatial and sectoral fragmentation: for example, the agricultural processing cluster is concentrated in the Douala zone, while most FEZs are located on the coast, limiting access for businesses in inland regions. Thus, the process of establishing public-private collaboration institutions for sustainable development is fragmented and requires further optimization.

To harmonize interests and test new forms of cooperation within the framework of government relations (GR) partnerships, a Sector Development Center under the Ministry of Economic Planning and Territorial Development was established. Its mandate focuses on stimulating public-private

partnership (PPP) projects in infrastructure development (transport corridors in Chad, Gabon, and Congo; highways; and energy facilities such as the Nachtigal Dam and the Grand Eweng hydroelectric power station).

Alongside the context of GR partnerships, the Center initiates support for accelerators and incubators (MEST, Techstars, FI Cameroon Startup Accelerator, United Nations Development Program (UNDP) Cameroon Accelerator Lab) based on a system of key performance indicators (KPIs), providing mentoring, educational programs, and financial support [36]. This facilitates the integration of SMEs into a digital ecosystem. These structures focus on promoting economic reforms and industrial diversification of the economy.

Dissemination of the GR management practices has also catalyzed the emergence of the national initiatives aimed at increasing transparency and accountability in both the government and business sector. Institutionalized collaboration with the civil society organizations (the Cameroon Consortium of English-Speaking Civil Society, Campos, and others) is implemented through public hearings on budgetary and regional projects.

Monitoring committees have become an important control tool since 2013. Together with the civil society groups (the Cameroon Union of Industrialists and Entrepreneurs, the Association of Cameroonian Banks, etc.), they monitor and verify budget execution at the national, regional, and municipal levels.

The conducted analysis proves the existence of a developed institutional basis for supporting the SMEs in Cameroon; however, its effectiveness requires significant optimization by overcoming departmental disunity and expanding the geographical coverage of the support programs.

4. Improving financial culture in the business environment and society as a determinant of structural transformation of the Cameroonian economy

Achieving sustainable rates of economic growth and deep structural transformation of the Cameroonian economy are determined not only by measures of direct regulatory and fiscal impact (export support, tax incentives), but also by the need for implementing a comprehensive policy aimed at forming a relevant financial culture in

the business environment and public consciousness [36].

Financial culture is a complex, multi-component socioeconomic construct, influenced by the level of financial literacy, individual and collective experience in making financial decisions, and the degree of institutional development of the financial market [37]. The key aspect of its development is the elimination of cognitive distortions and emotional barriers that determine irrational financial behavioral patterns. Consequently, improving financial culture should incorporate not only traditional financial education but also the development of decision-making skills under the conditions of uncertainty, taking into account behavioral economic models.

In Cameroon, this process is in its incubation phase and is being implemented piecemeal through targeted initiatives, such as the national entrepreneurship training program Kiro'o and the ActivSpaces incubator. These measures represent the initial stage of developing a public policy of building human capacities for priority economic sectors.

To intensify this process, it is necessary to implement a number of practical measures aimed at developing entrepreneurial initiative:

- 1) stimulating the formation of informal networks and business associations as the institutions of collective action that provide mutual support, knowledge transfer and access to resources;
- 2) development of business incubators and accelerators (based on the ActivSpaces model) focused not only on the GR interactions but also on the in-depth testing of practical business skills and financial management methods;
- 3) promoting successful local business cases to foster positive behavioral patterns and increase entrepreneurial motivation.

The effectiveness of integrating financial and cultural aspects is subject to quantitative assessment through a system of specialized indicators, including the sub-indices of "responsibility," "trust," and "long-term planning" [38]. These indicators establish a new standard for the requirements of business community competence.

Higher education institutions are expected to play a special role in this process. The researchers point out that it is crucial to develop graduates' soft skills, focused on social responsibility, risk management, and effective communication.

However, the low level of engagement of the Cameroonian universities in financial and digital literacy programs highlights the need to overcome the heterogeneity of the educational environment and develop individual professional pathways that integrate these components.

Thus, developing a financial culture in Cameroon is a complex task that requires synergy between the efforts of the state, educational institutions, and the business community to achieve long-term socio-economic development goals.

5. State programs as a tool for implementing national priorities: a program-targeted approach in the context of structural heterogeneity of the Cameroonian economy

The study reveals a deep structural duality as a systemic characteristic of Cameroon's economy, reflected in significant intersectoral heterogeneity. This phenomenon manifests itself in a paradoxical combination of high-tech segments, represented by a modern banking sector with developed financial technologies, and archaic forms of economic activity, determined by a persistent deficit in energy and transport infrastructure.

Leveling this imbalance and strengthening the country's economic sovereignty objectively requires the state's regulatory and coordinating functions to be intensified. Reducing the severity of structural contradictions and harmonizing the economic space appear achievable only through the implementation of a system of comprehensive state programs focused on addressing specific development challenges.

The implementation of this approach involves the formation of a clear system of performance indicators that ensure monitoring the target indicators' achievement and allow for timely adjustment of the program activities depending on variable external and internal conditions (see *Figure*).

Such initiatives should be inter-institutional rather than departmental, ensuring the synchronization of efforts to modernize infrastructure, stimulate the SME sector, build human capital, and digitally transform the economy. A program-based approach creates the institutional preconditions for consolidating the resources to achieve the strategic national priorities, generating synergies and overcoming the fragmentation inherent in the current economic policy.

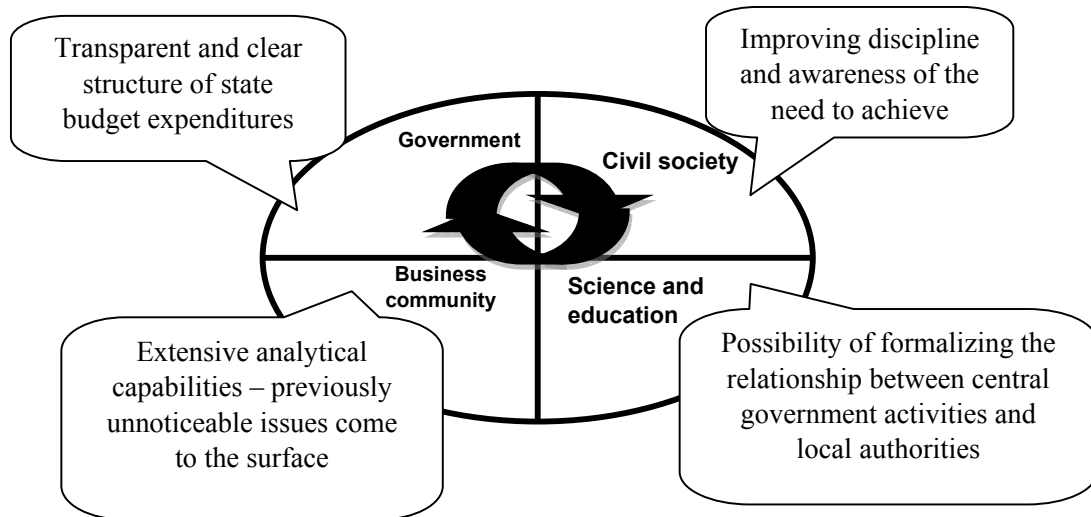


Fig. The main advantages of using a project approach in the development and implementation of state programs in budget planning

Source: Compiled by the authors.

6. Experience of state planning and methodological substantiation of the project approach in Cameroon

The analysis of Cameroon's public administration system reveals relevant experience in strategic planning, institutionalized in several key documents, such as the General Plan for Industrialization (Plan Directeur d'Industrialisation, PDI) and the national development strategy, Vision 2035. However, there is a significant methodological drawback in the current line-item budgeting model, which dominates at the national level. While focusing on the principles of targeted use of budget appropriations, it does not provide for a comprehensive mechanism for assessing the effectiveness and efficiency of funding across individual national projects. This circumstance leads to a systemic gap between the volume of allocated budgetary resources and the socioeconomic indicators actually achieved.

Improving the effectiveness of the government program implementation objectively requires transforming the existing budget management system toward a project-based approach. The methodological nature of this approach consists in the implementation of the following principles:

- 1) detailed integration of program activities with the priority course of the state policy;
- 2) application of a system of key performance indicators (KPI);
- 3) institutionalization of personal responsibility and transparent accountability mechanisms for achieving the planned results.

Testing a project-based approach to managing the SMEs sector development will significantly improve the validity of selecting and funding most relevant programs, providing a transition from cost-based management to results-based management.

Further optimization of the strategic planning system requires improving the methodology for identifying and prioritizing current development issues. To address this challenge, it is methodologically sound to use the fuzzy set theory, which provides formal tools for quantifying and analyzing semi-structured qualitative information. This approach can provide a more objective selection of the program targets and optimization of a range of measures to achieve the required socioeconomic results.

Discussion

The study allows us to conceptualize Cameroon's SME sector as a complex, semi-structured system characterized by a close relationship with the country's overall level of socioeconomic development. The key properties of this system are:

- directions diversity of ongoing processes;
- nonlinearity of cause-and-effect relationships between the system elements;
- high dynamism and instability of parameters;
- the necessity of applying a combined approach for a comprehensive analysis.

The research employed a systems approach aimed at identifying the most relevant areas with-

in the system for subsequent prioritization of the management impact. The applied fuzzy cognitive map revealed that concepts such as “level of industrial infrastructure development” and “effectiveness of anti-corruption policies” have the greatest strategic importance and influence on other factors.

The outcomes achieved have important practical implications. In terms of the institutional constraints, direct implementation of the advanced technological solutions appears ultimate. Priority efforts should be focused on creating fundamental conditions: providing a stable energy supply, developing logistics infrastructure, and expanding access to funding. The introduction of some technological innovations should not be considered as a starting point but as a natural consequence of improving these basic conditions.

The research has also revealed some potential systemic contradictions. For example, the increased infrastructure investment makes it possible to create positive externalities for the SMEs, on the one hand, and can also lead to the displacement of small businesses by larger players, on the other. Identically, the undifferentiated liberalization of government support measures at low levels of financial literacy can foster dependency attitudes and reduce the competitiveness of SMEs.

The use of cognitive modeling methods has demonstrated its heuristic value in analyzing complex socioeconomic systems, enabling the integration of both quantitative and qualitative factors. It is important to emphasize that the indicators used in the model and the identified priorities are relevant to the current timeframe. The model can be further verified with due regard for changing socioeconomic conditions.

The qualitative assessment was based on the expertise obtained using a stratified sampling method. To enhance the validity and reliability of the results in the long-range studies, it is advisable to apply more rigorous criteria for expert pool formation (level of competence, sectoral representativeness, and substantiated work experience).

The implemented methodology for constructing a cognitive model included a data triangulation stage — reconciling the results obtained from expert and statistical methods. This procedure ensures increased validity and reliability of the model. The reliability of a model constructed using the proposed algorithm is a prerequisite for developing effective management decisions based on it.

Prospects for further research lie in the development of dynamic versions of the model, allowing for time lags and nonlinear interaction effects. Despite the variability of external conditions, the proposed methodological approach retains its value as a tool for substantiating public policy priorities and ranking projects based on their potential impact on the system.

This study contributes to the development of methodology for analyzing complex economic systems and offers practical tools for developing balanced policies to support SMEs in emerging market economies.

Conclusion

The conducted research allows us to propose a system of conclusions that are theoretically and practically significant for solving the problems of sustainable development of the small and medium-sized business sector in the Republic of Cameroon:

1. The investment climate as an institutional foundation of development. Creating a favorable investment climate is an integral part of effective public economic policy. The development of such a climate in African countries is significantly hampered by the limited access of SMEs to financial resources, the spread of corrupt practices, and the lack of a systematic registry of long-range investment projects. There is a great need for a fundamentally new paradigm of attracting investment, focused on stakeholders and aimed not only at economic returns but also at creating positive social externalities.

2. Public-private partnership as a coordination mechanism. In terms of increasing external uncertainty, it is impossible to build a competitive economic system without the institutionalized interaction between the state and business. Harmonization of the interests of the society, business, and the state must be achieved with the coordinating role of public institutions. Regulatory measures provide the foundation of digital transformation and should be focused on achieving measurable socioeconomic results.

3. GR management as a tool for reducing transaction costs. Institutionalizing GR management technologies helps minimize risks and foster sustainable relationships between the SMEs and the government through the mechanisms of incorporating them into public organizations, con-

sultative commissions, and industry committees. The application of these technologies increases transparency in the business environment and creates the conditions for establishing an equitable dialogue with government agencies.

4. Financial culture as a factor in behavioral economics. The development of financial culture in the business community and public consciousness correlates with the improvement of educational programs and the rise of digital financial literacy. It creates a basis not only for effective business communications but also for a responsible approach to social and environmental obligations.

5. Financial system stability as a macroeconomic priority. Low levels of financial literacy hinder productivity growth, innovation, and the development of crisis resilience. Improving this level will strengthen the stability of the banking sector, providing SMEs financing and optimizing implementation of the international risk management standards.

6. Government programs as a strategic planning tool. The use of program-targeted methods in implementing national priorities al-

lows for the consolidation of financial resources from various sources in order to launch large-scale projects. This tool enhances the synergistic effect of approving the interests of the state and business, improves the quality of the SMEs' development management, and contributes to sorting out the current socioeconomic problems.

7. Project-based approach as a budget management paradigm. The introduction of a project-based approach into the development and implementation of government programs creates a methodological basis for improving the quality of budget planning and generates positive externalities for all stakeholders. The government receives results-oriented budget expenditures. Businesses receive new opportunities for growth, while the civil society receives transparency of budget expenditures and clear interaction between the various government levels.

These findings highlight the need for a comprehensive approach to the SME sector development that combines institutional reforms, improved management practices and human capital investments.

ACKNOWLEDGEMENTS

The authors would like to thank Cameroonian SMEs Ngameni Foleu Alain and Dom Domnu Robert Donny for collecting the empirical data.

REFERENCES

1. Bersanov M.M. The role of small business in forming a competitive environment]. *Nauchnyy Lider (Scientific Leader)*. 2024;(50):200. URL: <https://scilead.ru/article/7630-rol-malogo-biznesa-v-formirovanii-konkurentno> (In Russ.).
2. Kurpayanidi K.I. Small business development: Self-development or integrated development — which path are countries choosing? *Problems of Modern Economy*. 2021;3(79):92-95. URL: <https://www.m-economy.ru/art.php?nArtId=7155>
3. Okolo V.O., Ohanagorom M.I., Rejoice O.E., Muoneke O.B. Does financing SMEs guarantee inclusive growth and environmental sustainability in the European union? *Heliyon*. 2023;9(4): e15095. DOI: 10.1016/j.heliyon.2023. e15095
4. Akinboade O.A. Determinants of SMEs growth and performance in Cameroon's central and littoral provinces' manufacturing and retail sectors. *African Journal of Economic and Management Studies*. 2015;6(2):183-196. DOI: 10.1108/AJEMS-03-2013-0033
5. Fomba B.K., Talla M.F. Government support programs and SME growth in Cameroon: Challenges and opportunities. *African Journal of Economic and Management Studies*. 2023;14(2):210-225. DOI: 10.1108/AJEMS-03-2023-0078
6. Nguimkeu P., Tadadjeu S. Corruption and SME development in Cameroon: Evidence from firm-level data. *Journal of Development Economics*. 2023;157:102876. DOI: 10.1016/j.jdevco.2023.102876
7. Ndikumana L. Tax incentives and SME performance in resource-dependent economies. *Journal of Development Economics*. 2025;178:103312. DOI: 10.1016/j.jdevco.2024.103312
8. Charlier F., N'Cho-Oguie C. Decentralization and public service delivery in Cameroon. *African Development Review*. 2024;36(2):210-225. DOI: 10.1111/afdr.12456

9. Volkodavova E.V., Zhabin A.P. Improving the efficiency of industrial network business through digitalization of team building processes. *Leadership and Management*. 2020;7(2):257-270. (In Russ.). DOI: 10.18334/lim.7.2.100798
10. Abel E., Ntui O. Digital transformation challenges for SMEs in Sub-Saharan Africa: Evidence from Cameroon. *Journal of Small Business and Enterprise Development*. 2023;30(4):567-582. DOI: 10.1108/JSBED-03-2023-0121
11. Nkengfack H., Fotso L. Financial constraints and digitalization: A case study of Cameroonian small businesses. *International Journal of Emerging Markets*. 2023;18(3):432-450. DOI: 10.1108/IJOEM-05-2022-0743
12. Tchouassi G., Ngouhouo I. Digital skills gap and SME performance in Cameroon. *Journal of Innovation and Entrepreneurship*. 2025;14(1):22. DOI: 10.1186/s13731-025-00460-7
13. Nkengfack H., Fotso L. Bridging the digital divide: Training programs for Cameroonian entrepreneurs. *Technological Forecasting and Social Change*. 2024;188:122567. DOI: 10.1016/j.techfore.2024.122567
14. Ngwa W.T., Tande D.B. Why cash still rules: Cultural resistance to digital payments among Cameroonian SMEs. *Journal of African Business*. 2023;24(3):345-362. DOI: 10.1080/15228916.2023.2196068
15. Mbarga A., Fomba B. The role of government policies in enhancing digital adoption among Cameroonian SMEs. *Technology in Society*. 2024;66:101876. DOI: 10.1016/j.techsoc.2024.101876
16. Fonchingong C.C., Mbah P. Traditional leadership and digital adoption: Clash of mindsets in Cameroonian SMEs. *Technology in Society*. 2024;68:102456. DOI: 10.1016/j.techsoc.2024.102456
17. Kowalska M., Dupont J. Green subsidies and SME performance: A cross-country analysis. *Journal of Cleaner Production*. 2025;412:137285. DOI: 10.1016/j.jclepro.2025.137285
18. Anton C.E., Baba M.C., Bucşoiu O.-A. Perspectives on integrating risk management and sustainability for financial performance: A systematic literature review. *Sustainability*. 2025;17(8):3456. DOI: 10.3390/su17083456
19. Zakharova T.B. The Cluster Model as a Tool for Improving the Competitiveness of Small and Medium-Sized Entrepreneurs. *Regional Economics: Theory and Practice*. 2017;12:2284. DOI: 10.24891/re.15.12.2284
20. Petrova S.V. Innovative methods for developing small and medium-sized businesses in a cluster model. *Journal of Enterprising Communities: People and Places in the Global Economy*. 2022;16(2):34-41. DOI: 10.1108/JEC-12-2021-0169
21. Chabbouh H., Boujelbene Y. Open innovation, dynamic organizational capacities and innovation performance in SMEs: Empirical evidence in the Tunisian manufacturing industry. *The International Journal of Entrepreneurship and Innovation*. 2023;24(3):178-190. DOI: 10.1177/14657503221101234
22. Ndindah C.N., Tripathi A. A study of factors that account for the success of SMEs in the Western Region of Cameroon. *Research Journal of Business and Management*. 2022;14(7):56-67. URL: <https://www.researchgate.net/publication/362405117>
23. Gavrilenko I.V., Parshutina I.G., & Shvedova A.A. The Future of Digitalization of Small and Medium-Sized Businesses: An Analysis of Benefits and Challenges. *Scientific Result. Economic Research*. 2025;11(2), Article 1. DOI: 10.18413/2409-1634-2025-11-2-1-0
24. Pundziene A., Nikou S., Bouwman H. The nexus between dynamic capabilities and competitive firm performance: the mediating role of open innovation. *European Journal of Innovation Management*. 2021;25(5):152-177. DOI: 10.1108/EJIM-09-2020-0356
25. Mattos C.S., Pellegrini G., Hagelaar G., Dolsma W. Systematic literature review on technological transformation in SMEs: a transformation encompassing technology assimilation and business model innovation. *Management Review Quarterly*. 2024;74(2):1057-1095. DOI: 10.1007/s11301-023-00349-z
26. Nkengfack H., Fotso L.P. Gender and digital literacy gaps in Cameroonian small businesses. *Gender, Technology and Development*. 2025;29(1):78-95. DOI: 10.1080/09718524.2024.2435261
27. Fomina E.A., Khodkovskaya Yu.V., Fazrakhmanov I.I., Barkova E.E. Harmonizing the interests of the state and business in stakeholder management. In: E.G. Popkova, ed. *Industry 4.0: Implications for Management, Economics and Law*. Interdisciplinary Thought of the 21st Century. Berlin: De Gruyter; 2021:133-140. DOI: 10.1515/9783110677085-013
28. Fazrakhmanov I.I., Khodkovskaya Yu.V., Gaysina A.V. ESG principles in agribusiness management technology. *E3S Web of Conferences*. 2023;463:01015. DOI: 10.1051/e3sconf/202346301015
29. Khodkovskaya Yu.V., Fazrakhmanov I.I., Barkova E.E., Korsak K.P. Sustainable development of the region: Environmental and economic aspects of security. In: E.G. Popkova, B.S. Sergi, eds. *Geo-Economy of the Future*. Cham: Springer; 2022:717-726. DOI: 10.1007/978-3-030-92303-7_74

30. Haltiwanger J., Jarmin R.S., Kulick R.B. High growth firms: contribution to job, output and productivity growth. *SSRN Electronic Journal*. 2016. URL: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2866566 (accessed on 16.02.2025). DOI: 10.2139/ssrn.2866566
31. Fomina E.A., Khodkovskaya Yu.V., Beloliptsev I.A., Chuvilin D.V. Challenges in identifying fast-growing companies to differentiate government support measures. In: E.G. Popkova, ed. *Industry 4.0: Implications for Management, Economics and Law. Interdisciplinary Thought of the 21st Century*. Berlin: De Gruyter; 2021:3-12. DOI: 10.1515/9783110677085-002
32. Kaya M.C., Persson L. A theory of gazelle growth: Competition, venture capital finance and policy. *The North American Journal of Economics and Finance*. 2021;50:101019. DOI: 10.1016/j.najef.2019.101019
33. Volovikov B.P. Evaluation of the strategic sustainability of a project portfolio based on dynamic models. *Strategic Management*. 2015;(1):58-68. (In Russ.).
34. Bene C., Oosterveer P., Lamotte L., Brouwer I.D., de Haan S., Prager S.D., Talsma E.F., Khoury C.K. When food systems meet sustainability — Current narratives and implications for actions. *World Development*. 2019;113:116-130. DOI: 10.1016/j.worlddev.2018.08.011
35. Hikouatcha P., Tagne A.G.F., Kountelejou C.L.T., Mfokue H.M. Does culture empower inclusive finance? Empirical investigation into small business in Cameroon. *Heliyon*. 2024;10(2): e27750. DOI: 10.1016/j.heliyon.2024.e27750
36. Hasan M., Le T., Hoque A. How does financial literacy impact on inclusive finance? *Financial Innovation*. 2021;7:40. DOI: 10.1186/s40854-021-00259-9
37. Kokorev R.A., Lavrentyeva O.N., Tolstel M.S. [Formation of financial culture: a systematic approach]. *Izvestiya of Saint Petersburg State University of Economics*. 2024;(3):155-160. (In Russ.).
38. Goswami A.G., Medvedev D., Olafsen E. High-Growth Firms: Facts, Fiction, and Policy Options for Emerging Economies. Washington, DC: World Bank; 2019. 193 p. DOI: 10.1596/978-1-4648-1368-9

ABOUT THE AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

Elena A. Fomina — Cand. Sci. (Econ.), Associate Professor, Ufa branch of the Financial University under the Government of the Russian Federation, Ufa, Russian Federation

Елена Александровна Фомина — кандидат экономических наук, доцент, Уфимский филиал Финансового университета при Правительстве Российской Федерации, Уфа, Российская Федерация
<https://orcid.org/0000-0001-9968-9810>

Corresponding Author / Автор для корреспонденции:
eafomina@fa.ru

Yulia V. Khodkovskaya — Cand. Sci. (Econ.), Associate Professor, Ufa State Petroleum Technological University, Ufa, Russian Federation

Юлия Викторовна Ходковская — кандидат экономических наук, доцент, Уфимский государственный нефтяной технический университет, Уфа, Российская Федерация
<https://orcid.org/0000-0003-0112-9087>
khodkovskiy@bk.ru

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

*The article was submitted on 26.09.2025; revised on 02.02.2026 and accepted for publication on 25.02.2026.
The authors read and approved the final version of the manuscript.*

DOI: 10.26794/2308-944X-2026-14-1-91-110
UDC 336.14,336.22(045)
JEL E62

Increasing the Fiscal Autonomy of Regions: Reforming the Distribution of Tax Revenues in the Budget System of Russia

M.E. Kosov, M.L. Vasyunina, O.A. Polyakova

Financial University under the Government of the Russian Federation, Moscow, Russian Federation

ABSTRACT

This study addresses the critical challenge of interregional fiscal disparities and the excessive financial dependence of Russia's constituent entities on federal transfers. The primary **objective** is to develop and substantiate comprehensive measures to transform the allocation of tax revenues between the federal and regional budgets, thereby strengthening regional financial sustainability within the framework of competitive federalism. The research is highly **relevant** given the persistent spatial polarization of Russia's economic development and the new fiscal conditions created by recent tax innovations. This work proposes a model that combines three changes: moving some value-added tax (VAT), giving some control over the mineral extraction tax (MET), and changing the investment tax deduction into a federal-regional partnership. The method uses a systematic approach, with comparative, statistical, and system reviews of official data from the Ministry of Finance of the Russian Federation for 2019–2024. **The results** show that regions rely on the federal government, with federal taxes accounting for 64.5% to 67.7% of regional budget money. The study estimates that giving 25% of domestic VAT to the regions could cover a large part of their federal transfers. The suggested change to the investment tax deduction includes setting up federal standards and a way to make it work better. The proposals are discussed within the context of current sanctions, claiming that the change of fiscal flows allows the federal center to focus on important priorities while making regions partners in growth. **In conclusion**, implementing these connected steps in place will help switch from a support-based model to one that encourages competitive federalism, leading to a stronger and fairer federation. The findings suggest ways to change budget and tax laws.

Keywords: fiscal federalism; interbudgetary relations; tax revenue distribution; regional budgets; financial sustainability; value-added tax (VAT); mineral extraction tax (MET); personal income tax (PIT); corporate profit tax; investment tax deduction; spatial development

For citation: Kosov M.E., Vasyunina M.L., Polyakova O.A. Increasing the fiscal autonomy of regions: Reforming the distribution of tax revenues in the budget system of Russia. *Review of Business and Economics Studies*. 2026;14(1):91-110. DOI: 10.26794/2308-944X-2026-14-1-91-110

ОРИГИНАЛЬНАЯ СТАТЬЯ

Повышение фискальной автономии регионов: реформирование распределения налоговых доходов в бюджетной системе России

М.Е. Косов, М.Л. Васюнина, О.А. Полякова

Финансовый университет при Правительстве Российской Федерации, Москва, Российская Федерация

АННОТАЦИЯ

Исследование посвящено решению актуальной проблемы межрегиональной фискальной диспропорции и чрезмерной финансовой зависимости субъектов Российской Федерации от федеральных трансфертов. **Целью** работы является разработка и обоснование комплекса мер по трансформации распределе-

ния налоговых доходов между федеральным и региональными бюджетами для укрепления финансовой устойчивости регионов в рамках концепции конкурентного федерализма. **Научная новизна** заключается в предложении синергетической модели, интегрирующей три ключевых направления реформ: перераспределение доли налога на добавленную стоимость (НДС), делегирование части полномочий по налогу на добычу полезных ископаемых (НДПИ) и реорганизацию механизма инвестиционного налогового вычета в формате федерально-регионального партнерства. **Методологическая основа** включает системный подход, компаративный, статистический и ситуационный анализы официальных данных Министерства финансов Российской Федерации, Федеральной налоговой службы за период 2019–2024 гг. Результаты подтверждают структурный характер зависимости регионов, демонстрируя, что федеральные налоги составляют от 64,5 до 67,7% доходов региональных бюджетов. Проведена количественная оценка, показывающая, что закрепление 25% внутреннего НДС за регионами может покрыть значительную и растущую долю их безвозмездных поступлений из федерального бюджета. Предложенная реформа инвестиционного налогового вычета предполагает установление единых федеральных стандартов и механизма компенсации для повышения его эффективности. Обсуждение результатов доказывает, что реформа оптимизирует финансовые потоки, позволяя федеральному центру концентрировать ресурсы на стратегических приоритетах, а регионам — стать активными участниками развития. **В заключение** обосновано, что реализация предложенных взаимосвязанных мер обеспечит переход от компенсационной модели к стимулирующей системе конкурентного федерализма, способствуя созданию более сбалансированной и устойчивой бюджетной системы. Результаты исследования содержат практические рекомендации для совершенствования бюджетного и налогового законодательства.

Ключевые слова: фискальный федерализм; межбюджетные отношения; распределение налоговых доходов; региональные бюджеты; финансовая устойчивость; налог на добавленную стоимость (НДС); налог на добычу полезных ископаемых (НДПИ); налог на доходы физических лиц (НДФЛ); налог на прибыль организаций; инвестиционный налоговый вычет; пространственное развитие

Для цитирования: Kosov M.E., Vasyunina M.L., Polyakova O.A Increasing the fiscal autonomy of regions: Reforming the distribution of tax revenues in the budget system of Russia. *Review of Business and Economics Studies*. 2026;14(1):91-110. DOI: 10.26794/2308-944X-2026-14-1-91-110

1. Introduction

The Russian Federation's spatial development continues to be characterized by significant polarization in its constituent entities' economic and social standing. The gap between leading and lagging regions in terms of per GRP (gross regional product) reaches 30–40 times, while the disparity in household income levels ranges from 5 to 7 times. Over the past five years, this disproportion has shown no consistent trend toward reduction. Ten leading regions of Russia (including Moscow, Saint Petersburg, and oil-and-gas-producing regions) account for approximately 60% of the total gross regional product, whereas the per capita indicators for more than half of the regions fall below 5% of the national average. These issues exacerbate interregional imbalances in the distribution of tax revenues among the budgets of the constituent entities and undermine regional fiscal sustainability [1].

The relevance of this study is further proved by the numerous challenges faced by Russian regions, including high debt burdens, rising indebtedness among households and businesses, and financial sector instability. These factors can significantly

impact Russian regions' fiscal stability, affecting the population's quality and standard of living and overall socioeconomic development [2]. In the context of high interest rates and uncertainty in international markets, it is essential to understand how regions can adapt to these new conditions and what measures can be implemented to maintain their financial stability [3].

Government policy focused on social spending is now key to dealing with the fallout from economic and global financial troubles. Giving resources to important things such as schools, hospitals, and infrastructure can ease social stress and keep living standards high for people in the country. Regional governments should try to keep their budgets balanced and carry out local plans that ensure things are fair and that improvement can last in their areas [4]. Therefore, keeping Russian regions financially stable today is tricky and requires teamwork from different levels of government, businesses, and people. These things are very important when deciding how money is split between the central government and the regions.

The scientific novelty of this research lies in the development of a comprehensive, empirically

grounded model for transforming interbudgetary relations in Russia, which integrates three key initiatives into a unified systemic approach: the reallocation of a share of value added tax (VAT), the delegation of authority over the mineral extraction tax (MET), and the centralization of the investment tax deduction mechanism. Unlike existing studies that often focus on isolated aspects of fiscal federalism, this work proposes a synergistic set of reforms under the paradigm of competitive federalism, supported by a quantitative assessment of their potential impact on covering regional transfer dependence [5].

The primary goal of this study is to develop and substantiate a set of practical measures for transforming the allocation of tax revenues between the federal and regional budgets of the Russian Federation, aimed at strengthening the financial sustainability of the constituent entities.

The central hypothesis of the research is that the current model of fiscal federalism in Russia, characterized by a high degree of vertical centralization of tax revenues and significant dependence of regions on interbudgetary transfers, creates disincentives for regional economic growth and perpetuates interregional disparities. It is hypothesized that a shift towards a model of competitive federalism, achieved through the reassignment of a portion of stable federal tax revenues to regional budgets, the delegation of certain powers regarding MET, and the centralization of the investment tax deduction mechanism, will strengthen regional fiscal autonomy, enhance their motivation to develop their own tax base, and contribute to reducing spatial socioeconomic polarization.

The scientific significance of this work is determined by its contribution to the theory of fiscal federalism through the adaptation of the concept of competitive federalism to the modern Russian context, specifying the mechanisms for aligning the financial interests of the center and the regions. The practical significance lies in the development of specific proposals for reforming the budget and tax legislation of the Russian Federation, which can be used by federal and regional authorities to improve the system of interbudgetary relations and stimulate balanced spatial development.

To meet our goal and test our idea, we set these research tasks:

1. Examine how revenues and expenditures are structured in the budget system to determine to

what extent regions depend on federal transactions.

2. Judge if moving a portion of VAT revenues to regional budgets would be helpful and what the dangers might be.

3. Show if it makes good economic sense to give regions some control over the MET tax.

4. Suggest ways to change the investment tax deduction system to make it better at encouraging investment in regions.

2. Literature review

The academic discussion on the relationships between budgets and fiscal federalism is broad. Experts are mostly split between those who support more fiscal centralization to ensure a stable economy and national fairness, and those who back decentralization to improve regional efficiency and address local needs. Those who support centralization say that a strong center is needed to control overall fiscal policy, lessen the blow of regional economic issues, and redistribute resources to reduce inequalities through a single transfer system. On the other hand, those who support decentralization believe that local governments can better allocate resources based on local wants, improving public service and encouraging new ideas in public policy. This debate plays out in a complex way in Russia.

A significant body of research highlights the persistent challenges and unintended consequences of the current highly centralized fiscal model in Russia. Scholars consistently point to the acute vertical and horizontal imbalances within the Russian budget system. As Plisetskii notes, the deep-seated polarization in the economic and social standing of Russia's constituent entities not only persists but also exacerbates interregional imbalances, fundamentally undermining regional fiscal sustainability [1]. This view is strongly supported by empirical data showing that a limited number of regions, including Moscow, Saint Petersburg, and resource-rich areas, generate a disproportionate share of the GRP, leaving a majority of others structurally financially dependent. This dependency, as explored by Bukharian and Lavrov, is primarily addressed through a complex system of interbudgetary transfers, which, while aiming to equalize, often creates a "soft budget constraint" and reduces the incentive for regional authorities to cultivate their own tax bases and

pursue responsible, growth-oriented economic policies [6]. The reliance on transfers, rather than own-source revenues, weakens the direct link between local economic success and budgetary well-being, potentially stifling regional initiative and perpetuating a cycle of dependency. Vasyunina argued that this dependency is primarily addressed through a system of interbudgetary transfers, which, according to many analysts, reduces the incentive for regional authorities to cultivate their own tax bases and pursue responsible economic policies [7].

In parallel, a substantial field of research explores mechanisms for strengthening regional fiscal autonomy. The works of Yeremin and Kosov emphasize that in the face of global economic shifts and sanctions pressure, regional authorities must develop resilient financial foundations. This necessitates a transformation of the revenue allocation system [4]. The proposal to reassign a portion of federal tax revenues, particularly VAT, to regional budgets is a recurring theme. Gracheva revealed that this approach finds historical precedent in Russia in 1999–2000 and a contemporary analogue in nations like Germany [8]. However, the applicability of such international models is always subject to critical evaluation, as institutional frameworks, economic structures, and political systems vary significantly between nations, affecting the potential for successful transfer of fiscal mechanisms.

A key part of the literature looks at how money from natural resources is divided. Kolesnikova, for example, says that because the adverse impacts of mining are local and the costs for infrastructure and the environment are paid by the regions, there's a favorable reason to share MET [9]. This idea fits with the principle that decisions about taxes should be made by the level of government that can best deal with the results. The research on tax breaks for regional growth gives ideas about tools like the investment tax deduction. Studies show that while it's meant to encourage investment, it's not applied evenly in Russia, which makes the financial differences between regions bigger. The way things are now, regions can set their own rules for deductions, but this has led to strict rules and only partial repayment for lost income, which reduces how well it works [10]. This means that the system may need to be adjusted by controlling some parts of it from the center.

Thus, the existing research landscape confirms the pressing nature of transforming interbudgetary relations in Russia. A key question that's still open is how to assign tax income in a way that's both politically doable and beneficial for the economy [11]. The debate often comes down to two main ideas: Should the focus be on keeping the federal finances steady by centralizing them to control the economy and make sure things are fair all over the country? Alternatively, should the focus be on providing regions with incentives to grow by decentralizing authority to enhance local responsibility and economic performance? This disagreement is made harder by Russia's realities: its large size, the fact that resources are heavily focused in certain areas, and its past as a very centralized country. Because of this, many suggested fixes tend to address the symptoms instead of the real causes. They make small changes to how money is moved around without really changing the key way income is shared. Our study attempts to fill this gap by going beyond just listing the problems and suggesting real, cooperative changes. We think the best method is in the middle of centralization and decentralization. This study directly addresses the ongoing problem of balancing federal steadiness with solid reasons for areas to grow.

It is crucial to note that the fiscal landscape for regional budgets in Russia is undergoing significant transformation due to recent federal tax initiatives implemented in 2024–2025. Key innovations include the introduction of a progressive scale for the Personal Income Tax (PIT), an increase in the basic rate of the Corporate Profit Tax, and the granting of rights to regions to set increased rates for property taxes [12].

These measures are ostensibly designed to strengthen the revenue base of both the federal and regional budgets. However, their impact on the fundamental problem of regional fiscal dependency and autonomy requires careful analysis. While they may increase nominal revenue, they do not inherently address the structural imbalance where regions control a minor share of stable, economically sensitive tax revenues. The increased progressivity of PIT and the higher profit tax rate may even exacerbate volatility and concentration of revenues in more developed regions, potentially reinforcing existing spatial disparities unless accompanied by a fundamental recalibration

of the tax allocation mechanism itself. Therefore, the proposals of this study, focusing on the reallocation of VAT and MET, should be considered complementary and necessary measures within this new fiscal reality, aiming to provide regions with more predictable and stable revenue sources alongside these recent changes in tax parameters. This study seeks to add to this discussion by suggesting specific ways to change this mechanism.

3. Methods

This study uses a systematic approach to analyze how budgets relate to each other and how fiscal policy works. It aims for a thorough and organized look at how tax money is shared in Russia. The research combines different methods, using both comparison and statistics. Combining methods makes the results stronger, giving a diagnosis that is factual and considers context.

The methodological framework was executed in three distinct, yet interconnected stages to ensure the logical progression from diagnosis to prescription.

The first stage involved a comprehensive diagnostic analysis of the current structure of budget revenues across the federal and regional levels. The primary focus was to quantitatively assess the degree of financial dependence of regions on interbudgetary transfers. The initial step was a close look at what makes up regional budget income, focusing on how much comes from the regions themselves versus what they acquire from federal funds, and watching how these numbers changed during the study. Next, the study looked at what might happen if suggested changes were made and whether they could realistically work. This meant estimating how the budget would be affected if some VAT money was moved to regional budgets and looking at how regional leaders might react to the new rules. The goal was not just to find problems but to test possible answers and spot any dangers linked to them, such as VAT money not being spread evenly across regions. The last part was about the rules and plans already in place. This involved carefully checking the current laws and planning documents that control how tax money is shared and how areas are developed. This included seeing if the goals at the federal, regional, and city levels lined up with the budget money set aside to pay for them, mostly thinking about fair competition between federal areas.

First, the research analyzed the present design of budget incomes, focusing on the extent to which regions rely on financial help from other budgets. Second, the study judged how the planned changes might change the budget balance and what motivates regional leaders. Lastly, the research checked the legal methods for giving out tax money, giving specific consideration to how they affect the budget and if they match the idea of federal competition. The study used official numbers from the Russian Federation's Ministry of Finance from 2019 to 2024. The work used information on tax income from the federal budget and combined regional budgets, focusing especially on VAT and business profit tax.

The research employed conventional methods to compare and make broad statements, examined budget processes as a whole, and meticulously selected laws and statistics. The work added information about budget numbers but also looked at how regions differed financially. The team considered how well the investment tax break worked as a way to boost regional investment. The study also looked at how other countries share tax powers between different levels of their budget systems, mainly learning from how Germany handles VAT. The methodological approach allowed for a comprehensive assessment of the existing system of interbudgetary relations and developed scientifically grounded proposals for its transformation in the context of competitive federalism.

4. Results

First, achieving coherence within the spatial development strategic planning system for Russia's constituent entities and municipal entities necessitates the implementation of a robust, multi-tiered framework. This is proposed to be realized through several interconnected mechanisms designed to enforce vertical and horizontal integration:

- Establishing a strict and transparent hierarchy of strategic planning documents across the federal, regional, and municipal levels. This hierarchy must ensure that strategic vision and national priorities, as defined in federal documents, are systematically translated into concrete objectives and actionable measures within regional and municipal plans. The aim is to form a unified system where documents are linked, ensuring that local projects help achieve broad national objectives.

- Establishing necessary rules for what goes into strategic planning documents at local levels. These rules should make clear how these documents fit with broader plans. They should spell out how local goals and measures support national priorities. Such an arrangement prevents local plans from straying and ensures a single, united spatial development policy for the whole country.

- Creating and operationalizing a unified digital information system for strategic planning, built upon and integrating existing governmental platforms. This system would serve as the central nervous system for spatial development management. Its core function would be to enable real-time monitoring and comprehensive analysis of the dynamics related to achieving stated priorities and goals. Crucially, this system must integrate financial data, allowing for the tracking of key performance indicators against the planned funding volumes from all sources, including interbudgetary transfers [10]. This creates a closed-loop management cycle where budgetary allocations are directly linked to strategic targets, and spending efficiency can be systematically evaluated, thereby identifying potential fiscal risks and implementation bottlenecks early on.

A key aspect of organizing a unified system for strategic spatial development planning in Russia is ensuring full traceability of both the procedures for achieving the country's key development priorities, as reflected in various strategic planning documents, and the use of budgetary funds allocated for implementing the corresponding activities [13]. This traceability is fundamental to creating a closed-loop management cycle, where strategic goals are directly linked to budgetary allocations, and the results of spending are systematically evaluated against predefined targets. Without this vertical and horizontal integration of planning and budgeting, there is a high risk of strategic documents becoming declarative and budgetary resources being dispersed inefficiently, failing to catalyze the intended structural transformations in regional economies [14].

Despite the long history of delegating state powers to public authorities, several issues related to financial support remain critically relevant and act as a significant barrier to effective spatial development. These challenges are systemic and undermine the principles of fiscal fed-

eralism. The problems include, first and foremost, insufficient legal regulation of delegating powers within sectoral regulatory legal acts. This often leads to ambiguous interpretations of responsibilities between federal and regional authorities, creating accountability gaps and implementation delays [15].

Furthermore, a fundamental flaw lies in the discrepancies in the methodologies for calculating subsidies provided to reimburse additional costs incurred by public authorities when executing delegated powers. The current methodologies frequently fail to meet the requirement of completeness and adequacy in financing [16]. They often rely on outdated or averaged expenditure standards that do not account for regional specifics, such as differentiated costs for utilities and transportation in remote northern territories, varying demographic structures, or disparate starting conditions of social infrastructure. This situation leads to the persistent underfunding of assigned responsibilities. Regional and local budgets must then use their limited funds to make up the difference. As a result, they have less capacity to pay for projects related to their own areas of responsibility and improvement objectives. This situation effectively penalizes regions for executing federally mandated policies, creating a perverse incentive structure and weakening their financial sustainability [17]. Addressing these methodological and regulatory gaps is therefore a prerequisite for achieving genuine coherence in the strategic spatial development planning system and for building a more resilient and equitable model of fiscal federalism in Russia.

According to *Fig. 1*, federal budget tax revenues exceed those of all constituent entities. This ratio can be explained by the high concentration of tax powers at the federal level and the specificity of tax revenue allocation between budgets, regulated by budgetary legislation.

The high financial dependence of Russian regions and municipal entities on interbudgetary transfers remains a persistent and critically relevant issue, as unequivocally evidenced by the structure of the revenues of the consolidated budgets of the constituent entities (*Fig. 2*). This dependency is not a transient phenomenon but a structural feature of the current fiscal system, with profound implications for regional governance and economic development [18].

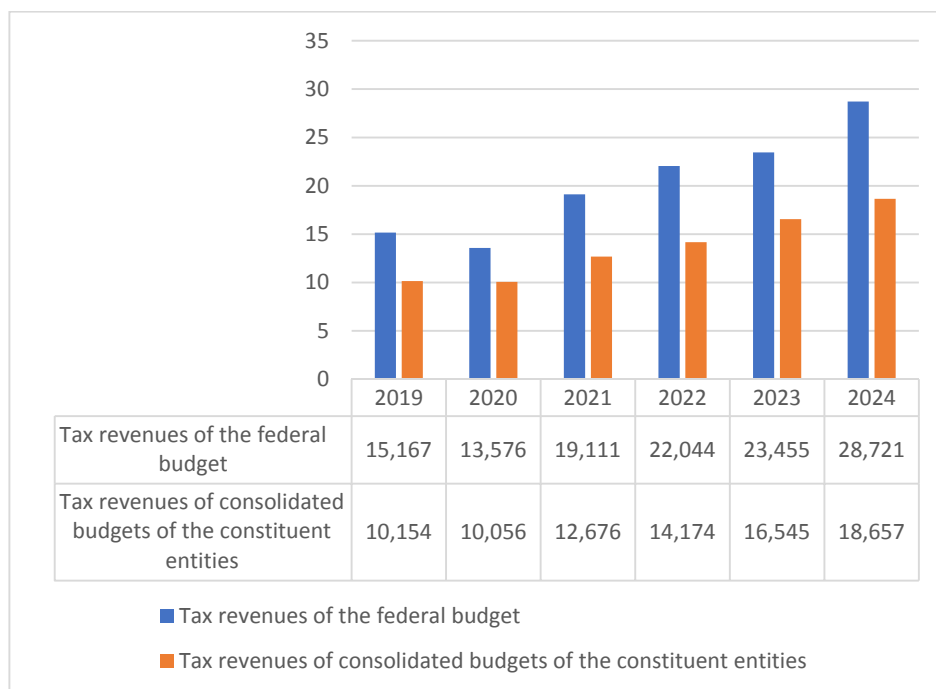


Fig. 1. Tax revenues of the federal budget and consolidated budgets of Russia's constituent entities, trillion rubles

Source: Calculated by the authors on the basis of information on the execution of the consolidated budgets of the subjects of the Russian Federation and the budgets of territorial state extra-budgetary funds on 01.01.2020, 01.01.2021, 01.01.2022, 01.01.2023, 01.01.2024, 01.01.2025. URL: https://roskazna.gov.ru/ispolnenie-byudzhetrov/konsolidirovannye-byudzhety-subektov-rossijskoj-federacii?filter_type=49 (accessed on 10.09.2025) and on data from the Electronic Budget, the unified portal of the Russian Federation's budget system. URL: <https://www.budget.gov.ru/%D0%B1%D1%8E%D0%B4%D0%B6%D0%B5%D1%82/%D0%B4%D0%BE%D1%85%D0%BE%D0%B4%D1%8B> (accessed on 10.09.2025).

This structural dependency manifests itself in several profound and interconnected ways that stifle regional initiative and perpetuate economic inefficiency. Firstly, it creates a deeply entrenched system of “soft budget constraints,” a phenomenon where regional authorities are incentivized to prioritize lobbying for federal subsidies and transfers over implementing politically difficult but economically necessary reforms to strengthen their own revenue base. This behavior fundamentally undermines the principles of fiscal responsibility and accountability at the sub-national level, as the consequences of poor fiscal management or a non-diversified economy are often mitigated by federal bailouts, creating a moral hazard [19].

Secondly, this financial reliance erodes the motivational foundation for regional governments to act as proactive agents of their own economic development. The analysis confirms that dependency reduces the impetus for public authorities to implement responsible, long-term economic and budgetary policies aimed at creating a favorable investment climate and fostering business growth within their territories. When a substantial and predictable portion of a region's budget is guar-

anteed through transfers, the direct, tangible link between successful local economic policy and increased budgetary resources is severed [20]. This decoupling can lead to a perverse incentive structure, where demonstrably successful economic development and an expanding tax base may be “punished” by a corresponding reduction or withdrawal of federal support, without a fully compensatory increase in the region's own revenues. Consequently, regions may consciously or subconsciously avoid pursuing aggressive economic development strategies, as the marginal benefit of such efforts is diminished, and the political costs of reform are high. This creates a vicious cycle where reliance on transfers discourages the very policies that could lead to fiscal self-sufficiency, thereby locking regions into a state of permanent dependency and hindering the transition to a model of competitive federalism where regions thrive based on their economic merits.

Furthermore, this model indicates spatial socio-economic disparities. While interbudgetary transfers are designed to equalize, they often fail to address the root causes of inequality [21]. The system manages the symptoms of regional

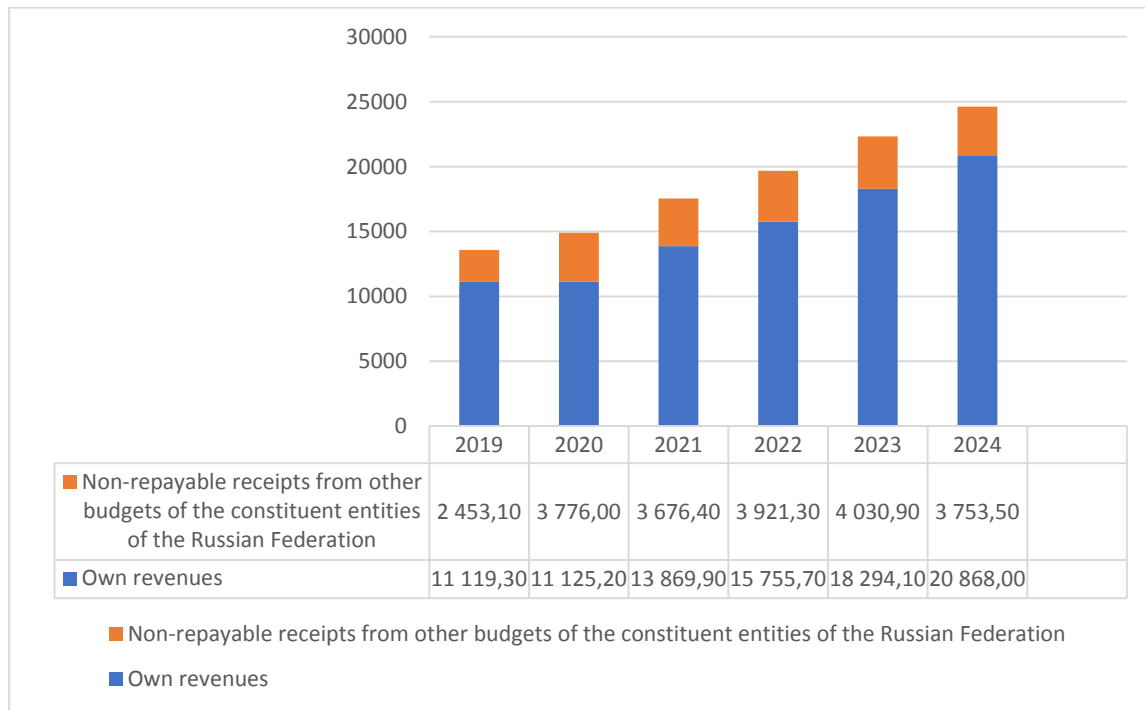


Fig. 2. Structure of revenues of the consolidated budgets of Russia's constituent entities, billion rubles

Source: calculated by the authors on the basis of information on the execution of the consolidated budgets of the subjects of the Russian Federation and the budgets of territorial state extra-budgetary funds for 01.01.2020, 01.01.2021, 01.01.2022, 01.01.2023, 01.01.2024, 01.01.2025. URL: https://roskazna.gov.ru/ispolnenie-byudzhetrov/konsolidirovannye-byudzhety-subektov-rossijskoj-federacii?filter_type=49 (accessed on 10.09.2025).

backwardness rather than catalyzing sustainable, internally driven growth. The data shows that, despite these transfers, the gap between leading and lagging regions in terms of GRP and household income remains stark, indicating that the current mechanism of financial support is insufficient for genuine convergence [22].

Therefore, the structure depicted in Fig. 2 is more than a simple statistical distribution; it is a symptom of a deeper imbalance in the allocation of financial resources and expenditure responsibilities. It confirms the urgent need for a paradigm shift from a compensatory model of fiscal relations to an incentive-based model of competitive federalism, where regions are empowered with greater control over stable revenue sources, thereby directly linking their fiscal well-being to the success of their own socioeconomic policies.

An examination of the revenue structure of Russia's regional budgets from 2019 to 2023 shows a clear and consistent reliance on federal taxes [19]. Over these five years, income from federal taxes, PIT and the corporate profit tax was always the largest portion, making up 64.5% to 67.7% of total regional budget income, as shown in Fig. 3. The Russian fiscal system shows strong

central control, even with shared taxes. Regions rely on these federal taxes for their budgets. The personal income tax (PIT), tied to population income and economic health, gives a large but fluctuating income. The corporate profit tax is also uneven and favors regions with many resources and industries.

The stability of this high percentage range (64.5–67.7%) indicates a rigid system that offers limited fiscal autonomy to the regions. Their capacity to influence these revenue streams through their own policy tools is constrained, as the key parameters (such as the distribution standards for the profit tax) are set at the federal level. This structural dependency creates a paradoxical situation: regions are responsible for a vast array of expenditure obligations, particularly in the social sphere (education, healthcare), yet they have limited control over their primary revenue sources. This reinforces their reliance on the system of interbudgetary transfers to balance their budgets, which, as our research shows, remains a pressing issue. Consequently, this fiscal configuration reduces the incentive for regional authorities to actively cultivate their own economic and tax potential [23], as the marginal gains from such efforts are often overshadowed by adjustments in federal

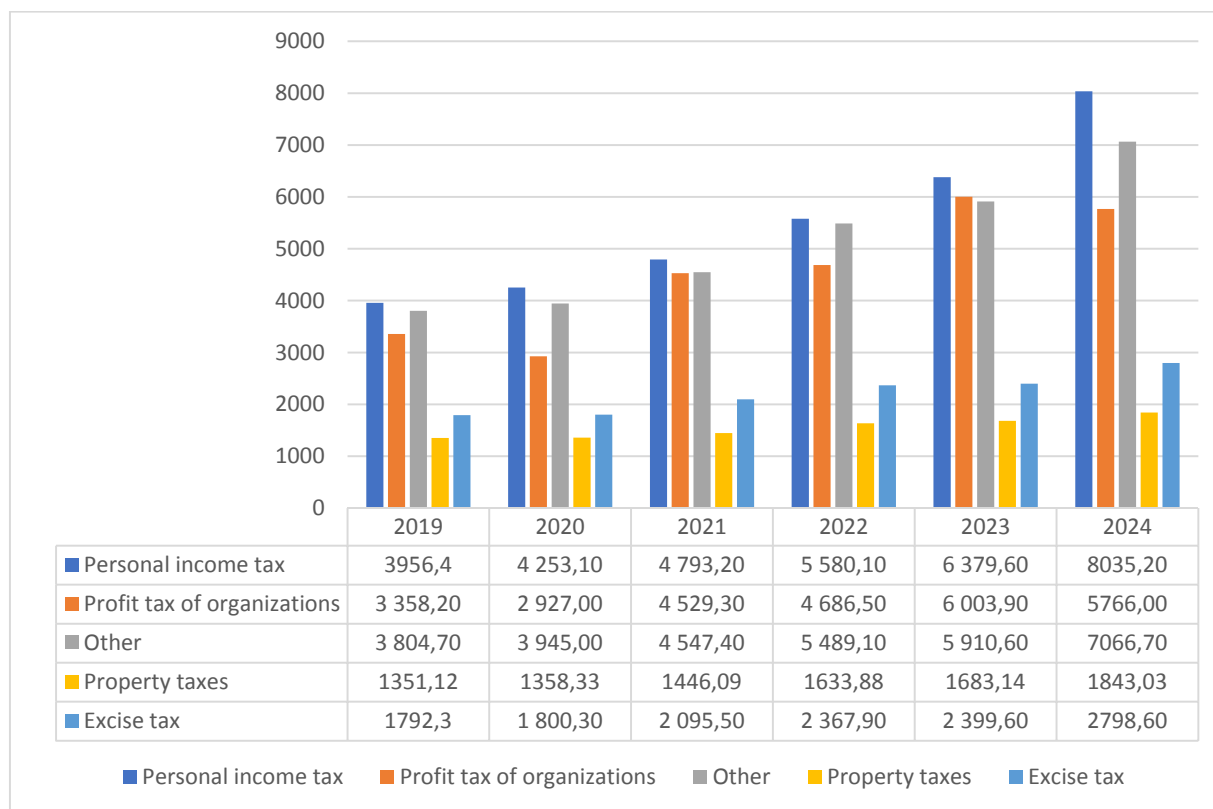


Fig. 3. Tax revenues of the consolidated budgets of the constituent entities of the Russian Federation, billion rubles

Source: calculated by the authors on the basis of information on the execution of the consolidated budgets of the subjects of the Russian Federation and the budgets of territorial state extra-budgetary funds for 01.01.2020, 01.01.2021, 01.01.2022, 01.01.2023, 01.01.2024, 01.01.2025. URL: https://roskazna.gov.ru/ispolnenie-byudzhetrov/konsolidirovannye-byudzhety-subektov-rossijskoj-federacii?filter_type=49 (accessed on 03.09.2025).

transfer payments. This analysis directly substantiates the need for the transformative initiatives proposed in this study, aimed at diversifying and strengthening the own-source revenue base of the constituent entities.

The systemic lack of sufficient autonomous tax sources and the resulting excessive dependence of Russian regions on interbudgetary transfers are not merely symptoms of vertical fiscal centralization but are its direct and debilitating consequences. This structural imbalance actively reduces the motivation of sub-national public authorities to implement responsible, long-term economic and budgetary policies. In a misguided attempt to gain a competitive edge with limited fiscal tools at their disposal, regions may engage in a fiscally detrimental “race to the bottom,” competing against one another by lowering key regional tax rates, such as the corporate profit tax, which ultimately erodes the collective revenue base without guaranteeing sustainable economic growth [24]. This pattern creates a cycle of reliance and weakens responsibility and good management in a federal state.

This can be addressed by putting in place related plans meant to reset the balance of tax powers and income sources between government levels. The advice we offer comes from the idea of competitive federalism, which tries to swap out the current reliance with a system that rewards regions for good financial planning. The following initiatives — concerning VAT, MET, and the investment tax deduction — are conceived as a synergistic package to create this new incentive-based framework.

To quantitatively confirm the structural nature of the identified dependence of regional budget revenues on deductions from federal taxes (personal income tax and corporate profit tax), as illustrated in Fig. 3, it is advisable to use an internal verification method based on calculating the relative range of variation. This approach makes it possible to assess the stability of the observed pattern over time, relying exclusively on the empirical data presented in this study for the period 2019–2024.

The proposed indicator is the stability coefficient (K_{stab}), calculated using the following formula (1).

$$K_{stab} = \frac{\max(FN_{2019-2024}) - \min(FN_{2019-2024})}{avg(FN_{2019-2024})} \times 100\%, \quad (1)$$

where FN is the share of federal taxes (PIT and corporate profit tax) in the revenues of the consolidated budgets of the constituent entities of the Russian Federation in the corresponding year.

Based on the dynamics presented in *Fig. 3*, the minimum (64.5% in 2019), maximum (67.7% in 2022), and arithmetic mean (66.1%) values of the share for the studied period were determined. The range of variation amounted to $67.7\% - 64.5\% = 3.2\%$. Thus, the value of the stability coefficient is:

$$K_{stab} = \frac{3.2\%}{66.1\%} \times 100\% = 4.84\%. \quad (2)$$

The obtained result ($K_{stab} = 4.84\%$) demonstrates low volatility in the share of federal taxes in regional budget revenues over the six-year period. A coefficient value of less than 5% indicates moderate fluctuations of the indicator and confirms the stable, structural nature of regional dependency. Crucially, such an insignificant range of values (only 3.2 percentage points) is observed against the backdrop of significant external macroeconomic shocks, including the COVID-19 pandemic and unprecedented sanctions pressure. For comparable economic indicators under similar conditions, one would expect significantly higher coefficient values (on the order of 10–15% or more), which would be characteristic of conjunctural or random fluctuations.

The low value of K_{stab} serves as a robust statistical argument supporting the thesis of rigid vertical centralization of tax revenues in the Russian budget system. It confirms that the established level of dependency (at the level of 64–68%) is not a temporary phenomenon but an institutionally entrenched characteristic of the current model of interbudgetary relations. This indicator strengthens the evidentiary base of the conducted analysis, demonstrating the statistical reliability of the conclusions outlined in Section 3. It substantiates the objective necessity of transitioning from a compensatory model to an incentive-based system of competitive federalism through the implementation of the proposed set of reforms: the reallocation of 25% of domestic VAT, the delegation of certain powers over the Mineral Extraction Tax (MET), and the

reorganization of the investment tax deduction mechanism.

The first initiative is the transfer of some tax revenues (federal) to the regional and local levels. It may be effective to allocate a portion of the revenues from VAT to the budgets of the regions, according to an established standard [25]. VAT provides a stable flow of income, as confirmed by *Table 1*. The high collection rate of VAT is attributed to the electronic declaration and the use of advanced information technologies by tax authorities in administration.

Thus, as a central pillar of fiscal reform, it is proposed to grant the constituent entities of the Russian Federation the right to receive a fixed share of the revenues from the domestic VAT. Specifically, we propose allocating 25% of the proceeds from the VAT on goods (works, services) sold within the territory of Russia directly to the budgets of the regions. This portion of the VAT is recommended to be allocated to the budget of the region where the seller, who is the taxpayer of this tax, is officially registered. This approach creates a direct and transparent link between a region's economic activity and its budgetary revenues, incentivizing regional authorities to foster a favorable business climate and expand the local tax base [26].

The proposed redistribution of tax revenues is designed to fundamentally strengthen regional financial autonomy. As demonstrated in *Table 2*, the allocated 25% of domestic VAT revenues could cover, on average, over 40% of the non-repayable transfers (subsidies) received by the consolidated budgets of the constituent entities between 2019 and 2024.

A main issue is the inconsistent VAT distribution across regions. To lessen the risk for regions with VAT deficits, we should adjust the current system of horizontal equalization transfers. If regions' income increases, their need for equalization will drop. Furthermore, to compensate for the federal budget's revenue shortfall, a concurrent review of federal expenditure obligations or other revenue sources would be necessary. This balanced approach ensures that the move towards competitive federalism does not exacerbate territorial inequalities but instead creates a more resilient and motivation-based system of interbudgetary relations (*Table 2*) [27].

This analysis directly substantiates the need for the transformative initiatives proposed in this

Table 1

Federal budget VAT revenues, billion rubles

Indicator	2019	2020	2021	2022	2023	2024
Total income	20,188.8	18,719.1	25,286.4	27,824.4	29,124.1	24,621.5
VAT total	7,095.2	7,202.2	9,212.2	9,552.8	11,614.4	13,523.1
VAT (domestic)	4,257.8	4,268.6	5,479.3	6,489.4	7,182.4	8,733.93
VAT on imported goods	2,837.4	2,933.5	3,733.0	3,063.4	4,432.0	4,789.17

Source: compiled by the authors based on data from the Electronic Budget, the unified portal of the Russian Federation's budget system. URL: <https://www.budget.gov.ru/web/guest/%D0%91%D1%8E%D0%B4%D0%B6%D0%B5%D1%82/%D0%94%D0%BE%D1%85%D0%BE%D0%B4%D1%8B/%D0%98%D1%81%D0%BF%D0%BE%D0%BB%D0%BD%D0%B5%D0%BD%D0%B8%D0%B5-%D0%B1%D1%8E%D0%B4%D0%B6%D0%B5%D1%82%D0%B0-%D0%BF%D0%BE-%D0%B2%D0%B8%D0%B4%D0%B0%D0%BC-%D0%B4%D0%BE%D1%85%D0%BE%D0%B4%D0%BE%D0%B2> (accessed on 20.09.2025).

study. To provide a comprehensive quantitative assessment of the current level of regional independence and the potential impact of our proposals, we calculated an Integral Fiscal Autonomy Index (IFAI). To quantitatively assess the level of financial independence of the constituent entities of the Russian Federation and verify the proposed reforms, we developed and calculated an Integral Fiscal Autonomy Index (IFAI). This indicator allows for a comprehensive evaluation of the regions' ability to cover their expenditure obligations using revenue sources under their control, adjusted for the level of fiscal dependency.

The IFAI methodology is based on the ratio of own-source (tax and non-tax) revenues of regional budgets to total expenditure obligations, adjusted by a quality of autonomy coefficient (K), which reflects the share of non-repayable transfers in total revenues (3).

$$IFAI = \frac{TR + NTR}{E} * K, \text{ where } K = 1 - \frac{NT}{R}, \quad (3)$$

where TR is tax revenues; NTR is non-tax revenues; E is expenditures of the consolidated regional budgets; NT is non-repayable transfers (grants); R is the total volume of revenues.

The analysis of the IFAI dynamics over the period 2019–2023 (Table 3) confirms the structural nature of the regions' dependence on the federal center, as identified in this study. On average, over the studied period, the actual IFAI stood at 0.796, meaning that only 79.6% of expenditure obligations were covered by own-source revenues. The most critical value of the index was recorded in 2020 (0.720), due to the crisis-induced decline in

tax revenues against the backdrop of increased social expenditures during the pandemic.

The application of scenario modeling, based on the measure proposed in this study to reallocate 25% of domestic VAT to regional budgets, demonstrates a significant positive effect. In the projected scenario (without the equalization coefficient), the average IFAI increases to 0.881, which corresponds to an increase in autonomy of 8.5 percentage points (or 10.7% relative to the base level). The largest absolute increase in the index was observed in 2023 (+0.092), which correlates with the growth of VAT revenues in the federal budget (Table 1) and confirms the high fiscal potential of this tax as a source of stable income for the regions.

Including the autonomy coefficient (K) in the model, which reflects the consistency of the horizontal equalization system, yields a more careful estimate. The final IFAI, adjusted for fiscal dependency, is about 0.690 over five years. This suggests that even with a stronger revenue base, regional differences are still present. Regions starting with a low tax base still need redistribution, which means the transfer system must be adjusted to fit the ideas of competitive federalism.

The main finding is that the suggested change could lower the difference between regional revenues and spending by about 42%. The obtained IFAI values (0.903 in the 2023 projected scenario) approach the level of full self-sufficiency, thereby creating effective incentives for regional authorities to enhance their own economic potential. At the same time, the final index values (0.584–0.749) point to the need to combine the tax reform with a modernization of the invest-

Table 2

Ratio of 1/4 domestic VAT and non-repayable receipts of the consolidated budgets of Russia's constituent entities

Indicators	2019	2020	2021	2022	2023	2024
Non-repayable receipts of the consolidated budgets of the constituent entities, billion rubles	2,453.1	3,776.0	3,676.4	3,921.3	4,030.9	3,753.5
1/4 of domestic VAT, billion rubles	1,064.4	1,067.2	1,369.8	1,622.3	1,795.6	2,183.48
Ratio of 1/4 of domestic VAT and non-repayable receipts of the consolidated budgets of the constituent entities (1/4 share of coverage of VAT non-repayable receipts), %	43.39	28.26	37.26	41.37	44.55	58.17

Source: Compiled by the authors based on the data from the Electronic Budget, the unified portal of the Russian Federation's budget system. URL: <https://www.budget.gov.ru/web/guest/%D0%91%D1%8E%D0%B4%D0%B6%D0%B5%D1%82/%D0%94%D0%BE%D1%85%D0%BE%D0%B4%D1%8B/%D0%98%D1%81%D0%BF%D0%BE%D0%BB%D0%BD%D0%B5%D0%BD%D0%B8%D0%B5-%D0%B1%D1%8E%D0%B4%D0%B6%D0%B5%D1%82%D0%B0-%D0%BF%D0%BE-%D0%B2%D0%B8%D0%B4%D0%B0%D0%BC-%D0%B4%D0%BE%D1%85%D0%BE%D0%B4%D0%BE%D0%B2?regionId=45000000> (accessed on 11.09.2025) and calculated by the authors on the basis of information on the execution of the consolidated budgets of the subjects of the Russian Federation and the budgets of territorial state extra-budgetary funds for 01.01.2020, 01.01.2021, 01.01.2022, 01.01.2023, 01.01.2024, 01.01.2025. URL: https://roskazna.gov.ru/ispolnenie-byudzhetrov/konsolidirovannye-byudzhety-subektov-rossijskoj-federacii?filter_type=49 (accessed on 03.09.2025).

Table 3

Dynamics of the Integral Fiscal Autonomy Index (IFAI) in 2019–2023

Indicator	2019	2020	2021	2022	2023
Actual IFAI (current model)	0.841	0.720	0.807	0.800	0.811
Projected IFAI (with 25% VAT)	0.928	0.794	0.891	0.887	0.903
Final IFAI (with coefficient K)	0.749	0.584	0.696	0.702	0.720

Source: compiled by the authors based on the data from the Electronic Budget, the unified portal of the Russian Federation's budget system. URL: <https://www.budget.gov.ru/%D0%91%D1%8E%D0%B4%D0%B6%D0%B5%D1%82/%D0%94%D0%BE%D1%85%D0%BE%D0%B4%D1%8B?regionId=45000000> (accessed on 11.09.2025) and calculated by the authors on the basis of information on the execution of the consolidated budgets of the subjects of the Russian Federation and the budgets of territorial state extra-budgetary funds for 01.01.2020, 01.01.2021, 01.01.2022, 01.01.2023, 01.01.2024. URL: https://roskazna.gov.ru/ispolnenie-byudzhetrov/konsolidirovannye-byudzhety-subektov-rossijskoj-federacii?filter_type=49 (accessed on 03.03.2026).

ment tax deduction mechanisms and the delegation of certain MET powers.

The proposal to reallocate a portion of VAT revenues to subnational budgets is not without precedent and finds support in both historical domestic experience and contemporary international practice. In Russia, a similar mechanism was actively employed during the formative period of its fiscal system, from 1999 to 2000. During this time, a defined share of VAT revenues, initially set at 25% and later reduced to 15%, was directly assigned to the budgets of the constituent entities. This historical experiment demonstrates the technical feasibility of such a model within the Russian budgetary framework and provides a valu-

able, albeit dated, reference point for its potential implementation and the challenges that may arise, such as the pressure to recentralize revenues during federal budget shortfalls.

Germany presents a tested model for VAT sharing under constitutional law. The German Basic Law dictates how VAT is divided among the federal government, states, and local areas. The VAT allocation adapts to reflect present financial needs and economic conditions by adjusting its rules within a solid legal base. The federal budget receives the largest portion, with states getting a substantial share and local governments a smaller guaranteed percentage. Germany's VAT system includes an equalization component, where por-

tions of richer states' VAT revenue go to poorer regions. This reduces potential financial disparities. A VAT-sharing arrangement may integrate equalization techniques to support both economic activity and inter-regional equity. State budgets get less than half of the VAT. Of the regional VAT income, 75% is allocated based on population size, and 25% acts as aid for the poorest regions. How local budgets get their share of VAT is based on indicators that reflect tax income per person [5, 8].

The German model operates within a long-standing, stable framework of cooperative federalism with strong, historically established *Länder* (states). The structure of the German economy is more diversified and less dependent on raw materials across its regions compared to Russia's pronounced resource-based regional economies.

The German experience should not be viewed as a blueprint for direct imitation but rather as a conceptual proof-of-concept that demonstrates the technical possibility and potential benefits of constitutionally mandating the sharing of a major federal tax like the VAT with subnational budgets. The specific parameters and mechanisms for such a sharing model in Russia, including the proposed 25% share and allocation criteria, must be designed based on a thorough analysis of domestic fiscal capacity, risks, and strategic priorities, as undertaken in this study. The primary justification for the proposed VAT reallocation in Russia thus rests not on foreign experience but on the internal logic of addressing the identified structural flaws within its own budget system, specifically, the need to reduce dependency on transfers and create a direct link between regional economic activity and budget revenues.

The generalization of experience allows us to identify several negative factors associated with certain risks of transferring a part of VAT revenues to the constituent entities. These include:

- Several regions have a negative VAT balance due to tax deductions. As of January 1, 2025, 11 regions reported negative VAT assessments. These regions include the Republic of Buryatia, the Republic of Sakha (Yakutia), Zabaykalsky Krai, Kamchatka Krai, Primorsky Krai, the Amur Region, the Magadan Region, the Sakhalin Region, the Jewish Autonomous Region, the Chukotka Autonomous Okrug, and the Murmansk Region.

- The dropout of federal budget revenues necessitates adequate compensation. 25% of in-

ternal VAT revenues accounted for 5.27% of the federal budget's income in 2019, 5.70% in 2020, 5.42% in 2021, 5.83% in 2022, and 6.17% in 2023, in 2024.

The uneven interregional distribution of VAT revenues is driven by disparities in labor resource distribution, industrial production and capacity, and natural resource availability.

For these reasons, transferring 25% of domestic VAT to regions will not completely solve the issue of horizontal fiscal imbalances across regions but will contribute to progress toward this goal. Increasing tax revenues will motivate regional authorities to intensify efforts to expand the tax base for assigned taxes. Creating favorable conditions for business development, including improving the effectiveness of regional tax policies, will help boost the volume of goods, works, and services sold [28].

The existing system of horizontal allocation of intergovernmental transfers will not require transformation due to changes in the distribution of tax revenues between government levels. With additional revenues, the budget sufficiency ratio of most regions is expected to improve, reducing their dependency on equalization grants. Federal budget subsidies for various purposes (including co-financing capital investments in state or municipal property) may be reduced.

The second initiative involves transferring part of the tax authority for the MET from the federal to the regional level. A significant share of revenues from this tax (92%) is concentrated in the federal budget. Considering that the negative externalities associated with mineral extraction are predominantly localized within specific regions and the high costs borne by Russian regions to restore natural resources and develop infrastructure, transferring part of the tax authority for MET is economically justified.

Following the subsidiarity principle in the allocation of tax authorities among public governance bodies, we propose implementing the following measures: the delegation of powers to regional authorities to set the MET rate and determine the tax base; the establishment by federal government authorities of restrictions on changes in the rate by the constituent entities outside a certain range.

The third initiative involves reorganizing as a tool for tax-based stimulation of the investment appeal of the constituent entities. Invest-

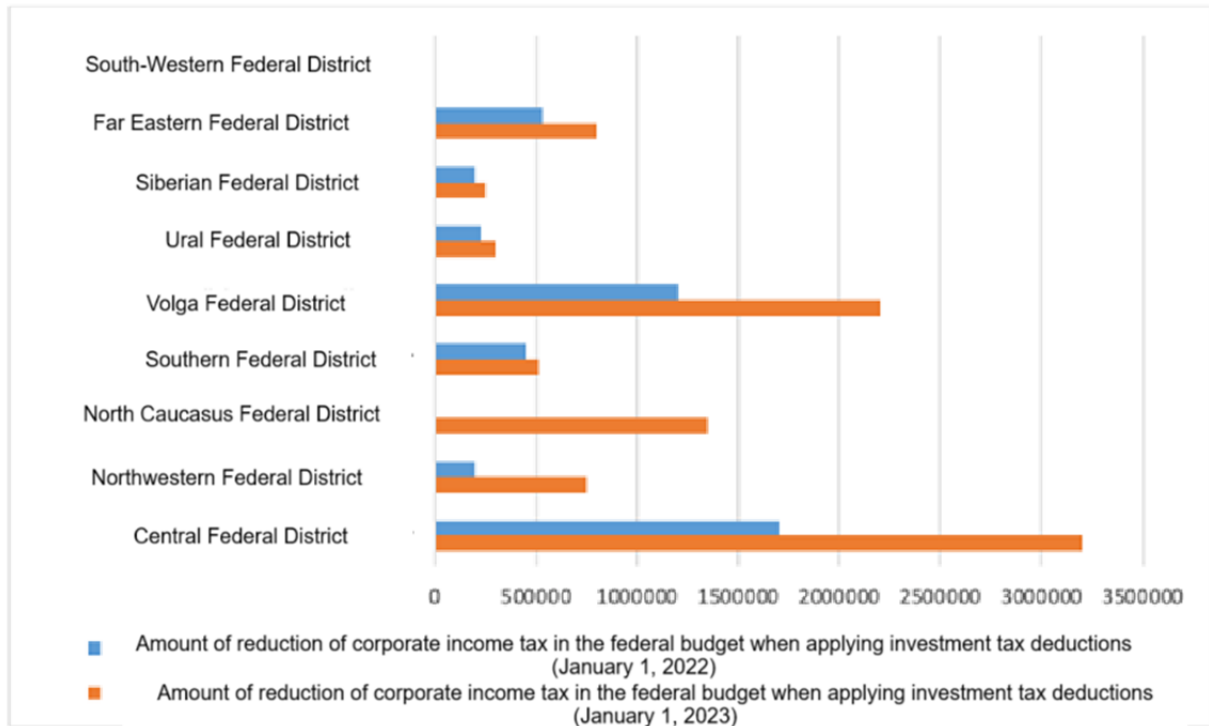


Fig. 4. Decrease in corporate income tax in the federal budget as a result of the provision of ITC by federal districts

Source: compiled by the authors based on data from the reports on the accrual and receipt of taxes, fees, insurance premiums, and other mandatory payments (form No. 1-NM, consolidated in the Russian Federation as a whole) of the Federal Tax Service of Russia URL: https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/ (accessed on 10.09.2025).

ment tax deductions hold significant potential for encouraging investment activity in regions and municipalities by reducing corporate income tax payable to regional budgets by up to 90% of investment expenses on fixed assets and to the federal budget by up to 10% of similar expenses. The primary goal of introducing investment tax deductions is to increase the share of investments [29].

The application is uneven across Russian regions, leading to interregional differentiation in the volumes of granted investment tax deductions and the reduction of corporate income tax revenues (Figs. 4 and 5).

Despite the increase in ITC, few tax-paying organizations have utilized the right to claim these deductions. The limited use of ITC can be explained by several reasons, including:

1. The transfer of the authority to establish these deductions to the regional level (the constituent entities introduce additional restrictive conditions, reducing the accessibility of ITC).

2. The compensation for the lost revenues of the budgets of the regions that have implemented ITC is partial and does not fully cover the financial losses of the regions.

Our analysis reveals that the current model of fully regional administration of the ITD has led to its inefficiency and underutilization. Regions, especially those with weaker fiscal capacity, are reluctant to actively use this tool due to the direct and uncompensated loss of their already scarce budget revenues.

The proposed measures are as follows:

1. Establishing a unified federal standard for the key parameters (e.g., minimum investment threshold, list of eligible assets, maximum deduction rate). This will create a predictable and attractive environment for investors nationwide and prevent interregional fragmentation of the instrument.

2. Introducing a federal mechanism to compensate regional budgets for a significant portion of the foregone revenues resulting from the application of the ITD. This will remove the key barrier for regions to use the tool actively, as it will mitigate the direct negative impact on their fiscal capacity. The compensation could be partial and tied to the performance of the investments (e.g., job creation, growth in tax base in subsequent periods).

3. Extending to small- and medium-sized enterprises operating under the simplified tax

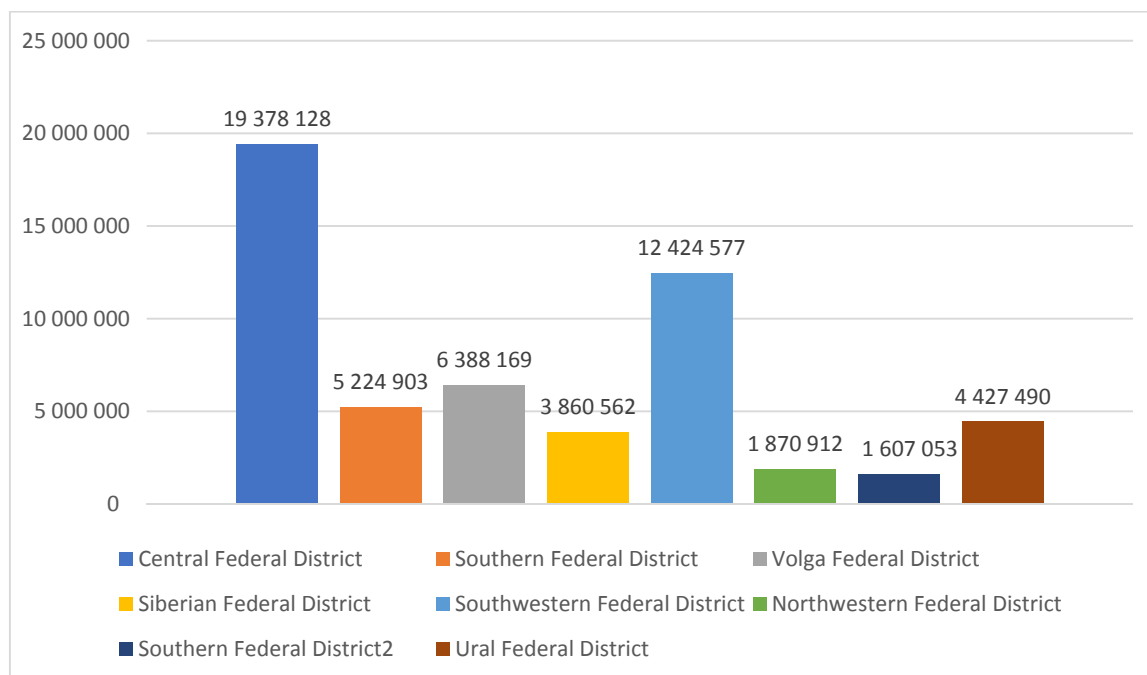


Fig. 5. Distribution of ITC by federal districts, thousand rubles

Source: compiled by the authors based on data from the reports on the accrual and receipt of taxes, fees, insurance premiums, and other mandatory payments (form No. 1-NM, consolidated in the Russian Federation as a whole) of the Federal Tax Service of Russia URL: https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/ (accessed on 10.09.2025).

system to reduce their current tax obligations associated with the payment of the unified tax, thereby broadening the base of beneficiaries and stimulating investment in this sector.

This recalibrated model positions the ITD as an instrument of partnership. The federal center bears the cost of stimulating investments in the real sector (through foregone profits tax and compensation to regions), while the regions gain, federally co-financed tool to attract investors without fear for their immediate budget revenues, aligning their incentives with the national goal of accelerating investment activity.

Therefore, the proposed model (scheme), which reveals the systemic interconnection between all elements of the strategic planning system for spatial development at the federal, regional, and municipal levels, is presented in Fig. 6.

The model links strategic goals, regional fiscal power, and budget execution [30].

Thus, the imperative for improving the allocation of tax revenues between budgets is fundamentally linked to achieving overarching national strategic goals [10]. A reformed system directly addresses the critical objectives of mitigating profound interregional and intraregional socioeconomic disparities, which currently pose a significant risk to the nation's cohesive spatial

development. Furthermore, it is a prerequisite for ensuring the long-term fiscal balance and stability of the budgets of the constituent entities and local budgets. By empowering regional and municipal authorities with more predictable and growth-sensitive revenue sources, the system moves away from a model of compensatory dependence towards one of proactive, responsible financial management, all while maintaining the strategic direction defined at the federal level.

The three practical recommendations outlined in this study — concerning VAT, MET — are not isolated measures but represent an interconnected set of reforms designed to work in synergy. Each action has particular steps for doing it. Table 4 puts together these steps and their expected results.

5. Discussion

A proposal for reforming interbudgetary relations must be considered within the context of the current period, characterized by severe sanctions pressure and geopolitical tensions. In such conditions, the argument for the concentration of financial resources at the federal level to ensure national security and macroeconomic stability is paramount. However, the proposed transformation of tax revenue allocation is not antitheti-

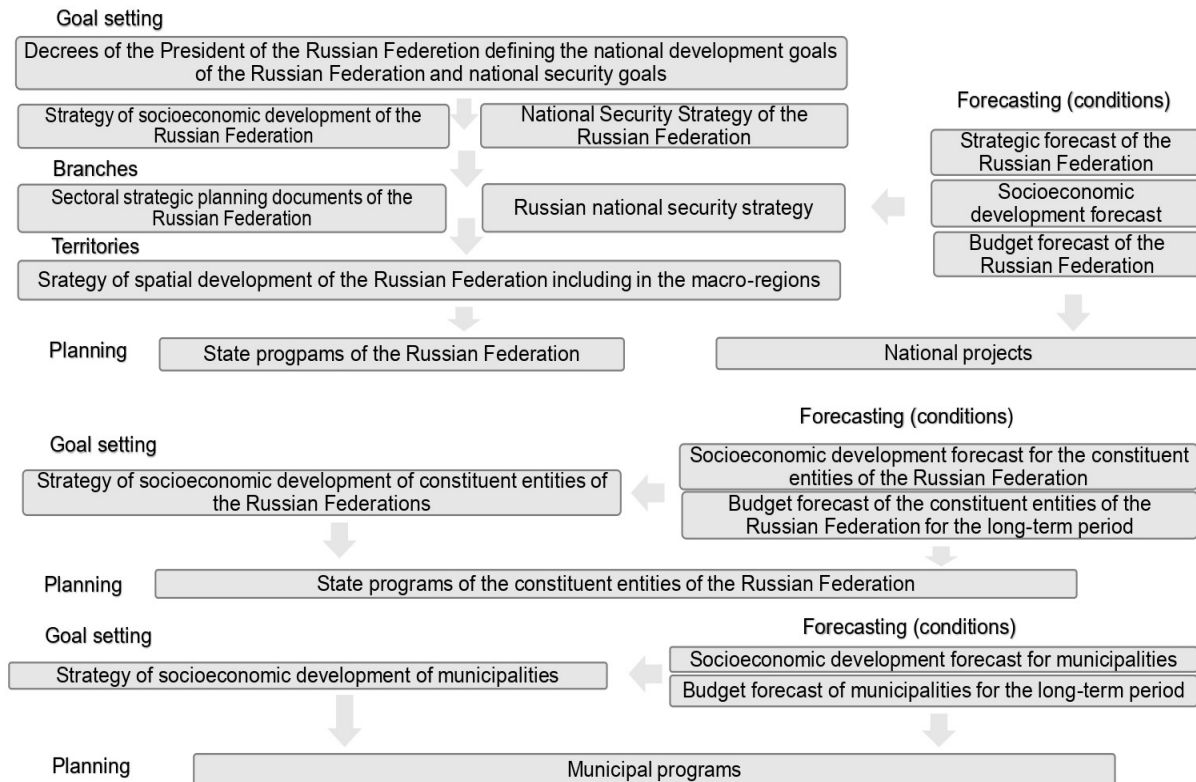


Fig. 6. Target model of the system of strategic planning of spatial development at the federal, regional, and municipal levels

Source: Compiled by the authors via Rakovsky I.D. Issues of Ensuring Unity in Territorial Development Management. *Innovations*. 2024;2(298):23–29. URL: <https://www.elibrary.ru/item.asp?id=76096999> (accessed on 10.09.2025).

Table 4

Proposals to improve the differentiation of tax revenues between the federal budget and the budgets of Russia's constituent entities

Development trends	Implementation measures	Expected results
Spatial polarization of socioeconomic development of the constituent entities of the Russian Federation, concentration of a larger share of GDP in a limited number of regions; Lack of sufficient tax revenues and excessive dependence of the budget of the constituent entities of the Russian Federation on interbudgetary transfers	Transferring some tax powers on MET from the federal level to the level of the constituent entities of the Russian Federation; Assigning the share of VAT to the budget of the constituent entities of the Russian Federation; Adjusting the investment tax deduction mechanism in terms of the powers of the federal authorities of the Russian Federation, subsidizing shortfall revenues, and expanding its application	Strengthening the financial independence of the constituent entities of the Russian Federation; Increasing the financial sustainability of the regions; Ensuring fair inter-territorial distribution of revenues from the use of natural resources; Stimulating government authorities of the constituent entities of the Russian Federation to carry out socioeconomic transformations and intensify investment activity in the region

Source: Compiled by the authors.

cal to this objective. The existing model of high centralization coupled with significant reverse transfers creates substantial transaction costs. By providing regions with a stable, own-source revenue stream linked to their economic activity, the proposed model aims to reduce their chronic dependency on federal subsidies. Thus, the reform is not about dispersing resources but about optimizing their flow and creating a more resilient, self-sufficient economic system where regions become active partners in development.

In Russia, a key part of a unified system for strategic spatial development planning is ensuring that we can trace both the actions taken to meet the country's main goals (as seen in planning papers) and the ways that budget money is spent on related work. This traceability is needed to make a management cycle where goals are tied to budgets, and spending results are checked against targets. If planning and budgeting aren't integrated, strategic documents may just be statements, and budget money may be spread out in a way that doesn't help regional economies change as planned.

Even with the tradition of giving state powers to public entities, budget support is still important and slows spatial progress. These problems affect the entire system and fiscal federalism. First, there isn't enough legal control when giving powers in sectoral regulatory acts. This can cause confusion about who is responsible between federal and regional bodies, which makes it difficult to hold people responsible and causes delays. Also, there are differences in how subsidies are calculated to repay extra costs that public entities have when using given powers. These calculations often don't fully fund what's needed. They may use spending amounts that don't consider regional differences, such as utility and transportation costs, population differences, or the state of social systems. The chronic underfunding of assigned duties forces regional and local budgets to use their limited funds to cover deficits. Talks about changing inter-budgetary relations should consider the recent tax changes from 2024–2025. A progressive PIT scale, higher rates, and more regional control over property taxes mark a big change. While these changes could increase total budget revenue, they don't automatically fix the main problem of vertical imbalance, which this study found. The increased progressivity of PIT may cause greater revenue

changes for regions that rely on a few high-income taxpayers. Similarly, the ability to raise property tax rates is a tool with limited applicability and political costs, which may not be equally effective across all regions. Therefore, the proposed reallocation of a share of VAT, a stable and broad-based tax, becomes even more critical. It would provide regions with a counter-cyclical, predictable revenue stream, complementing the more volatile revenue sources enhanced by the recent reforms. The suggestions for the MET ought to be seen as key parts of a full reform plan.

6. Conclusion

This study met its main goal: creating and backing up a set of steps to change how tax money is split between the Russian federal and regional budgets. By looking at budget numbers from 2019–2024 and reviewing planning strategies, the research made a practical plan for reform. The empirical evidence demonstrates that the existing system, where regions control a minor share of stable revenue sources despite bearing significant expenditure obligations, fosters a “soft budget constraint”, discourages the cultivation of their own tax bases, and weakens the crucial link between local policy effectiveness and fiscal well-being. The analysis of data from 2019–2024 provides empirical evidence that this structural dependency remains a persistent issue.

The scientific novelty of this research lies in the integrated approach of its proposals. This work:

- Applied a comprehensive methodology that combined statistical analysis of budget indicators and system analysis of strategic planning processes.
- Provided a quantitative assessment of a key reform initiative, demonstrating that reallocating 25% of domestic VAT to the regions could cover a significant and growing share (from 28 to 58% in 2019–2024) of their non-repayable federal transfers.
- Proposed a transformative concept of competitive federalism for the Russian context. It posits that competition should be driven not by a “race to the bottom” in tax rates but by creating a direct link between regional economic policy effectiveness and the growth of stable, own-source revenues (like a share of VAT), while mitigating risks through a recalibrated equalization system.

The theoretical significance of the results is their contribution to the theory of fiscal federalism, specifically in adapting the principles of competitive federalism to a large, spatially heterogeneous federation with a legacy of high centralization. The study clarifies the conditions under which delegating control over more stable revenue sources can create positive incentives for regional authorities without jeopardizing federal macroeconomic stability, thereby enriching the academic discourse on optimal tax assignment.

The research offers actionable recommendations for fiscal policy:

- For federal authorities, it provides a calculated model for strengthening regional budgets, which can reduce long-term equalization pressures and free up federal resources for strategic national priorities.
- For regional authorities, the proposals outline a pathway to greater financial autonomy and a more predictable revenue base, directly linking their fiscal well-being to the success of local economic development policies.
- The developed target model for strategic planning offers a blueprint for achieving greater coherence and traceability in spatial development policy across all levels of government.

This study's results and suggestions lead to various paths for looking into things later:

1. Risk models and pay structures: Later studies should create ways to pay back the federal budget for moved VAT income and make good transfer plans to aid areas with bad VAT numbers.

2. Area and region examples: We need a close look at what could happen if some areas that are rich in resources get MET power, plus models on how it hits their budget staying power.

3. Comparing systems: A better compare of money sharing models in other big resource-heavy federations (such as Canada and Australia) could bring good ideas on running up and down balances in places close to Russia.

4. Keeping tabs on change success: Making a key sign system to watch how the planned changes affect regional investment, small business growth, and gaps between regions would be key for study later on.

Putting the planned steps in place, such as moving VAT, giving MET power, and cutting in a federal-regional team, is a must for Russia's budget relations to get anywhere. This switch is not just a tech budget fix, but a plan must be made so that the federation is strong, motivated, and has a good money balance.

ACKNOWLEDGEMENTS

This article was prepared based on research funded by the budgetary resources allocated through the state assignment of the Financial University under the Government of the Russian Federation.

REFERENCES

1. Plisetskii E. L. Structural changes in Russia's spatial development: new realities. *Management Sciences*. 2022;13(3):21-33.
2. Eremin V. V., Silvestrov S. N., Kotova N. E. Forming the goals of structural modernization of the Russian economy under sanctions. *Bulletin of the Altai Academy of Economics and Law*. 2023;(5-1):48-53. (In Russ.). DOI: 10.17513/vaael.3411
3. Kosov M. E. Monetary regulation and its impact on the economy and finance. *Bulletin of the Moscow University of the Ministry of Internal Affairs of Russia*. 2024;(1):184-191. (In Russ.). DOI: 10.24412/2073-0454-2024-1-184-191
4. Kosov M. E., Eremin V. V., Pobyvaev S. A., Gaibov T. S. O. Applying the investment multiplier to identify key points of economic growth. *Emerging Science Journal*. 2022;6(2):273-285. DOI: 10.28991/ESJ-2022-06-02-05
5. Gracheva M. V. The German federal budget: the outcome of 2022 and the crisis of 2023. *Scientific Analytical Bulletin of the Institute of Europe RAS*. 2023;(2):61-70. DOI: 10.15211/vestnikieran220246170
6. Bukharian V. V., Lavrov A. M. Interbudgetary relations and public administration: opportunities and limitations of decentralization. *Issues of Public and Municipal Administration*. 2021;(2):126-153. (In Russ.).
7. Vasyunina M., Kosov M., Gorlova O., Masterov A., Zambaev K., Safronova E., Shmigol N. New economic model and conceptual directions for increasing Russia's regional budgets sustainability. *Emerging Science Journal*. 2024;8(2):603-624. DOI: 10.28991/ESJ-2024-08-02-015
8. Trofimova Ya. The German path to fiscal federalism. *Economic Policy*. 2025;20(1):106-124. (In Russ.). DOI: 10.18288/1994-5124-2025-1-106-124

9. Kolesnikova E.N. Prospects for the formation of federal budget tax revenues in 2024. In: Socio-Economic and Legal Measures to Combat Crimes and Other Offenses: All-Russian Conference: Collection of Scientific Papers. Ryazan: V. Ya. Kikot Moscow University of the Ministry of Internal Affairs of the Russian Federation; 2024:95-99. (In Russ.).
10. Rakovsky I.D. Issues of Ensuring Unity in Territorial Development Management. *Innovations*. 2024;2(298):23-29. EDN: DBGAOR. (In Russ.).
11. Kolesnikov D.A. The effectiveness of the tax revenue distribution system between the federal center and the regions in modern Russia. In: *MNSK-2022: Proceedings of the 60th International Scientific Student Conference*. Vol. 1. Novosibirsk: Novosibirsk National Research State University; 2022:39-40. (In Russ.).
12. Yarullin R.R., Trishina I.A. Problems of distinguishing revenues between budgets of the budget system of the Russian Federation. *Bulletin of the Altai Academy of Economics and Law*. 2024;(2):299-308. (In Russ.). DOI: 10.17513/vaael.3857
13. Dobrynin N.M. Russian federalism as a prototype of the global multipolarity of the future. *State and Law*. 2024;(2):32-42. (In Russ.). DOI: 10.31857/S1026945224020037
14. Karavaeva O.A., Litvinenko E.N. Increasing the sustainability of regional budgets in the context of disinflation. *Economics and Entrepreneurship*. 2020;(4):292-295. (In Russ.).
15. Tarabara D.O. The problem of insufficient tax revenue for the budgets of the subjects of the Russian Federation. In: *State and Law: Proceedings of the 58th International Scientific Student Conference*. Novosibirsk: Novosibirsk National Research State University; 2020:54-55. (In Russ.).
16. Sumskaya T.V. Analysis of the budgetary security of Russian regions: approaches and conclusions. *Region: Economics and Sociology*. 2025;(2):29-52. (In Russ.). DOI: 10.15372/REG20250202
17. Dynnikova O.V., Kyobe A., Slavov S. Regional disparities and fiscal federalism in Russia. *Journal of the New Economic Association*. 2022;3(55):102-138. DOI: 10.31737/2221-2264-2022-55-3-6
18. Kiseleva E.G. Assessment of the debt sustainability of the regional budget system. *Regional Economics and Finance*. 2022;(3):110-128. (In Russ.).
19. Tedeeva Z.B., Tedeev A.A., Pukhaev M.M. The main problems of forming regional budgets of the Russian Federation and ways to strengthen them. *Financial Management*. 2023;(6-2):188-194. (In Russ.). DOI: 10.25806/fm6-22023188-194
20. Zhuravleva T.A., Semenova E.M., Goltsova O.M. Financial sustainability of regional budgets in the context of cyclical economic development. *Regional Economics. South of Russia*. 2021;9(4):166-180. (In Russ.).
21. Arlashkin I. Yu. Interbudgetary instruments for stimulating regional economic growth in Russia. *Financial Journal*. 2020;12(6):54-68. (In Russ.).
22. Bulochnikov P.A. On the typology of the subjects of the Russian Federation. *Petersburg Economic Journal*. 2020;(4):82-89. (In Russ.).
23. Mikhailova A.A., Timushev E.N. The budget system of Russia: how sustainable is it? *HSE Economic Journal*. 2020;(4):572-597. (In Russ.).
24. Abuselidze G. The intergovernmental relations and their regulation in the context of decentralization of fiscal policy. *E3S Web of Conferences*. 2021;280:02010. DOI: 10.1051/e3sconf/202128002010
25. Dynnikova O.V., Kyobe A., Slavov S. Regional disparities and fiscal federalism in Russia. *Journal of the New Economic Association*. 2022;3(55):102-138. DOI: 10.31737/2221-2264-2022-55-3-6
26. Pobedin A.A. Federal Intergovernmental Transfers in the Russian Federation: Experience and Results of Implementation. *R-Economy*. 2024;10(2):174-189. DOI: 10.15826/recon.2024.10.2.011
27. Zenkina M.V., Shcherbakova E.N., Milchakova N.N., Reshetnikov L.L. Some aspects of the regional policy for interbudgetary relations. *International Journal of Civil Engineering and Technology*. 2018;9(2):765-775.
28. Nigmatullina G.R., Gusmanov R.U., Ableeva A.M. et al. Content-analysis of the consolidated budget of the region *Economics, Labor, Management in Agriculture*. 2024;11(117):43-50. (In Russ.). DOI: 10.33938/2411-43
29. Tashtamirov M.R. The effectiveness of interbudgetary regulation of highly subsidized budgets of the subnational level. *Finance: Theory and Practice*. 2022;26(2):136-159. (In Russ.). DOI: 10.26794/2587-5671-2022-26-2-136-159
30. Szarowska I. Fiscal decentralisation and economic development in selected unitary European countries. *European Financial and Accounting Journal*. 2014;9(1):22-40.

ABOUT THE AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

Michael E. Kosov — Ph.D. (Brit.), Cand. Sci. (Econ.), associate professor at the Department of public finance of the Finance faculty at the Financial University under the Government of the Russian Federation, Moscow, Russian Federation

Михаил Е. Косов — PhD (Великобритания), кандидат экономических наук, доцент кафедры общественных финансов финансового факультета, Финансовый университет при Правительстве Российской Федерации, Москва, Российская Федерация

<https://orcid.org/0000-0002-1067-0935>

Corresponding Author / Автор для корреспонденции:

mekosov@fa.ru

Margarita L. Vasyunina — Cand. Sci. (Econ.), head of the Department of public finance of the Finance faculty at the Financial University under the Government of the Russian Federation, Moscow, Russian Federation

Маргарита Леонидовна Васюнина — кандидат экономических наук, заведующая кафедрой общественных финансов финансового факультета, Финансовый университет при Правительстве Российской Федерации, Москва, Российская Федерация

<https://orcid.org/0000-0002-3737-3607>

mvasyunina@fa.ru

Olga A. Polyakova — Cand. Sci. (Econ.), associate professor at the Department of public finance of the Finance faculty at the Financial University under the Government of the Russian Federation, Moscow, Russian Federation

Ольга Александровна Полякова — кандидат экономических наук, доцент кафедры общественных финансов финансового факультета, Финансовый университет при Правительстве Российской Федерации, Москва, Российская Федерация

<https://orcid.org/0000-0003-4722-7053>

opolyakova@fa.ru

Authors' declared contribution:

M.E. Kosov — development of the theoretical framework, critical analysis of research findings, and formulation of practical recommendations for transforming tax revenue allocation; analysis of international practices in fiscal federalism, formulation of recommendations for adapting foreign experience to the Eurasian economic context, critical revision of the research for key intellectual content, and interpretation of the obtained results.

M.L. Vasyunina — conceptualization of the research, literature review development, formulation of methodological approaches.

O.A. Polyakova — statistical data processing, econometric modeling, preparation of visual materials (tables and figures), and data visualization.

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The article was submitted on 09.10.2025; revised on 24.01.2026 and accepted for publication on 25.02.2026.

The authors read and approved the final version of the manuscript.

DOI: 10.26794/2308-944X-2026-14-1-111-134
UDC 336.3,338.2(045)
JEL F34, E23, O33, E21

Impact of External Debt, Capacity Utilization and Digital Infrastructural Architecture on National Savings in African Debt-Distressed Countries

I.C. Nwakoby¹, C.O. Manasseh², J.O. Nwakoby³,
C.S. Logan⁴, O.C. Okanya⁵, C.G. Okeke⁶

^{1,2,3} University of Nigeria, Nsukka, Nigeria;

⁴ Liberty University, Lynchburg, United State;

⁵ Institute for Management and Technology, Enugu, Nigeria;

⁶ Coal City University, Enugu, Nigeria

ABSTRACT

Purpose. This study examines the impact of external debt, capacity utilisation, and digital infrastructural architecture on national savings in African debt-distressed countries. It addresses a critical gap in the literature by providing a holistic empirical assessment of how debt dynamics, productive efficiency, and digital transformation jointly influence domestic resource mobilisation in vulnerable economies. **Methods.** The analysis employs panel data from 18 African debt-distressed countries covering 2011–2024. The panel system generalised method of moments (GMM) is used as the baseline estimator to address endogeneity and dynamic panel bias, while the threshold cross-sectionally augmented autoregressive distributed lag (CS-ARDL) model serves as a robustness check to capture short and long-run dynamics and cross-sectional dependence. The **findings** reveal that rising external debt measured through debt ratios, servicing obligations, and debt stock significantly reduces national savings in both the short and long run, reflecting fiscal crowding-out effects. Capacity utilisation indicators also exert a negative influence on savings, suggesting structural inefficiencies rather than productivity-enhancing expansion. Digital infrastructural architecture shows negative short-run effects on savings due to high investment costs and institutional constraints, though potential long-term benefits remain evident. Diagnostic tests confirm model validity and robustness. **Significance.** The results underscore the need for prudent debt management, productivity-oriented investment, and institutionally grounded digital infrastructure reforms to enhance national savings and strengthen macroeconomic resilience in African debt-distressed economies.

Keywords: external debt; domestic savings; digital infrastructure; financial inclusion; Sub-Saharan Africa; system GMM; CS-ARDL; debt sustainability; macroeconomic policy; financial development

For citation: Nwakoby I.C., Manasseh C.O., Nwakoby J.O., Logan C.S., Okanya O.C., Okeke C.G. Impact of external debt, capacity utilization and digital infrastructural architecture on national savings in African debt-distressed countries. *Review of Business and Economics Studies*. 2026;14(1):111-134. DOI: 10.26794/2308-944X-2026-14-1-111-134

Влияние внешнего долга, использования производственных мощностей и архитектуры цифровой инфраструктуры на национальные сбережения в африканских странах, испытывающих проблемы с задолженностью

И.С. Нвакоби¹, Ч.О. Манассе², Дж.О. Нвакоби³,
Ч.С. Логан⁴, О.С. Оканья⁵, Ч.Г. Океке⁶

^{1,2,3} Университет Нигерии, Нсукка, Нигерия;

⁴ Университет Либерти, Линчберг, США;

⁵ Институт менеджмента и технологий, Энугу, Нигерия;

⁶ Университет Коул-Сити, Энугу, Нигерия

АННОТАЦИЯ

Цель. В исследовании рассматривается влияние внешнего долга, коэффициента использования мощностей и архитектуры цифровой инфраструктуры на национальные сбережения в африканских странах, испытывающих долговую нагрузку. Оно восполняет существенный пробел в литературе, предоставляя целостную эмпирическую оценку того, как динамика долга, эффективность производства и цифровая трансформация совместно влияют на мобилизацию внутренних ресурсов в уязвимых экономиках. **Методы.** В анализе используются панельные данные по 18 африканским странам, испытывающим проблемы с задолженностью, за период 2011–2024 гг. Метод обобщенных моментов панельной системы (GMM) используется в качестве базовой оценки для определения эндогенности и динамического смещения панели, а пороговая модель авторегрессионного распределенного лага (CS-ARDL) служит для проверки устойчивости краткосрочной и долгосрочной динамики. **Результаты** показывают, что рост внешнего долга, измеряемый с помощью коэффициентов задолженности, обязательств по обслуживанию и объемом долга, значительно снижает национальные сбережения как в краткосрочной, так и в долгосрочной перспективе, что отражает эффект вытеснения бюджета. Показатели использования производственных мощностей также указывают на отрицательное влияние на сбережения, что свидетельствует о структурной неэффективности, а не о росте производительности. Цифровая инфраструктурная архитектура демонстрирует отрицательное краткосрочное влияние на сбережения из-за высоких инвестиционных затрат и институциональных ограничений, хотя потенциальные долгосрочные выгоды остаются очевидными. Диагностические тесты подтверждают достоверность и надежность модели. **Значимость.** Результаты подчеркивают необходимость разумного управления долгом, инвестиций, ориентированных на повышение производительности, и институционально обоснованных реформ цифровой инфраструктуры для увеличения национальных сбережений и укрепления макроэкономической устойчивости в африканских странах, испытывающих проблемы с долгом.

Ключевые слова: внешний долг; внутренние сбережения; цифровая инфраструктура; доступность финансовых услуг; страны Африки к югу от Сахары; система GMM; CS-ARDL; приемлемый уровень задолженности; макроэкономическая политика; финансовое развитие

Для цитирования: Nwakoby I.C., Manasseh C.O., Nwakoby J.O., Logan C.S., Okanya O.C., Okeke C.G. Impact of external debt, capacity utilization and digital infrastructural architecture on national savings in African debt-distressed countries. *Review of Business and Economics Studies*. 2026;14(1):111-134. DOI: 10.26794/2308-944X-2026-14-1-111-134

1. Introduction

Persistently low national savings remain a fundamental barrier to macroeconomic stability and sustainable development in Africa's most indebted countries. Domestic savings serve as a critical source of investment capital, reduce current account imbalances, and provide a buffer against external shocks. In economies burdened by high

external debt, weak savings undermine fiscal sustainability, restrict productive investment, and increase reliance on costly foreign financing. This issue has intensified recently, as several African nations have experienced sovereign debt distress, defaults, and protracted restructuring processes. Zambia's debt default in 2020 and Ghana's suspension of external debt payments in 2022 ex-

emphasize how limited domestic savings amplify vulnerability to external shocks and constrain governments' capacity to finance development independently.¹ By contrast, countries such as Botswana, which maintain higher domestic savings through institutional mechanisms including stabilization and sovereign wealth funds, exhibit greater macroeconomic resilience and reduced exposure to external debt pressures.² Enhancing national savings in debt-distressed economies requires integrated strategies combining sound fiscal management, productive investment, and inclusive financial systems. External debt, capacity utilisation, and digital infrastructural architecture are key determinants shaping saving behaviour. Elevated external debt increases debt servicing obligations, limiting resources for investment and domestic savings. Efficient utilisation of productive capacity enhances output and income, generating scope for higher savings. Likewise, comprehensive digital infrastructure fosters financial inclusion, improves access to savings platforms, and increases operational efficiency across public and private sectors. Countries such as Kenya and Rwanda illustrate how digital finance can support domestic savings even under fiscal pressures. Strengthening these interlinked factors is therefore vital for mobilising domestic resources and advancing sustainable economic growth across Africa's highly indebted economies.

External debt plays a critical role in shaping national savings in Africa's most indebted economies, frequently undermining both macroeconomic stability and long-term growth prospects. When debt levels become unsustainable, governments are forced to dedicate a substantial portion of national income to servicing external obligations, thereby limiting resources available for domestic investment, public savings, and essential development priorities. More than twenty African countries, including Zambia, Ghana, and Ethiopia, are either in or at high risk of debt distress.³ Zambia's debt default in 2020 illustrates how escalating debt

service obligations can overwhelm fiscal capacity, constrain savings and reduce the ability to finance productive investment despite ongoing restructuring efforts. Elevated external debt also discourages private saving by increasing uncertainty about future taxation, inflation, and economic stability. Debt overhang theory, as articulated by Krugman (1988) [1], posits that expectations of fiscal pressure from unsustainable debt diminish incentives for both investment and savings, as households and firms anticipate economic instability. In Ghana, where public debt exceeded ninety percent of gross domestic product in 2022, stringent fiscal consolidation measures reduced household disposable income, further limiting savings.⁴ Beyond immediate fiscal constraints, excessive external debt restricts government investment in infrastructure, education, and health, weakening long-term income generation and the capacity to save. These dynamics underscore that while external borrowing can support short-term development objectives, without effective debt management and allocation toward productive sectors, high external debt erodes the domestic resource base required to sustain national savings and strengthen economic resilience.

Capacity utilisation plays a critical role in determining productivity, revenue generation, and overall economic performance, with direct implications for national savings in Africa's most indebted economies. High-capacity utilisation indicates that industrial and production facilities are operating close to their full potential, generating higher output, employment opportunities, and household incomes, which collectively enhance the capacity to save. Conversely, low-capacity utilisation signals underused resources, operational inefficiencies, and limited production, all of which constrain government revenues and household savings (Kojo et al., 2020) [2]. Several debt-distressed African countries, including Zambia and Ghana, continue to face persistently low-capacity utilisation, driven by inadequate infrastructure, energy supply constraints, and inconsistent policy implementation. For example, frequent electricity outages in Zambia have restricted manufacturing output and limited firms' ability to maintain efficient operations. These inefficiencies reduce both public and private income streams, diminishing the domestic savings base and heightening dependence on external bor-

¹ International Monetary Fund (IMF, 2023). World Economic Outlook Database.

² African Development Bank (AfDB, 2022). African Economic Outlook.

³ With 21 African countries either at high risk or in Debt Distress, Continental Leaders Unite to Demand Reform & Equitable Systems. URL: <https://au.int/en/pressreleases/20250519/continental-leaders-unite-demand-reform-equitable-financial-systems>

⁴ World Bank (2023). Global Debt Monitor.

rowing.⁵ Low-capacity utilisation also discourages domestic and foreign investment, further weakening financial resources available for saving. In contrast, investments in infrastructure, reliable energy provision, and stable macroeconomic management can improve productive capacity, increase output, and expand the tax base, thereby enhancing national savings. Initiatives in Kenya, including public-private partnerships aimed at modernising industrial facilities and increasing operational efficiency, demonstrate that targeted policy interventions can strengthen production, support income growth, and expand the domestic savings potential in debt-stressed African economies.

Digital infrastructure plays a pivotal role in shaping national savings in Africa's most indebted economies by enhancing financial inclusion, reducing transaction costs, and improving economic efficiency. Well-developed digital systems, including mobile networks, broadband connectivity, and digital payment platforms, facilitate access to financial services for previously underserved and marginalised populations, fostering a culture of saving. Digital financial technologies, such as mobile banking applications and fintech platforms, have enabled millions of individuals in countries such as Nigeria and Kenya to conduct financial transactions and maintain savings accounts even in remote areas (Kouladoun, 2023) [3]. In countries facing high debt burdens, including Ethiopia and Ghana, expanding digital infrastructure contributes to formalising economic activity by integrating informal operators into the formal financial system. This integration increases domestic resource mobilisation, broadens the tax base, and encourages regular saving habits, thereby strengthening national savings (Zhao and Dong, 2025) [4]. Beyond individual saving, digital tools enhance government revenue collection, reduce inefficiencies, and free resources that can be allocated to sovereign wealth funds or public saving schemes. Moreover, digital infrastructure stimulates entrepreneurship, innovation, and job creation, raising household incomes and expanding the capacity to save. Despite these benefits, challenges remain, including unequal access to digital technologies and emerging cybersecurity risks. To fully realise the potential of digital infrastructure in supporting national savings, policy

interventions must focus on strengthening digital ecosystems, promoting financial literacy, and establishing robust regulatory frameworks that channel digital financial activity toward productive and savings-oriented uses.

Building on the preceding discussions, it is critical to explore how external debt, capacity utilisation, and digital infrastructural architecture jointly shape national savings in Africa's debt-distressed economies. External debt, when effectively managed, can support productive investments that raise income and stimulate savings. Similarly, the efficient utilisation of productive capacity enhances output and income generation, creating opportunities for greater domestic savings. Digital infrastructure plays a complementary role by promoting financial inclusion, reducing transaction costs, and facilitating saving behaviours among households and enterprises. Collectively, these factors form an integrated framework that can strengthen domestic savings and support sustainable economic development. In this study, external debt is measured by the external debt to gross domestic product ratio, external debt shocks, and total external debt stock. Capacity utilisation is proxied through industrial production indices, industrial capacity utilisation, and electricity consumption, while digital infrastructure is captured by internet penetration, mobile broadband subscriptions, and fixed broadband subscriptions. National savings, the dependent variable, is measured using net national savings in selected debt-distressed countries.

To guide the analysis, the study addresses three research questions: (a) What is the role of external debt in shaping national savings? (b) How does capacity utilisation influence national savings? and (c) In what ways does digital infrastructure affect national savings?

The panel system generalised method of moments is employed as the primary analytical model, with the threshold cross-sectionally augmented autoregressive distributed lag model used as a robustness check. While prior studies (Manasseh et al., 2022; Okeke and Ogbuabor, 2025) [5, 6] have examined these variables individually, no study has simultaneously assessed their combined effects on national savings, leaving a significant gap. Mixed findings in the literature [7–11] highlight the importance of a comprehensive and context-specific investigation, particularly for highly indebted countries such as Zambia, Ghana, and Ethiopia.

⁵ African Development Bank (AfDB, 2023). Zambia Country Strategy Paper 2023–2027.

This study contributes to the existing literature in several ways. First, it examines the influence of external debt on national savings in African debt-distressed countries. High external debt burdens reduce national savings by increasing interest obligations, which crowd out public investment. Anticipated future taxes to service debt discourage private saving, while debt overhang deters both domestic and foreign investment, limiting income growth and saving capacity. Inflationary pressures from debt servicing erode purchasing power, and sustained debt distress undermines economic stability and long-term savings potential. Second, the study assesses the impact of capacity utilisation on national savings. Higher capacity utilisation enhances production efficiency and income, reduces idle resources, and increases output without additional investment. Greater productivity raises profits and government revenues, supporting public savings, while lowering production costs encourages reinvestment and strengthens economic performance, fostering higher national savings. Third, digital infrastructural architecture expands financial inclusion by providing broader access to banking and savings platforms. It reduces transaction costs, improves the efficiency of financial services, and encourages both individual and institutional savings. Enhanced digital connectivity facilitates mobile banking, digital wallets, and e-commerce, generating income opportunities and supporting public finance transparency, revenue collection, and expenditure monitoring [7, 8]. Finally, the study evaluates the combined effect of external debt, capacity utilisation, and digital infrastructure on national savings using the panel system generalised method of moments as the primary model and the threshold cross-sectionally augmented autoregressive distributed lag model for robustness. These approaches address endogeneity, unobserved heterogeneity, and nonlinear dynamics, ensuring credible and reliable estimation [12–14].

The remainder of the paper is structured as follows. Section 2 presents the theoretical framework and reviews the relevant empirical literature. Section 3 details the methodology, data sources, and model specifications employed in the analysis. Section 4 reports the empirical results and provides a comprehensive discussion of the findings. Finally, Section 5 concludes the study and offers policy recommendations grounded in the evidence.

2. Literature review

2.1. Theoretical literature

2.1.1. Solow-Swan growth model with augmented savings function

The Solow-Swan growth model, independently developed by Solow and Swan in 1956, offers a fundamental framework for understanding the determinants of long-term economic growth through capital accumulation, labour expansion, and technological progress. The model assumes diminishing returns on capital and labour, exogenous technological advancement, and a fixed savings rate, establishing a direct link between national savings, capital formation, and output growth. Extensions of this framework incorporate additional structural factors, including human capital, productive capacity utilisation, and digital infrastructure, which enhance the efficiency and productivity of both capital and labour (Mankiw, Romer, and Weil, 1992) [15]. In African economies burdened by high external debt, effective utilisation of industrial capacity can raise output without requiring additional capital, while investments in digital infrastructure facilitate technological adoption, knowledge diffusion, and innovation, thereby increasing income and the potential for domestic savings (Barro, 1991) [16]. These augmented factors offer a pathway to partially counteract the negative effects of debt accumulation and support more resilient economic trajectories.

2.1.2. Life-cycle hypothesis

The life-cycle hypothesis, developed by Modigliani and Brumberg in 1954 [17], explains savings behaviour across the lifespan. Individuals accumulate resources during working years and draw on them in retirement to maintain stable consumption, producing predictable patterns in aggregate savings determined by demographic composition (Modigliani, 1986) [18]. In contexts characterised by elevated public debt, expectations of reduced future income may discourage current savings (Loayza et al., 2000) [19]. However, improvements in capacity utilisation and digital infrastructure can enhance income generation and productivity, fostering a stronger propensity to save and partially offsetting the adverse impact of fiscal imbalances on national saving behaviour.

2.1.3. Debt overhang theory

Debt overhang theory, advanced by Krugman in 1988 [1] and Sachs in 1988 [20], posits that excessive external debt creates disincentives for investment and savings by generating expectations of higher future taxation, inflation, or economic instability. Anticipation of these outcomes undermines confidence, reduces private investment, and diminishes national savings. In heavily indebted African economies, persistent debt pressures weaken macroeconomic stability and suppress saving behaviour. Nevertheless, enhanced capacity utilisation and digital infrastructure can increase income, strengthen institutional trust, and support the recovery of saving activity even in the presence of significant debt burdens.

2.2. Review of related empirical studies

This section critically examines empirical studies on the determinants of national savings, with a particular focus on external debt, capacity utilisation, and digital infrastructural architecture. The review is organised thematically rather than chronologically, enabling a more analytical discussion that highlights recurring patterns, methodological approaches, and points of convergence and divergence across studies. The first theme explores the relationship between external debt and national savings, the second addresses capacity utilisation, and the third evaluates digital infrastructural architecture. Structuring the literature in this manner facilitates the identification of unresolved questions, empirical contradictions, and underexplored linkages, providing a solid foundation for the present study.

External debt and national savings

Qureshi and Liaqat (2020) [21], utilising a panel Vector Autoregression (VAR) model encompassing 123 countries from 1990 to 2015, determined that external debt influences economic growth chiefly through savings and investment. In contrast, Hassan and Meyer (2021) [7], using a generalised method of moments (GMM) framework on 30 Sub-Saharan African (SSA) countries from 1985 to 2019, reported that external debt negatively influences growth through private investment, public investment, and total factor productivity, with interest rates serving as a direct transmission channel. Unlike Qureshi and Liaqat (2020) [21], they found no evidence that savings mediated

the effect in SSA. Similarly, Makinde and Oladele (2023) [22], using a mixed-methods approach for Nigeria from 1985 to 2022, confirmed that external debt undermines economic growth. Imoagwu et al. (2023) [23], employing augmented autoregressive distributed lag (ARDL) analysis from 1980 to 2021, concluded that external debt service as a share of gross domestic product (GDP) does not significantly impact exchange rate depreciation. Madhavi (2022) [24] and Aisen et al. (2021) [8] examined exchange rate pass-through to inflation in Sri Lanka and Mozambique, respectively, demonstrating that exchange rate depreciation significantly influences domestic prices, although effects are asymmetric. Asue and Ikyaator (2023) [25] found comparable results for Nigeria using a structural VAR model, showing that debt service increases exchange rate depreciation and inflation, while the direct effect on inflation remains statistically insignificant. Manasseh et al. (2022) [5] and Hoti et al. (2022) [10] provide additional evidence on SSA and Western Balkan countries, illustrating regional differences in the growth effects of public and external debt.

Capacity utilisation and national savings

Okeoma et al. (2022) [26] reported a strong positive link between manufacturing capacity utilisation and GDP in Nigeria, highlighting the sector's contribution to overall economic growth. In contrast, Oniyide and Ogunjinmi (2021) [27] observed a modest negative effect. Yuan et al. (2022) [28] and Luan et al. (2022) [29] examined industrial intelligence and robotics, finding mixed effects on capacity utilisation and environmental outcomes. Ihenyen et al. (2024) [30] confirmed the positive role of manufacturing capacity utilisation in sectoral growth using OLS regression. Kojo et al. (2020) [2] showed that both capacity utilisation and government capital expenditure significantly enhance manufacturing value addition, whereas electricity supply has a negligible impact. Singh et al. (2021) [31] emphasised the strategic management of capacity to improve efficiency. Additional studies by Wang and Feng (2023) [32], Nishi (2020) [33], Nishi and Stockhammer (2020) [34], Holm et al. (2024) [35], and Rotemberg (1982) [36] integrated capacity utilisation with productivity, labour dynamics, and New Keynesian pricing models to explain broader macroeconomic outcomes.

Digital infrastructural architecture and national savings

Digital infrastructural architecture encompasses digital technologies, governance structures, and user-driven ecosystems that enable economic transactions, financial intermediation, and innovation. Unlike conventional information and communication technology (ICT) infrastructure, it includes broadband networks, mobile systems, cloud computing, digital payment platforms, and interoperable data systems, as well as regulatory frameworks and behavioural adoption patterns that influence financial inclusion and savings behaviour. Kouladoun (2023) [3] found that internet use, broadband access, and mobile subscriptions enhance inclusive growth in 44 SSA countries. Zhao and Dong (2025) [4] demonstrated that digital infrastructure significantly improves corporate innovation efficiency in China. Caldera et al. (2021) [37] and Zhang et al. (2023) [38] highlighted the contribution of digital infrastructure and asset management to urban resilience. In Nigeria, Manasseh and Ede (2024) [39] reported that digital finance supports economic development, while Manasseh et al. [9, 40, 41] confirmed that digital financial innovation, fintech adoption, and financial inclusion substantially enhance banking performance and promote economic growth across the Common Market for Eastern and Southern Africa (COMESA) and the Economic Community of West African States (ECOWAS) member states. Collectively, these studies illustrate that digital infrastructural architecture not only facilitates financial transactions but also strengthens the broader capacity for domestic savings, particularly in economies experiencing structural and fiscal constraints.

3. Methodology

3.1. Data meaning and sources

This paper is solely aimed at investigating the impact of external debt, capacity utilisation, and digital infrastructural architecture on national savings in African debt-distressed countries. The top 10 most indebted African countries were selected based on data availability. As such, annual time series data that covered the period from 2011 to 2024 were utilised. After conducting an extensive review of the literature, we chose variables for the study in this manner. External debt was measured using the External Debt to GDP

Ratio (EDR), External Debt shocks (EDS) and External Debt Stock (EDST); capacity utilisation was measured with Industrial Production Index (IPI), Industrial Capacity Utilisation (ICU), and Electricity Consumption (ELC); digital infrastructural architecture was measured with the Internet Penetration Rate (IPR), Mobile Broadband Subscriptions (MBS), and Fixed Broadband Subscriptions (FBS), and the national savings (NAS) was measured with Net National Savings (% of GNI), and we controlled for Inflation Rate (INF), Interest Rates (INTR) and Exchange rates (EXR). These variables were chosen based on data availability and were mostly sourced from the World Bank's World Development Indicators (WDI) and the International Monetary Fund (IMF). In *Table 1*, we further describe the data in terms of its meaning, sources and repositories.

3.2. Theoretical framework

This study is underpinned by the augmented Solow-Swan growth model, which integrates structural variables beyond capital and labour specifically external debt, capacity utilisation, and digital infrastructural architecture, to explain national savings dynamics in African debt-distressed economies. In the original Solow-Swan model, national savings (S) drive capital accumulation, which in turn influences output (Y), assuming constant returns to scale and exogenous technological growth. However, in the context of Africa's debt vulnerabilities, an augmented model is more appropriate. Following Mankiw et al. (1992) [15] and Barro (1991) [16], we specify the extended functional form as:

$$Y = A \cdot K^{\alpha} \cdot L^{\beta} (1 - \alpha) \cdot CU^{\gamma} \cdot DI^{\delta} \quad (1)$$

where output (Y) represents aggregate income and serves as a proxy for national savings. Capital stock (K) reflects accumulated investment, which is inherently linked to savings behaviour, while labour (L) captures the contribution of the workforce to production. Capacity utilisation (CU) measures the extent to which existing productive resources are efficiently employed, and digital infrastructure (DI) reflects the depth and quality of technological systems that facilitate economic transactions, innovation, and financial intermediation. Total factor productivity (A) is adjusted to incorporate the adverse effects of external debt,

particularly through debt overhang and crowding-out mechanisms that constrain productive investment and reduce efficiency. The parameters α , β , and γ denote the respective output elasticities of the production inputs. Within this structure, higher capacity utilisation enhances output by improving efficiency without requiring additional capital accumulation, while strengthened digital infrastructure fosters innovation, expands financial inclusion, and supports productivity growth. Consequently, improvements in *CU* and *DI* can partially mitigate the growth-inhibiting effects of external debt, reinforce income generation, and, by extension, strengthen national savings and long-term economic resilience in African economies facing debt distress.

3.3. Model specifications

3.3.1. Baseline system GMM model

The system GMM estimator was employed as the baseline model to examine the impact of external debt, capacity utilisation, and digital infrastructural architecture on national savings in African debt-distressed countries. This approach aligns with the methodology of Manasseh et al. (2022) [5], who also adopted system GMM in their empirical analysis. The system GMM technique is particularly suitable for this study due to its ability to efficiently estimate long-run relationships while addressing key econometric challenges such as endogeneity, instrument overidentification, and simultaneity bias (Arellano and Bond, 1991; Arellano and Bover, 1995) [42, 50]. Furthermore, the model is effective in exploring long-term interactions among variables like microfinance development, external borrowing, institutional quality, and economic performance, particularly in dynamic panels such as those found in African debt-distressed countries.

In this study, the panel system GMM model is specified as follows:

$$P_{i,t} = \alpha + \tau P_{i,t-1} + \sigma Y_{i,t-1} + \theta_i + \varepsilon_{i,t}, \quad (2)$$

where $P_{i,t}$ denotes the national savings of country i at time t , and $Y_{i,t-1}$ represents a vector of explanatory variables, including external debt, capacity utilisation, and digital infrastructural measures. The term θ_i captures unobserved, time-invariant country-specific effects, while $\varepsilon_{i,t}$ is the idiosyncratic error term assumed to follow a normal distribution, $N(0, \delta^2)$. The parameters τ

and σ measure the persistence of national savings and the effects of the explanatory variables, respectively. The subscripts i and t indicate country and time dimensions of the panel.

The use of the system GMM estimator is justified when the dataset comprises a large cross-section (N) and a small-time dimension (T). In this study, the cross-sectional dimension includes 18 countries ($N = 18$), and the period covers 13 years ($T = 13$), aligning with these conditions. This estimation technique is considered highly insightful, robust, and appropriate due to several key features highlighted by Blundell and Bond (1998) [12]. First, system GMM effectively addresses endogeneity issues, which often arise from including the initial value of national savings (NAS) and other endogenous regressors. It achieves this by employing lagged values of explanatory variables as instruments. Second, it corrects for unobserved country-specific heterogeneity, a common issue in panel data involving diverse economies such as those in African Debt-Distressed Countries. Third, it resolves model misspecification that typically affects static models, particularly due to the omission of lagged dependent variables. These lags are crucial for capturing the dynamic behaviour of national savings. Additionally, Blundell and Bond (1998) [12] demonstrated that System GMM is more efficient than Difference GMM, especially when instruments weaken in first-differenced estimations. Finally, the robust version of System GMM ensures consistent standard errors, even under heteroscedasticity and serial correlation, enhancing the reliability of the results [12].

To estimate equation (1) effectively, the dependent variable must be lagged to mitigate country-specific effects and address endogeneity concerns. While [48] Levine and Zervos (1998) [48] employed the initial values of explanatory variables as instruments to tackle simultaneity issues, their approach led to a loss of information and potential inconsistency, ultimately reducing the efficiency of the estimation. To ensure both efficiency and consistency, it is essential to adopt more appropriate instruments rather than relying solely on initial values. In this regard, Blundell and Bond (1998) [12] introduced the system GMM estimator as a superior alternative. They observed that instruments tend to weaken after the first-difference transformation, which compromises estimation quality. The system GMM approach addresses this limitation and is expressed as follows.

Table 1
Definition of data

Acronyms	Definition	Repository
NAS	National Savings (as % of GDP)	https://data.worldbank.org/indicator/NY.ADJ.NNAT.GN.ZS
EDR	External Debt Ratio (% of GDP)	https://data.worldbank.org/topic/external-debt
EDS	External Debt Servicing (% of GDP)	https://data.worldbank.org/topic/external-debt
EDST	External Debt Stock (total USD billions)	https://data.worldbank.org/indicator/DT.DOD.DECT.CD
IPI	Industrial Production Index	https://databank.worldbank.org/metadataglossary/statistical-capacity-indicators/series/5.01.01.01.indust
ICU	Industrial Capacity Utilisation (%)	https://fred.stlouisfed.org/series/CAPUTLB50001A
ELC	Electricity Consumption (kWh per capita)	https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC
IPR	Investment in Productive Resources (% of GDP)	https://data.worldbank.org/indicator/IT.NET.USER.ZS
MBS	Monetary Base Share (% of GDP)	https://data.worldbank.org/indicator/IT.CEL.SETS
FBS	Fiscal Balance Share (% of GDP)	https://data.worldbank.org/indicator/IT.NET.BBND.P2
INF	Inflation Rate (annual %)	https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG
INTR	Interest Rate (%)	https://data.worldbank.org/indicator/FR.INR.RINR
EXR	Exchange Rate (local currency per USD)	https://data.worldbank.org/indicator/PA.NUS.FCRF
K	Capital Stock (USD millions)	https://data.worldbank.org/indicator/NE.GDI.TOTL.ZS
A	Total Factor Productivity (index)	https://www.frbsf.org/research-and-insights/data-and-indicators/total-factor-productivity-tfp/

Source: Author's concept.

$$P_{i,t} - P_{i,t-1} = \pi(P_{i,t-1} - P_{i,t-2}) + \vartheta(Y_{i,t} - Y_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}). \quad (3)$$

In equation (3), first-differencing eliminates the intercept and the country-specific effects (η). However, the estimation of equation (2) will be biased and inconsistent, as the lagged dependent variable ($P_{i,t-1} - P_{i,t-2}$) and the error term ($\varepsilon_{i,t} - \varepsilon_{i,t-1}$) will be correlated and would render the explanatory variables to be endogenous [12]. Therefore, Arellano and Bond (1991) [42] posit that the model must pass the following moment conditions.

$$E[P_{i,t-n}(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \text{ for } n \geq 2, t = 3, \dots, T,$$

$$E[Y_{i,t-n}(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \text{ for } n \geq 2, t = 3, \dots, T.$$

Thus, to ensure that some estimation issues like identification, simultaneity and restrictions are treated, it is pertinent to shed light on how they are going to be resolved by the model. The statistical test to validate the selected variables is assessed using the Hansen J test of identification, and the null hypothesis of the underlying Sargan overidentifying restrictions test should not be rejected for the strictly exogenous variables to explain the dependent variable exclusively via the channel of predetermined or suspected endogenous variables (Manasseh et al. 2022) [5]. Also, we estimated the Arellano-Bond (1991) and Arellano-Bover (1995) [42, 50] serial correlations, which have both AR1 and AR2, to ensure that there is no presence of AR2 in the estimated results (Arellano and Bond 1991) [42].

3.3.2. Panel threshold CS-ARDL

The threshold cross-sectionally augmented autoregressive distributed lag (Threshold CS-ARD) model is designed to examine both linear and nonlinear long-run and short-run relationships among variables in dynamic heterogeneous panels while accounting for cross-sectional dependence. Its core objective is to identify how the effect of a key regressor (e.g., external debt) changes once a specific threshold is crossed. This method assumes (i) slope heterogeneity across units, (ii) weakly exogenous regressors, (iii) stationarity or cointegration among variables, and (iv) the presence of cross-sectional dependence managed through augmentation by cross-sectional averages. It combines ARDL modelling with threshold effects and common correlated effects (CCE). The model is highly suitable for panel macroeconomic studies involving structural shifts and spillover dynamics. Let the baseline long-run relationship be specified as:

$$NAS_{it} = \alpha_i + \phi_i NAS_{it-1} + \beta_1 EXDT_{it} + \beta_2 CUI_{it} + \beta_3 DIA_{it} + \beta_4 K_{it} + \beta_5 A_{it} + \beta_6 INF_{it} + \beta_7 INTR_{it} + \beta_8 EXR_{it} + \varepsilon_{it}. \quad (4)$$

To account for potential nonlinear (threshold) effects of external debt on national savings, a threshold variable (e.g., external debt, EXDT) is introduced to capture structural changes when debt surpasses a certain critical level (γ):

$$NAS_{i,t} = \alpha_i + \phi_i NAS_{it-1} + \theta_1 EXDT_{it} \cdot \mathbb{I}(EXDT_{it} \leq \gamma) + \theta_2 EXDT_{it} \cdot \mathbb{I}(EXDT_{it} > \gamma) + \sum_{j=1}^7 \beta_j X_{jit} + \varepsilon_{it}, \quad (5)$$

where i and t represent the index of country and time respectively, $\mathbb{I}(\cdot)$ is an indicator function that equals 1 if the condition is true and 0 otherwise, γ is the debt threshold level (to be estimated or set based on theoretical/empirical cutoff), X_{jit} represent the vector of explanatory variables including (external debt, digital infrastructural architecture, capital, total factor of productivity, inflation rate, interest rate and exchange rate). Additionally, ϕ_i , α_i and ε_{it} are speed of adjustment, country-specific effects and idiosyncratic error term respectively.

To fully account for cross-sectional dependence, the CS-ARDL model augments the above equation with cross-sectional averages of both dependent and independent variables:

$$NAS_{it} = \alpha_i + \phi_i NAS_{it-1} + \sum_{j=1}^8 \beta_j X_{jit} + \sum_{j=1}^8 \delta_j \widehat{X}_{it} + \delta_0 \widehat{NAS}_t + \varepsilon_{it}. \quad (6)$$

This specification enables the examination of both long-run and short-run effects, captures the nonlinear impacts of external debt through the inclusion of threshold dynamics, and incorporates the influence of macro-structural variables such as capacity utilization and digital infrastructural development. Additionally, it effectively accounts for unobserved common factors and spillover effects that may arise across African debt-distressed countries, ensuring robust and comprehensive econometric analysis.

4. Empirical results and discussion of findings

This section presents and analyzes the empirical results derived from the study on the impact of external debt, capacity utilization, and digital infrastructural architecture on national savings in African debt-distressed countries. The analysis is based on annual time series data spanning the period from 2011 to 2024, constrained by data availability. Before estimating the model, a series of preliminary econometric tests were conducted, including descriptive statistics, Spearman's correlation, normality tests, serial correlation tests, and White's heteroscedasticity tests. These diagnostic tests were essential for understanding the behaviour and distributional properties of the variables and for guiding appropriate model selection and estimation techniques. The outcomes of these tests also significantly inform the robustness and credibility of the study's findings. The following section provides a detailed description of the dataset used in the analysis.

4.1. Data description

To investigate the impact of external debt, capacity utilisation, and digital infrastructural architecture on national savings in African debt-distressed countries, we begin with an examination of the dataset using descriptive statistics. These statistics offer a concise overview of the central tendency, dispersion, and distributional characteristics of the model variables, including the mean, median, standard deviation, skewness, and kurtosis. The results are summarised in *Table 2*.

Table 2
Descriptive statistics

Variable	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability	Observations
NAS	0.432	0.610	2.105	-2.311	0.847	1.021	3.481	21.93	0.000	234
EDR	0.732	0.210	10.54	0.624	5.212	1.187	4.132	6.374	0.000	234
EDS	1.087	0.511	5.822	0.878	4.614	1.412	5.38	132.2	0.000	234
EDST	0.764	0.721	4.909	1.442	0.665	0.214	6.854	73.56	0.000	234
IPI	2.495	0.523	6.845	-5.784	21.37	3.15	12.3	426.5	0.000	234
ICU	97.84	81.96	463.0	0.097	76.82	1.774	6.312	131.9	0.000	234
ELC	0.591	0.600	1.158	2.314	0.612	0.060	3.048	3.964	0.114	234
IPR	0.548	0.652	1.372	1.824	0.578	0.582	2.763	6.527	0.000	234
MBS	0.690	0.715	1.102	2.367	0.591	0.305	2.861	1.847	0.000	234
FBS	2.105	0.865	1.078	6.234	8.004	1.85	9.82	491.0	0.000	234
INF	2.814	0.710	6.814	0.998	2.105	2.54	8.54	37.45	0.000	234
INTR	2.178	2.154	4.112	0.415	0.887	0.495	6.822	7.993	0.000	234
EXR	0.701	0.010	6.891	-1.679	4.964	0.928	10.48	57.29	0.000	234
K	382.7	5.127	3.054	-2.316	29.40	1.02	9.64	45.98	0.000	234
A	278.6	2.018	3.944	-0.731	22.57	1.23	14.57	10.78	0.000	234

Source: Developed by the authors.

The dataset exhibits substantial variability across variables, reflecting the heterogeneous economic conditions of the sampled countries. For example, values range from a minimum of -5.784 (IPI) to a maximum of 463.0 (ICU), with the mean and median values indicating general consistency in central tendency for most variables. Standard deviations highlight the degree of dispersion, with ICU (76.82) and IPI (21.37) showing particularly wide spreads. Some variables, notably IPI (skewness = 3.15, kurtosis = 12.3) and FBS (skewness = 1.85, kurtosis = 9.82), display pronounced skewness and kurtosis, indicative of heavy-tailed distributions or potential outliers. These extreme values have been retained to faithfully represent actual economic conditions, while their influence is mitigated in subsequent analysis through robust estimation methods. Assessment of normality using the Jarque-Bera test reveals that, with the exception of ELC ($p = 0.114$), all variables reject the null hypothesis of normality at the five percent significance level, confirming deviations from a Gaussian distribution. This non-normality does not undermine the validity of the econometric analysis, as both System GMM and CS-ARDL estimators are robust to heteroskedasticity and

non-normally distributed panel data. Accordingly, these methods are well-suited for examining the dynamic relationships among external debt, capacity utilisation, digital infrastructure, and national savings in the context of African debt-distressed economies.

4.2. Correlation tests

To examine the interrelationships among external debt, capacity utilisation, digital infrastructural architecture, and national savings in African debt-distressed countries, we conducted a Spearman rank correlation analysis (see Table 3). This method is well-suited for non-normally distributed data and assesses the strength and direction of monotonic associations between variables.

The results, presented in Table 3, reveal that indicators of external debt generally exert a negative influence on national savings. Debt stock ($EDST = -0.711$) and debt service ($EDS = -0.653$) are strongly negatively correlated with NAS, indicating that higher debt burdens are associated with lower domestic savings. In contrast, the external debt ratio ($EDR = 0.432$) shows a moderate positive correlation, reflecting the nuanced impact of debt composition on savings. Exchange rate vola-

Table 3
Spearman rank correlation results

Variable	NAS	EDR	EDS	EDST	IPI	ICU	ELC	IPR	MBS	FBS	INF	INTR	EXR	K	A
NAS	1.000														
EDR	0.432	1.000													
EDS	-0.653	0.224	1.000												
EDST	-0.711	0.139	-0.132	1.000											
IPI	0.589	0.043	0.613	-0.195	1.000										
ICU	0.618	0.172	0.083	-0.177	0.354	1.000									
ELC	0.527	0.097	0.034	-0.122	0.146	0.612	1.000								
IPR	-0.451	0.002	0.146	-0.189	0.258	0.721	0.534	1.000							
MBS	0.409	0.198	-0.136	-0.145	0.094	0.054	-0.124	0.065	1.000						
FBS	0.603	0.066	0.648	0.045	0.097	-0.113	-0.140	0.044	-0.291	1.000					
INF	0.712	-0.031	0.062	-0.099	-0.247	0.223	0.153	0.412	0.027	-0.084	1.000				
INTR	-0.342	0.691	-0.312	-0.248	0.132	0.417	0.201	0.538	0.385	-0.092	0.428	1.000			
EXR	-0.642	-0.002	-0.319	-0.188	0.073	0.433	0.263	0.615	0.112	-0.109	0.392	0.871	1.000		
K	0.491	0.779	-0.601	0.527	0.443	-0.314	-0.184	0.371	-0.142	-0.102	0.117	0.436	-0.201	1.000	
A	0.489	0.041	-0.337	0.082	-0.075	-0.047	-0.058	-0.061	0.112	-0.053	-0.096	-0.126	-0.097	-0.472	1.000

Source: Developed by the authors.

tility ($EXR = -0.642$) also exhibits a strong negative correlation, suggesting that currency instability may undermine savings accumulation. Capacity utilisation ($ICU = 0.618$) shows a strong positive correlation with national savings, while industrial productivity ($IPI = 0.589$) demonstrates a moderate positive correlation. These findings imply that higher utilisation of productive capacity and greater industrial efficiency support domestic savings. Digital infrastructure variables display mixed effects: electricity consumption ($ELC = 0.527$) and fixed broadband ($FBS = 0.603$) correlate positively at moderate and strong levels, respectively; mobile broadband ($MBS = 0.409$) exhibits a moderate positive correlation; however, internet penetration ($IPR = -0.451$) shows a moderate negative correlation with NAS . Macroeconomic controls further highlight diverse associations. Inflation ($INF = 0.712$) is strongly positively correlated with savings, whereas interest rates ($INTR = -0.342$) show a weak negative relationship. Capital stock ($K = 0.491$) and total factor productivity ($A = 0.489$) both exhibit moderate positive correlations with NAS . Collectively, these correlations provide pre-

liminary insights into the determinants of national savings in debt-distressed African countries and offer a foundation for the subsequent econometric analyses using system GMM and CS-ARDL.

4.3. Stationarity analysis

To ensure the robustness and validity of the panel econometric analysis, we conducted a series of unit root tests on all model variables to determine whether they exhibit stochastic trends and to identify their order of integration, consistent with standard econometric practice [43] (Gujarati, 2003). Specifically, we applied multiple panel unit root tests, including the Levin-Lin-Chu (LLC, 2002) test [44], Im-Pesaran-Shin (IPS, 2004) test [45], Fisher-type tests (Fisher-ADF and Fisher-PP) [46] and (Maddala and Wu, 1999) [47]. These tests examine the null hypothesis of a unit root (non-stationarity) against the alternative hypothesis of stationarity. The decision criterion is straightforward: the null hypothesis is rejected when the probability value is less than 0.05, indicating that the series is stationary, whereas a p-value above 0.05 implies non-stationarity.

Table 4
Panel unit root test results

Variable	LLC	IPS	Fisher-ADF	Fisher-PP	Integration Order
NAS	−18.22*** (0.000)	−19.45*** (0.000)	477.3*** (0.000)	463.6*** (0.000)	I(0)
EDR	−3.48*** (0.000)	−4.11*** (0.000)	439.9*** (0.000)	502.7*** (0.000)	I(1)
EDS	−7.11*** (0.000)	−9.87*** (0.000)	298.5*** (0.000)	319.3*** (0.000)	I(0)
EDST	−11.75*** (0.000)	−14.64*** (0.000)	521.6*** (0.000)	645.8*** (0.000)	I(1)
IPI	−5.32*** (0.000)	−5.31*** (0.000)	177.5*** (0.000)	183.2*** (0.000)	I(1)
ICU	−6.20*** (0.000)	−6.60*** (0.000)	251.4*** (0.000)	240.6*** (0.000)	I(1)
ELC	−5.09*** (0.000)	−14.32*** (0.000)	472.3*** (0.000)	460.5*** (0.000)	I(1)
IPR	−4.85*** (0.000)	−5.02*** (0.000)	210.4*** (0.000)	221.1*** (0.000)	I(1)
MBS	−6.98*** (0.000)	−4.96*** (0.000)	188.2*** (0.000)	191.7*** (0.000)	I(0)
FBS	−9.04*** (0.000)	−7.92*** (0.000)	275.1*** (0.000)	261.6*** (0.000)	I(0)
INF	−20.74*** (0.000)	−18.23*** (0.000)	507.6*** (0.000)	538.8*** (0.000)	I(0)
INTR	−17.66*** (0.000)	−20.79*** (0.000)	627.4*** (0.000)	589.5*** (0.000)	I(0)
EXR	−11.12*** (0.000)	−17.91*** (0.000)	514.3*** (0.000)	522.1*** (0.000)	I(0)
K	−34.86*** (0.000)	−25.59*** (0.000)	841.1*** (0.000)	870.5*** (0.000)	I(1)
A	−7.13*** (0.000)	−10.23*** (0.000)	293.7*** (0.000)	291.6*** (0.000)	I(0)

Source: Developed by the authors.

Note: *** denotes significance at the 1% level.

The results, summarized in Table 4, reveal that the dataset contains a mix of stationary and non-stationary variables. Variables such as *NAS*, *EDS*, *MBS*, *FBS*, *INF*, *INTR*, *EXR*, and *A* are stationary in levels, classified as *I*(0), while *EDR*, *EDST*, *IPI*, *ICU*, *ELC*, *IPR*, and *K* achieve stationarity only after first differencing, indicating integration of order one, *I*(1). This combination of *I*(0) and *I*(1) variables validates the application of the CS-ARDL model, which can accommodate mixed orders of integration and captures both short- and long-

run dynamics. Moreover, system GMM remains appropriate in this context, as it addresses potential endogeneity and heteroskedasticity issues, providing reliable estimates despite the heterogeneous stationarity properties across the variables.⁶

⁶ For the LLC and IPS tests, negative t-statistics indicate rejection of the null hypothesis of a unit root, while for Fisher-type tests, higher chi-square values correspond to rejection of the unit root null. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 5
Cointegration results

Model	Pedroni Cointegration Test							Kao (1999) Test
	Panel v-Stat	Panel rho-Stat	Panel PP-Stat	Panel ADF-Stat	Group rho-Stat	Group PP-Stat	Group ADF-Stat	ADF-Stat
1	-5.589*** (0.000)	-4.041*** (0.000)	-5.058*** (0.000)	-6.152*** (0.000)	-9.547** (0.014)	3.587*** (0.000)	0.745 (0.227)	-1.759 (0.960)
2	-0.996 (0.159)	-1.591 (0.055)	-1.082 (0.139)	-0.425 (0.335)	0.057 (0.365)	7.254*** (0.000)	7.119*** (0.000)	2.348*** (0.006)
3	-17.86*** (0.000)	-18.01*** (0.000)	-18.61*** (0.000)	-16.78*** (0.000)	0.745 (0.227)	-1.759 (0.960)	-13.11*** (0.000)	-2.827*** (0.002)

Source: Developed by the authors.

Note: ***, ** and * denote the 1%, 5% and 10% significant levels, respectively. Number in brackets represents the probability test.

4.4. Cointegration test

To further assess the existence of a long-run equilibrium relationship among external debt, capacity utilisation, digital infrastructural architecture [53], and national savings in African debt-distressed countries, panel cointegration tests were conducted. This step is particularly important given the mixed integration properties of the variables identified in the unit root analysis, which necessitate formal testing for long-run comovement. The analysis employs the Pedroni (2004) [48] panel cointegration test as the primary method, alongside the Kao (1999) test [49] as a robustness check. The Pedroni [48] framework comprises seven statistics, including four within-dimension statistics (panel v, panel rho, panel Phillips-Perron (PP), and panel Augmented Dickey-Fuller (ADF) and three between-dimension statistics (group rho, group PP, and group ADF). These tests evaluate the null hypothesis of no cointegration against the alternative of a long-run cointegrating relationship, with rejection of the null determined at the 5 percent significance level.

The results, reported in *Table 5*, reveal heterogeneous cointegration outcomes across model specifications rather than uniform evidence of long-run association. For Model 1, the majority of the Pedroni (2004) [48] within-dimension statistics are statistically significant; however, the group ADF statistic and the Kao (1999) [49] ADF statistic are not significant ($p = 0.960$). Consequently, the null hypothesis of no cointegration cannot be rejected conclusively for this specification, indicating weak and inconsistent evidence of cointegration. In con-

trast, Model 2 presents stronger and more consistent evidence of cointegration. Although several Pedroni (2004) [48] statistics are insignificant, both the group ADF statistic and the Kao (1999) [49] ADF statistic are highly significant at the 1 percent level, providing support for rejecting the null hypothesis of no cointegration in this model. For Model 3, the evidence of cointegration is most robust. All within-dimension Pedroni statistics are statistically significant, and both the group ADF and Kao ADF statistics strongly reject the null hypothesis at conventional significance levels. This pattern confirms the presence of a stable long-run relationship among the variables in this specification. Thus, the cointegration results suggest that long-run relationships exist in selected model specifications rather than uniformly across all models. These findings justify proceeding with estimation techniques such as CS-ARDL, which accommodate heterogeneous long-run dynamics, and system GMM, which remains suitable for addressing endogeneity concerns in dynamic panel settings. Importantly, the model-specific nature of the cointegration evidence is explicitly acknowledged, ensuring accurate interpretation and alignment with the reported test statistics.

4.5. Baseline model – system GMM analysis

This study investigates the influence of external debt, productive capacity, and digital infrastructure on national savings in African economies experiencing debt distress. The analysis employs the panel system generalised method of moments

estimator, which is well suited for dynamic panel data where endogeneity, omitted variables, measurement error, and reverse causality are potential concerns (Arellano and Bond, 1991; Blundell and Bond, 1998) [42, 12]. By incorporating the lagged dependent variable and using internal instruments, the estimator controls for unobserved country effects and captures the persistence that characterises savings behaviour. The approach also reduces simultaneity bias between savings and macroeconomic variables, thereby strengthening the credibility of the estimated relationships.

The findings reported in *Table 6* confirm that national savings in the sampled economies exhibit strong dynamic properties. The coefficient of the lagged savings variable is positive and statistically significant in all three specifications. This result indicates that past savings performance exerts a substantial influence on current savings outcomes. The stability of the coefficient across models supports the appropriateness of the dynamic specification and suggests a gradual adjustment process toward equilibrium. This pattern is consistent with the persistence documented by Qureshi and Liaqat (2020) [21], although it differs from the more limited transmission effects identified by Hassan and Meyer (2021) for Sub Saharan Africa. Measures of external debt display a consistent and statistically significant negative association with national savings. In the first specification, the external debt ratio reduces savings, indicating that higher debt burdens constrain domestic saving capacity. In the second specification, external debt servicing also depresses savings, reflecting the fiscal pressure created by repayment obligations. The third specification shows that external debt stock similarly undermines savings performance. The consistency of these results across alternative debt indicators strengthens the conclusion that excessive external borrowing weakens domestic savings in debt distressed economies. These findings accord with the evidence presented by Manasseh et al. (2022) [5], Manasseh et al. (2019) [49], and Makinde and Oladele (2023) [22], who emphasise the adverse macroeconomic consequences of high debt exposure. The effects of productive capacity and digital infrastructure are more varied but remain economically meaningful. Industrial production in the first model is associated with a reduction in savings, suggesting that in heavily indebted econo-

Table 6
Estimated system GMM results

Variable	Model 1	Model 2	Model 3
NAS (-1)	0.421*** (0.000)	0.398*** (0.000)	0.367*** (0.001)
EDR	-0.614*** (0.000)		
EDS		-0.462*** (0.000)	
EDST			-0.531*** (0.000)
IPI	-0.218*** (0.000)		
ICU		-0.176*** (0.001)	
ELC			-0.185*** (0.000)
IPR	-0.493*** (0.004)		
MBS		-0.071 (0.311)	
FBS			-0.229*** (0.000)
INF	-0.584*** (0.000)	0.267*** (0.000)	-0.702*** (0.000)
INTR	-0.098 (0.214)	-0.041 (0.742)	-0.136 (0.188)
EXR	-0.693** (0.021)	0.582** (0.027)	0.601** (0.032)
K	0.036 (0.481)	0.514*** (0.000)	-0.841*** (0.000)
A	-0.226*** (0.000)	-0.214*** (0.000)	0.193** (0.041)
Instruments	22	24	23
AR(1)	-2.91*** (0.004)	-2.77*** (0.006)	-2.68*** (0.007)
AR(2)	-1.21 (0.226)	-1.08 (0.281)	-1.15 (0.249)
Hansen J	18.37 (0.421)	20.11 (0.312)	17.84 (0.463)

Source: Authors' conception.

Note: AR tests follow Arellano-Bond (1991). Instrument matrix is collapsed and lag depth restricted. (.) is the probability value, and the variables are expressed in natural logarithm. All continuous variables were transformed into natural logarithms, except for inflation, interest rate, and ratio variables. This approach facilitates interpretation in elasticity terms while avoiding distortions associated with variables that can take negative or bounded values. *Note:* ***, ** denote significance at the 1% and 5% levels, respectively.

mies, expansion in output may be financed through borrowing or increased consumption rather than through higher savings. Capacity utilisation in the second model also shows a negative effect on savings, contrasting with the positive relationship reported by Okeoma et al. (2022) [26]. This outcome may reflect structural constraints in debt distressed environments, where higher utilisation does not necessarily translate into improved saving behaviour at the household or public level.

Digital infrastructure variables produce differentiated results. Internet penetration in the first model reduces savings, and fixed broadband subscriptions in the third model show a similar negative effect. These findings suggest that digital expansion may initially encourage consumption and financial access in ways that reduce short term savings. Although digital inclusion has been linked to broader development gains (Kouladoun, 2023) [3], the present evidence indicates that its immediate effect on aggregate savings in debt distressed settings may be negative. In contrast, mobile broadband subscriptions do not show a statistically significant relationship with savings in the second model, implying that not all forms of digital development exert a direct measurable impact on aggregate saving behaviour. Macroeconomic control variables reveal additional insights. Inflation reduces savings in the first and third specifications, consistent with the erosion of real income and macroeconomic instability. In the second model, however, inflation is positively associated with savings, which may reflect precautionary behaviour under certain fiscal conditions. Exchange rate movements also display varying effects. Currency depreciation reduces savings in the first specification but increases savings in the second and third specifications, possibly reflecting differences in debt composition and capital flow dynamics. These patterns illustrate the structural complexity of debt distressed economies.

Table 6 results also revealed that capital stock and total factor productivity exhibit differences across specifications. Capital accumulation enhances savings in the second model but reduces savings in the third model, suggesting that the financing structure of investment may differ depending on the debt measure employed. Total factor productivity reduces savings in the first two models but increases savings in the third, supporting the argument advanced by Hassan and Meyer

(2021) [7] that debt conditions can influence savings through investment and productivity channels. The interest rate variable is not statistically significant in any of the specifications. This outcome indicates that monetary policy instruments may not have a strong direct effect on aggregate savings in the sampled economies. Recognising this lack of significance contributes to a balanced interpretation of the findings. Diagnostic tests support the reliability of the estimation. The Arellano Bond tests show significant first order serial correlation, which is expected in differenced dynamic panels, and no evidence of second order serial correlation, thereby validating the underlying moment conditions. The Hansen test statistics indicate that the null hypothesis of instrument validity cannot be rejected. Instruments were limited and structured to ensure that their number remained below the number of cross-sectional units, which strengthens confidence in the results. In summary, the evidence indicates that high levels of external debt, inflationary pressures, and certain aspects of digital expansion are associated with weaker national savings in African economies facing debt distress. Productive capacity and structural variables display varying effects depending on model specification. The persistence of savings and the satisfactory performance of diagnostic tests support the theoretical coherence and econometric soundness of the model.

4.6. Threshold CS-ARDL analysis

This study investigates the impact of external debt, capacity utilisation, and digital infrastructural architecture on national savings in African debt-distressed countries. To ensure the robustness of findings, the panel cross-sectionally augmented autoregressive distributed lag (CS-ARDL) model is employed as a robustness check. The CS-ARDL technique accounts for cross-sectional dependence, heterogeneity, and nonstationarity features common in macro-panel data (Chudik et al. 2016) [13]. Its ability to capture both short-run and long-run dynamics enhances the reliability of empirical estimates. This is particularly valuable in African contexts, where countries often exhibit heterogeneous structural characteristics. Moreover, CS-ARDL effectively mitigates omitted variable bias by incorporating cross-sectional averages. Thus, it offers a more credible validation of the GMM-based results.

While system GMM provides valuable insights into the short-run dynamics of national savings and effectively addresses endogeneity, it is limited in its ability to explicitly account for cross-sectional dependence and to separate long-run equilibrium relationships from short-run adjustment processes. To address these limitations and strengthen the robustness of the empirical findings, this study employs the panel cross-sectionally augmented autoregressive distributed lag (CS-ARDL) model as a complementary estimation framework. The CS-ARDL approach is particularly suited for macroeconomic panel data because it accommodates cross-sectional dependence, parameter heterogeneity, and mixed orders of integration (Chudik et al. 2016) [13]. By incorporating cross-sectional averages of dependent and independent variables, the model effectively controls for unobserved common factors, including regional policy spillovers, synchronized shocks, and global financial turbulence. These features are especially pertinent in African debt-distressed economies, where macroeconomic outcomes are strongly shaped by regional interdependencies, global financial cycles, and coordinated policy responses. In this context, the CS-ARDL framework provides insights that system GMM cannot, particularly regarding long-run elasticities, equilibrium relationships, and the persistence of effects under cross-sectional interdependence. Hence, the estimated results of the cross-sectionally augmented autoregressive distributed lag (CS-ARDL) model are presented in Table 7.

The long-run CS-ARDL estimates, presented in Table 7, reveal persistent structural relationships that are obscured in short-run analyses. External debt measures, including the external debt ratio (*EDR*), external debt servicing (*EDS*), and external debt stock (*EDST*), consistently exert negative and statistically significant effects on national savings. The magnitude of these coefficients demonstrates that increasing external obligations systematically erode domestic saving capacity, even after accounting for global and regional shocks. Unlike short-run fluctuations, these long-term effects do not dissipate, confirming the enduring consequences of external debt on savings accumulation in debt-distressed African economies such as Nigeria, Kenya, and Ghana. These results are consistent with Qureshi and Liaqat (2020) [21], who emphasise a global savings-debt-growth nexus, and with Ma-

kinde and Oladele (2023) [22], who document similar patterns in Nigeria. While Hassan and Meyer (2021) [7] argue that debt primarily affects growth through investment and productivity channels, the CS-ARDL results show that external debt directly suppresses national savings over the long term in highly indebted African contexts.

Capacity utilisation variables also exhibit negative and statistically significant long-run effects, particularly through the industrial capacity utilisation rate (*ICU*). This finding suggests that persistent inefficiencies in production and energy use prevent increases in productive capacity from translating into sustained savings accumulation. Although Okeoma et al. (2022) [26] report positive associations between capacity utilisation and output growth, the present evidence indicates that growth-enhancing effects may not lead to higher savings when economies are burdened by chronic debt pressures and energy inefficiencies. Similarly, digital infrastructural variables, including the industrial production index (*IPI*), electricity consumption (*ELC*), and internet penetration rate (*IPR*) exert negative long-run relationship, implying that current digital investments may impose substantial costs without immediate returns in savings. This contrasts with the long-term developmental and financial inclusion benefits reported by Kouladom (2023) [3], Manasseh et al. (2023) [40] and Nwakoby et al. (2026) [48], suggesting that in debt-constrained African economies, the savings gains from digitalisation may lag behind broader economic growth and development outcomes.

The short-run CS-ARDL estimates complement the long-run findings by highlighting adjustment dynamics. Across all short-run specifications, changes in external debt measures, including *EDR*, *EDS*, and *EDST*, exert negative and statistically significant effects on national savings. This indicates that increases in debt obligations immediately constrain domestic saving capacity, even after accounting for cross-sectional dependence and heterogeneous country responses. These short-run effects reinforce Qureshi and Liaqat (2020) [21], who highlight the adverse impact of rising debt on savings, and complement Hassan and Meyer (2021) [7], who emphasise debt's inhibitory effects on investment and productivity. Short-run capacity utilisation indicators, such as *IPI*, *ICU*, and *ELC*, also negatively affect national savings. This suggests that increases in productive activity may

Table 7
Estimated results of CS-ARDL

Variable	Long-Run			Variable	Short-Run (Δ)		
	1	2	3		4	5	6
NAS (−1)	0.487*** (0.000)	0.822*** (0.000)	0.603*** (0.000)	Δ NAS (−1)	−0.392** (0.016)	−0.334** (0.019)	0.384** (0.015)
EDR	−1.487*** (0.000)			Δ EDR	−0.695*** (0.000)		
EDS		−0.902*** (0.000)		Δ EDS		−0.439*** (0.000)	
EDST			−1.122*** (0.000)	Δ EDST			−0.545*** (0.000)
IPI	−0.582*** (0.000)			Δ IPI	−0.243*** (0.000)		
ICU		−0.402*** (0.000)		Δ ICU		−0.188*** (0.000)	
ELC			−0.416*** (0.000)	Δ ELC			−0.193*** (0.000)
IPR	−1.106*** (0.001)			Δ IPR	−0.714*** (0.008)		
MBS		−0.228 (0.581)		Δ MBS		−0.123 (0.585)	
FBS			−0.531*** (0.000)	Δ FBS			−0.243*** (0.000)
INF	−1.103*** (0.000)	0.544*** (0.000)	−1.634*** (0.000)	Δ INF	−0.615*** (0.000)	0.243*** (0.000)	−0.756*** (0.000)
INTR	−0.209 (0.215)	−0.038 (0.915)	−0.879 (0.118)	Δ INTR	−0.115 (0.229)	−0.019 (0.926)	−0.453 (0.123)
EXR	−1.343** (0.042)	1.219** (0.033)	1.281** (0.038)	Δ EXR	−0.820** (0.035)	0.611** (0.025)	0.635** (0.031)
K	0.045 (0.582)	0.890*** (0.000)	−1.762*** (0.000)	Δ K	0.019 (0.594)	0.541*** (0.000)	−0.992*** (0.000)
A	−0.527*** (0.000)	−0.498*** (0.000)	0.436** (0.031)	Δ A	−0.241*** (0.000)	−0.238*** (0.000)	0.205** (0.036)
Normality	1.238 (0.537)	0.982 (0.612)	1.450 (0.484)	ECM(−1)	−0.684*** (0.000)	−0.743*** (0.000)	−0.689*** (0.000)
Serial Correlation	−1.933 (0.853)	−1.560 (0.988)	−1.623 (0.884)				
Heteroscedasticity	2.319 (0.128)	1.744 (0.198)	2.094 (0.147)				
Ramsey RESET	1.423 (0.244)	1.884 (0.162)	1.730 (0.181)				
Hausman Test	0.013 (0.547)	0.292 (0.369)	0.078 (0.588)				

Source: Authors' conception.

Note: ***, ** represent the 1% and 5% significant levels, respectively, numbers in brackets are the probability values, and the variables are expressed in natural logarithms.

be financed through borrowing or consumption rather than through savings mobilisation, weakening short-term saving outcomes. The findings support Oniyide and Ogunjinmi (2021) [27], who report slightly negative effects of capacity utilisation on economic growth, and underscore structural inefficiencies common in African economies facing heavy debt burdens. In contrast to conventional growth narratives, higher capacity utilisation does not automatically translate into improved saving behaviour where fiscal constraints dominate.

Digital infrastructure variables display heterogeneous short-run effects. Internet penetration (*IPR*) and fixed broadband subscriptions (*FBS*) negatively affect national savings, whereas mobile broadband subscriptions (*MBS*) remain statistically insignificant. This suggests that certain forms of digital expansion may initially encourage consumption, facilitate credit access, or increase engagement with digital services in ways that reduce short-term savings. These short-run effects contrast with the long-term benefits of digital inclusion reported by Kouladom (2023) [3] and Manasseh et al. (2023) [40], indicating that savings benefits from digitalisation may only materialise once sufficient scale, network maturity, and financial integration are achieved. Inflation (*INF*) and exchange rate movements (*EXR*) further amplify short-term declines in national savings, consistent with [25] Asue and Ikyaator (2023), who link debt accumulation to heightened inflationary pressures and currency volatility in African economies. The robustness of the CS-ARDL estimates is supported by diagnostic tests. Jarque-Bera statistics indicate approximate normality of residuals across all specifications, suggesting that extreme descriptive values do not distort coefficient estimates. Serial correlation tests fail to reject the null hypothesis of no residual autocorrelation, confirming that the dynamic specification adequately captures short-run adjustment processes. White heteroscedasticity tests show homoscedastic residuals, indicating reliable standard errors and efficient coefficient estimates. The Ramsey RESET test shows no evidence of functional form misspecification, and the Hausman test supports the consistency of the selected estimator. Collectively, these diagnostics confirm that the CS-ARDL estimates are robust, resilient to cross-country heterogeneity, and not driven by statistical artefacts.

In conclusion, while system GMM captures average short-run dynamics under conditions of endogeneity control, the CS-ARDL framework provides complementary insights by uncovering long-run equilibrium relationships, quantifying persistent effects, and explicitly accounting for cross-sectional dependence. By integrating unobserved common factors and heterogeneous country responses, the CS-ARDL results offer a more comprehensive and policy-relevant understanding of how external debt, capacity utilisation, and digital infrastructural architecture shape national savings in African debt-distressed economies. This dual-estimation approach strengthens confidence in the findings and underscores the importance of debt management, productive efficiency, and strategic digital investments in fostering sustainable saving behaviour.

4.7. Discussion of findings

This study examined the influence of external debt, capacity utilisation, and digital infrastructural architecture on national savings in eighteen African debt-distressed countries over the period 2011 to 2024, employing the panel system generalised method of moments (GMM) as the baseline estimation technique and the panel cross-sectionally augmented autoregressive distributed lag (CS-ARDL) model as a robustness check. The panel system GMM results offer substantial insights into the determinants of national savings in these economies. The consistently negative and statistically significant coefficient of lagged national savings across all specifications indicates strong persistence in saving behaviour, supporting the observations of Qureshi and Liaqat (2020) [21], while diverging from Hassan and Meyer (2021) [7], who reported weak savings transmission in Sub-Saharan Africa.

In Model 1, the external debt ratio (*EDR*), inflation (*INF*), internet penetration (*IPR*), industrial production index (*IP*), and exchange rate depreciation (*EXR*) significantly reduce national savings, highlighting the destabilising effects of macroeconomic imbalances, consistent with Manasseh et al. (2022) [5] and Makinde and Oladele (2023) [22]. Model 2 identifies external debt servicing (*EDS*), inflation, and capacity utilisation (*ICU*) as key detractors of savings, suggesting that in contexts of high debt, excess productive capacity may signal inefficiencies rather than growth, contrary to the

findings of Okeoma et al. (2022) [26]. In Model 3, external debt stock (*EDST*), inflation, and electricity consumption (*ELC*) negatively affect savings, corroborating Asue and Ikyaator (2023) [25] on the inflation and exchange rate transmission channels. Fixed broadband subscriptions (*FBS*) also exhibit a negative impact, indicating that digital infrastructure investments may initially stimulate consumption rather than savings accumulation. Capital formation (*K*) and total factor productivity (*A*) display mixed effects, reflecting the complex transmission mechanisms between investment, productivity, and savings. Diagnostic assessments further validate the robustness of the models: the AR (1) test is significant, AR (2) is insignificant, and Hansen test p-values confirm instrument validity, with Models 2 and 3 demonstrating relatively higher statistical reliability.

The CS-ARDL robustness checks reveal both short- and long-run dynamics that complement and extend the GMM findings. In the long run, external debt measures including *EDR*, *EDS*, and *EDST* exert consistently negative and statistically significant effects on national savings, demonstrating that rising debt obligations structurally erode domestic saving capacity. These long-term results align with Qureshi and Liaqat (2020) [21] and Makinde and Oladele (2023) [22] while extending the argument of Hassan and Meyer (2021) [7] by highlighting direct debt-savings transmission mechanisms in African debt-distressed contexts. Capacity utilisation, particularly *ICU*, maintains a negative long-run effect, reflecting persistent inefficiencies in production and energy use that prevent capacity expansion from translating into sustainable savings growth. Digital infrastructural variables, including *IPI*, *ELC*, and *IPR* also retain negative long-run coefficients, suggesting that despite their potential developmental benefits, current digital investments may not yet support savings accumulation, consistent with the notion that the savings returns of digitalisation may lag broader growth outcomes by Kouladoum (2023) [3].

In the short run, the CS-ARDL estimates demonstrate that fluctuations in external debt indicators continue to suppress national savings, reinforcing the short-term constraints imposed by rising debt burdens. Capacity utilisation indicators (*IPI*, *ICU*, *ELC*) also display negative short-run effects, consistent with structural inefficiencies that hinder savings mobilisation, supporting Oniyide

and Ogunjinmi (2021) [27]. Digital infrastructure variables present mixed short-run outcomes: *IPR* and *FBS* significantly reduce savings, while mobile broadband subscriptions (*MBS*) remain statistically insignificant, indicating that early-stage digital expansion may initially encourage consumption and credit access rather than savings. Inflationary pressures (*INF*) and exchange rate volatility (*EXR*) further reinforce short-term declines in national savings, corroborating Asue and Ikyaator (2023) [25] on the inflationary and currency destabilisation effects associated with debt accumulation. Conclusively, the CS-ARDL results highlight that in African debt-distressed countries, external debt, structural capacity constraints, and immature digital infrastructure consistently undermine national savings in both the short and long run. By capturing cross-sectional interdependencies and providing clear distinction between short-run adjustments and long-run equilibrium effects, the CS-ARDL framework complements the GMM estimates and provides a richer, policy-relevant understanding of the macroeconomic determinants of savings. These findings underscore the importance of prudent debt management, efficiency in capacity utilisation, and the strategic development of digital infrastructure to strengthen domestic savings and promote financial stability across the continent.

5. Conclusion and policy recommendations

This study examined the dynamic effects of external debt, capacity utilisation, and digital infrastructural architecture on national savings in eighteen African debt-distressed countries over the period 2011 to 2024, using both panel system GMM and threshold cross-sectionally augmented autoregressive distributed lag (CS-ARDL) estimations. The empirical findings provide clear and robust answers to the study's research questions. First, external debt, measured through debt ratios, debt servicing obligations, and debt stock, consistently exerts negative and statistically significant effects on national savings in both the short and long run. These results confirm the presence of debt overhang and fiscal crowding out; whereby rising debt obligations reduce domestic resource mobilisation and undermine macroeconomic stability. Second, capacity utilisation indicators show a negative association with national savings, suggesting that industrial capacity in many Afri-

can debt-distressed economies reflects structural inefficiencies, including energy shortages and production bottlenecks, rather than productive expansion that enhances savings. Third, digital infrastructural architecture demonstrates negative short-run effects on national savings, likely due to high initial investment costs, limited institutional readiness, and consumption-oriented digital adoption. However, the long-term potential of digital infrastructure to support productivity and savings accumulation remains evident, particularly when linked with formal financial systems and effective regulatory frameworks.

These findings have specific policy implications. To mitigate the negative impact of external debt on savings, governments should pursue prudent debt management strategies, including keeping external debt at sustainable levels, ideally below fifty percent of GDP in highly vulnerable economies, conducting comprehensive debt audits, and prioritising loans that finance productive infrastructure rather than consumption. To improve capacity utilisation, public investment should focus on eliminating structural bottlenecks, particularly by expanding energy supply, upgrading industrial infrastructure, and enhancing maintenance and logistics systems, ensuring that increases in industrial capacity translate into sustained savings and productivity gains. In relation to digital infra-

structure, policymakers should integrate digital expansion with formal financial inclusion by promoting digital finance platforms that encourage savings, strengthening digital literacy, and enforcing regulatory measures that channel digital activity toward investment and productive applications rather than short-term consumption.

This study contributes to the literature by providing a comprehensive assessment of how external debt dynamics, productive efficiency, and digital transformation jointly shape national savings in African debt-distressed economies. Addressing these structural and policy gaps is essential for mobilising domestic savings, improving macroeconomic resilience, and supporting sustainable long-term development across the continent. Future research could build on this analysis in several ways. Country-specific studies could examine the heterogeneous effects of debt and capacity utilisation across African subregions. The role of institutional quality, governance, and political stability as mediators in the relationship between digital infrastructure and savings warrants further investigation. Finally, as digital finance and fintech adoption continue to expand in Africa, longitudinal studies could explore how mobile banking, digital wallets, and financial literacy initiatives influence savings behaviour over time, providing evidence to guide targeted policy interventions in local contexts.

REFERENCES

1. Krugman P. Financing versus forgiving a debt overhang. *Journal of Development Economics*. 1988;29:253-268. DOI: 10.1016/0304-3878(88)90044-2
2. Kojo E.R., Nchege J., Dorathy I. Infrastructure development, capacity utilisation and manufacturing value added in Nigeria. *The Economics and Finance Letters*. 2020;7(2):104-111. DOI: 10.18488/journal.29.2020.72.104.111
3. Kouladoun J.C. Digital infrastructural development and inclusive growth in Sub-Saharan Africa. *Journal of Social and Economic Development*. 2023;25:403-427. DOI: 10.1007/s40847-023-00240-5
4. Zhao X., Dong F. Digital infrastructure construction and corporate innovation efficiency: Evidence from Broadband China Strategy. *Humanities and Social Sciences Communications*. 2025;12:347. DOI: 10.1057/s41599-025-04614-4
5. Manasseh C.O., Abada F.C., Okiche E.L., Okanya O., Nwakoby I.C., Offu P., Ogbuagu A.R., Okafor C.O., Obidike P.C., Nwonye N.G. External debt and economic growth in Sub-Saharan Africa: Does governance matter? *PLoS ONE*. 2022;17(3):1-28. DOI: 10.1371/journal.pone.0264082
6. Okeke C.G., Ogbuabor J.E. Effects of climate change and agricultural productivity on poverty outcomes in Africa: A system GMM perspective. *African Journal of Agricultural and Resource Economics*. 2025;20(1). DOI: 10.53936/afjare.2025.20(1).4
7. Hassan A., Meyer D. Exploring the channels of transmission between external debt and economic growth: Evidence from Sub-Saharan African countries. *Economies*. 2021;9(2):50. DOI: 10.3390/economies9020050
8. Aisen A., Manguinhane E., Simone F.F. An empirical assessment of the exchange rate pass-through in Mozambique. International Monetary Fund Working Paper. 2021. URL: <https://papers.ssrn.com/sol3/Delivery.cfm?abstractid=4026308>

9. Manasseh C. O., Ngong C. A., Logan C. S., Ede K., Okanya O. Financial technology, innovation, and bank performance nexus: Evidence from ECOWAS member countries. *Journal of African Business*. 2025. DOI: 10.1080/15228916.2025.2465118
10. Hoti A., Shkurti A., Rehman S. Impact of external debt on economic growth in Western Balkan countries. *Academic Journal of Interdisciplinary Studies*. 2022;11(2):192. DOI: 10.36941/ajis-2022-0045
11. Ibrahim A.B. Effect of domestic and external debt on Nigeria's economic growth. *SSRN Electronic Journal*. 2023. DOI: 10.2139/ssrn.4999558
12. Blundell R., Bond S. Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*. 1998;87(1):115-143. DOI: 10.1016/S0304-4076(98)00009-8
13. Chudik A., Mohaddes K., Pesaran M.H., Raissi M. Long run effects in large heterogeneous panel data models with cross-sectionally correlated errors. In: *Essays in Honor of Man Ullah*. Emerald Publishing; 2016. DOI: 10.1108/S0731-905320160000036013
14. Solow R.M. A contribution to the theory of economic growth. *Quarterly Journal of Economics*. 1956;70:65-94. DOI: 10.2307/1884513
15. Mankiw N.G., Romer D., Weil D.N. A contribution to the empirics of economic growth. *Quarterly Journal of Economics*. 1992;107(2):407-437. DOI: 10.2307/2118477
16. Barro R.J. Economic growth in a cross-section of countries. *Quarterly Journal of Economics*. 1991;106(2):407-443. DOI: 10.2307/2937943
17. Modigliani F., Brumberg R. Utility analysis and the consumption function: An interpretation of cross-section data. In: Kurihara K., editor. *Post Keynesian Economics*. Rutgers University Press; 1954. DOI: 10.4324/9781315016849
18. Modigliani F. Life cycle, individual thrift, and the wealth of nations. *American Economic Review*. 1986;76(3):297-313. URL: <https://www.jstor.org/stable/1813352>
19. Loayza N., Schmidt-Hebbel K., Servén L. What drives private saving across the world? *Review of Economics and Statistics*. 2000;82(2):165-181. URL: <http://www.jstor.org/stable/2646814> (accessed on 07.03.2026).
20. Sachs J.D. The debt overhang of developing countries. In: Calvo G.A., Findlay R., Kouri P.J. K., de Macedo J.B., editors. *Debt, Stabilization and Development: Essays in Memory of Carlos Diaz Alejandro*. Blackwell Publishing; 1988.
21. Qureshi I., Liaqat Z. The long-term consequences of external debt: Revisiting the evidence using panel VAR. *Journal of Macroeconomics*. 2020;63:103184. DOI: 10.1016/j.jmacro.2019.103184
22. Makinde A., Oladele T. The impact of internal and external debt on Nigeria's economic indicators: A mixed methods approach. *Journal of Economic Studies*. 2023. DOI: 10.2139/ssrn.4999558
23. Imoagwu C.P., Ezenekwe U.R., Nwogwugwu U.C. Rising external debt and exchange rate: Empirical evidence from Nigeria. *International Journal of Advanced Economics*. 2023;5(4):90-106. DOI: 10.51594/ijae.v5i4.457
24. Madhavi J.A. Exchange rate pass-through and domestic inflation in Sri Lanka. *SSRN Electronic Journal*. 2022;4138576. DOI: 10.2139/ssrn.4138576
25. Asue E.A., Ikyator J.V. External debt pass-through to inflation in Nigeria. *CBN Journal of Applied Statistics*. 2023;14(2). URL: <https://dc.cbn.gov.ng/jas/vol14/iss2/5>
26. Okeoma T.F., Nwaobilor N.C., Amaechi U.G. Impact of manufacturing capacity utilisation on the Nigerian economy. *Journal of Energy Technology and Environment*. 2022;4(4):76-86. DOI: 10.5281/zenodo.7446344
27. Oniyide F.V., Ogunjinmi O.O. Effect of manufacturing capacity utilisation on economic growth in Nigeria. *International Journal of Research and Scientific Innovation*. 2021;8(5):39-48. URL: <https://rsisinternational.org/journals/ijrsi/digital-library/volume-8-issue-5/39-48.pdf>
28. Yuan Y., Yu L., Kumar S., Zhang Y. Industrial intelligence and capacity utilisation from a green development perspective. *Frontiers in Environmental Science*. 2022;10:1006630. DOI: 10.3389/fenvs.2022.1006630
29. Luan F., Yang X., Chen Y., Regis P. Industrial robots and air environment: A moderated mediation model. *Sustainable Production and Consumption*. 2022;30:870-888. DOI: 10.1016/j.spc.2022.01.015
30. Ihenyen C.J., Ogwu F.E., Abraham T.K. Manufacturing capacity utilisation and growth of the manufacturing industry in Nigeria. *World Journal of Finance and Investment Research*. 2024;8(4):54-68. DOI: 10.56201/wjfir.v8.no4.2024.pg54.68
31. Singh M., Rath R., Kaswan M. Capacity utilisation in the industrial sector: A structured review. *World Journal of Engineering*. 2021. DOI: 10.1108/wje-09-2020-0447

32. Wang M., Feng C. Measuring capacity utilisation under energy and CO₂ constraints. *Resources Policy*. 2023;80:103278. DOI: 10.1016/j.resourpol.2022.103278
33. Nishi H. A two-sector Kaleckian model of growth and distribution with endogenous productivity dynamics. *Economic Modelling*. 2020;88:223-243. DOI: 10.1016/j.econmod.2019.09.022
34. Nishi H., Stockhammer E. Distribution shocks in a Kaleckian model with hysteresis and monetary policy. *Economic Modelling*. 2020;90:465-479. DOI: 10.1016/j.econmod.2020.01.008
35. Holm M.B., Lerdalen L.O., Vines D. The effect of capacity constraints on the slope of the Phillips curve. *Oxford Economic Papers*. 2024;76(4):1226-1238. DOI: 10.1093/oep/gpae012
36. Rotemberg J.J. Sticky prices in the United States. *Journal of Political Economy*. 1982;90(6):1187-1211. DOI: 10.1086/261138
37. Caldera S., Mostafa S., Desha C., Mohamed S. Digital infrastructure asset management tools for resilient infrastructure. *Sustainability*. 2021;13(21):11965. DOI: 10.3390/su132111965
38. Zhang J., Yang Z., He B. Digital infrastructure and urban economic resilience. *Sustainability*. 2023;15(19):14289. DOI: 10.3390/su151914289
39. Manasseh C.O., Ede K.K. Digital finance, cybersecurity challenges and economic development in Nigeria. In: *Emerging Trends in Conflict Resolution, Peace and Strategic Studies*. 2024. URL: <https://www.nijpcr.nou.edu.ng/wp-content/uploads/2024/11/Book-ETPCS-CHAPTERS-COMPLETE-PDF-1.pdf>
40. Manasseh C.O., Okanya O.C., Logan C.S., Ede K.K., Ejim E.P., Ozor S.N., Onuoha O., Okiche E.L. Digital finance, financial inclusion and economic growth nexus in COMESA. *Russian Law Journal*. 2023;11(5):376-401. DOI: 10.17589/2309-8678-2023-11-5-376-401
41. Manasseh C.O., Nwakoby I.C., Okanya O.C., Nwonye N.G., Odidi O., Thaddeus K.J., Ede K.K., Nzidee W. Impact of digital financial innovation on financial system development in COMESA countries. *Asian Journal of Economics and Banking*. 2023;8(1):121-142. DOI: 10.1108/AJEB-04-2022-0041
42. Arellano M., Bond S. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies*. 1991;58(2):277-297. DOI: 10.2307/2297968
43. Gujarati D.M. Basic Econometrics. 4th ed. New York: McGraw Hill; 2003.
44. Levin A., Lin C.F., Chu C.S. Unit root tests in panel data: Asymptotic and finite sample properties. *Journal of Econometrics*. 2002;108(1):1-24. DOI: 10.1016/S0304-4076(01)00098-7
45. Im K.S., Pesaran M.H., Shin Y. Testing for unit roots in heterogeneous panels. *Journal of Econometrics*. 2003;115(1):53-74. DOI: 10.1016/S0304-4076(03)00092-7
46. Pedroni P. Panel cointegration tests with an application to purchasing power parity. *Econometric Theory*. 2004;20:597-625. DOI: 10.1017/S0266466604203073
47. Maddala G.S., Wu S. A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics*. 1999;61:631-652. DOI: 10.1111/1468-0084.61.s1.13
48. Nwakoby I.C., Manasseh C.O., Nwakoby J.O., Logan C.S., Okanya O.C. Linking debt sustainability, green infrastructure innovation, exchange rate volatility, and output growth in Sub-Saharan Africa. *Energy Technologies and Environment*. 2026;4(1):22. DOI: 10.58567/ete04010002
49. Manasseh C.O., Abada F.C., Ogbuabor J.E., Urama C., Onwumere J. External debt and economic growth: An impact analysis. *SSRN Electronic Journal*. 2019. DOI: 10.2139/ssrn.5361943. URL: <https://ssrn.com/abstract=5361943>
50. Arellano M., Bover O. Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*. 1995;68:29-52. DOI: 10.1016/0304-4076(94)01642-D

ABOUT THE AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

Ifeoma C. Nwakoby — PhD in Banking and Finance, Professor, Business Administration Department, University of Nigeria, Nsukka, Nigeria

Ифеома С. Нвакоби — PhD в области банковского дела и финансов, профессор кафедры делового администрирования, Университет Нигерии, Нсукка, Нигерия

<https://orcid.org/0009-0009-5536-8631>

ifeoma.nwakoby@unn.edu.ng

Charles O. Manasseh — PhD in Financial Economics, Senior Lecturer, Business Administration Department, University of Nigeria, Nsukka, Nigeria

Чарльз О. Манассе — PhD в области финансовой экономики, старший преподаватель кафедры делового администрирования, Университет Нигерии, Нсукка, Нигерия
<https://orcid.org/0000-0001-9937-6208>

Corresponding Author / Автор для корреспонденции:
charssille@gmail.com

John O. Nwakoby — DBA in Finance, Visiting Scholar, Business School, University of Nigeria, Nsukka, Nigeria

Джон О. Нвакоби — DBA в области финансов, приглашенный научный сотрудник, Бизнес-школа, Университет Нигерии, Нсукка, Нигерия
<https://orcid.org/0009-0002-6370-8092>
jonwakoby@gmail.com

Chine S. Logan — PhD in Public Policy and National Security, Visiting Scholar, Public Policy Department, Liberty University, Lynchburg, United State

Чин С. Логан — PhD в области государственной политики и национальной безопасности, приглашенный научный сотрудник кафедры государственной политики, Университет Либерти, Линчберг, США
<https://orcid.org/0009-0002-2523-5159>
cslogan11@gmail.com

Ogochukwu C. Okanya — PhD in Banking and Finance, Senior Lecturer, Institute for Management and Technology, Enugu, Nigeria

Огочукве С. Оканья — PhD в области банковского дела и финансов, старший преподаватель, Институт менеджмента и технологий, Энугу, Нигерия
<https://orcid.org/0000-0003-2575-6077>
ookanya@imt.edu.ng

Chizoba Gideon Okeke — PhD in Economics, Lecturer 1, Department of Economics, Coal City University, Enugu, Nigeria

Чизоба Гидеон Океке — PhD в области экономики, преподаватель 1-го уровня, кафедра экономики, Университет Коул-Сити, Энугу, Нигерия
<https://orcid.org/0000-0002-9850-5407>
gideonite2010@gmail.com

Authors' declared contribution:

I.C. Nwakoby — conceptualization, writing — original draft, writing — review and editing, supervision, project administration.

C.O. Manasseh — conceptualization, methodology, formal analysis, writing original draft, data curation.

J.O. Nwakoby — software, formal analysis, validation, visualization.

C.S. Logan — data curation, investigation, resources, writing — review and editing.

O.C. Okonya — literature review, investigation, validation, writing — review and editing.

C.G. Okeke — data curation, visualization, editing, administrative support.

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

The article was submitted on 18.09.2025; revised on 19.02.2026 and accepted for publication on 03.03.2026.

The authors read and approved the final version of the manuscript.