
| RESEARCH ARTICLE

Smart R&D Pathways and Export Competitiveness: A Comparative Analysis of Bangladesh and China's Pharmaceutical Industry

Deepto Chakraborty¹ ✉ and Nirjona Mondal²

¹Dhaka University, Bangladesh

²Wenzhou University, China

Corresponding Author: Deepto Chakraborty, **E-mail:** chakrabortydeepto85@gmail.com

| ABSTRACT

This study examines how smart research and development (R&D) financing can promote sustainable pharmaceutical export growth by comparing Bangladesh and China. Using descriptive statistical analysis and secondary data from 2020–2025, the study evaluates pharmaceutical exports, R&D expenditure, domestic credit to the private sector, and GDP growth. The findings show that China's strong performance is supported by sustained R&D investment, diversified financing mechanisms, and coordinated government policies that foster innovation and high-value pharmaceutical exports. In contrast, Bangladesh has achieved notable success in generic medicine production and export expansion but continues to face challenges, including low R&D investment, limited innovation financing, and weak industry–university collaboration. As Bangladesh prepares for post-LDC graduation, strengthening its innovation ecosystem through increased R&D funding, financial incentives, venture capital, and institutional reforms will be crucial for maintaining export competitiveness. The study concludes that adopting smart R&D financing strategies can help Bangladesh transition toward an innovation-driven pharmaceutical industry and achieve sustainable export growth.

| KEYWORDS

Pharmaceutical exports; Research and development (R&D); Innovation finance; Export competitiveness; Bangladesh; China; Sustainable economic growth

| ARTICLE INFORMATION

ACCEPTED: June 11, 2026

PUBLISHED: July 20, 2026

DOI: <https://doi.org/10.61424/rjbe.v4i3.955>

1. Introduction

Pharmaceuticals are now being considered as strategic exports that are high-value and very essential in terms of social good. Unlike clothes or products, pharmaceutical exports must be provided under strict regulations, with a high level of R&D and innovation. By 2030, the pharmaceuticals market will probably be larger than USD 1.5 trillion, and emerging economies will be progressively taking a larger share in the market (OECD, 2023). Nevertheless, low-cost manufacturing is not all it takes to succeed in this sector, and instead, it needs to create the ecosystems of R&D that would be powered by smart financial solutions.

A good example of how this can be done is China. It has seen a shift over the last twenty years in its strategy from a low-cost manufacturer of bulk drugs to an innovation-driven pharmaceutical exporter. This has been done with a purposeful plan of financial support in R&D, both in terms of tax credits and government grants, as well as venture capital incentives for biotech start-ups. The pharmaceutical sector of China is developing at an ongoing rapid pace

globally today, with increasing exportation of generic medicines, active pharmaceutical ingredients (API), and, recently, patented pharmaceuticals (Hu and Mathews, 2021).

Instead, Bangladesh has had a dynamic pharmaceutical industry that fulfills 97 percent of the domestic market and exports to over 150 nations (Export Promotion Bureau, 2023). The competitive advantage of the same is that it produces low-cost generics as per the flexibilities of the WTO Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement. This benefit, however, will weaken over time as Bangladesh ceases to be a Least Developed Country (LDC) in the year 2026. Bangladesh will be losing its competitive advantage in pharmaceuticals without robust financial channels to spur R&D and innovation (UNCTAD, 2023).

At the moment, Bangladesh allocates less than 0.2 percent of its GDP to R&D, in contrast to the 2.65 percent in China (World Bank, 2023). Bank loans and government subsidies still constitute a large part of the financial ecosystem, with little venture capital, export credit, or blended financing for pharmaceutical innovation (Rahman and Bari, 2022). In comparison, the success of China demonstrates the significance of aligning financial policies with R&D so that the local companies can become technologically advanced to enter the markets of higher-value exports.

The purpose of the paper is to discuss how smart financial pathways can be used to develop a stable pharmaceutical export base in Bangladesh. In particular, it analyses the following research questions:

This research is relevant to the policy and academic discourses by answering these questions. It outlines realistic lessons that can guide Bangladesh, shows how finance can be used to encourage exports that are driven by innovation, and suggests a structure that will integrate financial rewards with sustainable development policies in pharmaceuticals.

1.1 Research objectives

- What have been the financial instrument applications by China to bridge R&D and pharmaceutical export development?
- What are the key financial and institutional limits to the pharmaceutical R and exports of Bangladesh?
- What are the intelligent financial strategies and techniques that Bangladesh can follow to attain sustainable and competitive development in the post-LDC period?

2. Literature Review

2.1 Theoretical Foundations: Finance, R&D, and Export Competitiveness

The connection between innovation and international trade literature regards the relationship between research and development (R&D), financial systems, and export performance. Defenders of endogenous growth theory point to the fact that knowledge accumulation and technological innovation are the key to a sustained economic growth, not just factor endowment (Paul Romer, 1990). Especially in high-technology sectors like pharmaceuticals, the issue of innovation is especially important since product development cycles are lengthy, regulation is very stringent, and market structure is determined by intellectual property protection.

Empirical studies indicate that companies that invest in R&D tend to enter into export markets and compete in high-value markets (Philippe Aghion et al., 2005). In the pharmaceutical industry, the intensity of research and development is directly linked to productivity increase, the number of patents, and export maturity (OECD, 2023). Nonetheless, pharmaceutical research and development are expensive and risky ventures. It entails patient capital, venture funding, regulatory encouragement, and integrated public-private investment.

Financial development thereof is catalytic. Ross Levine (2005) argues that efficient financial systems can mobilize savings, direct the capital to innovative firms, and diversify the risk. State interventions and the use of targeted

financial instruments have become especially significant in supporting the upgrading of innovation-based exports in emerging economies where capital markets tend to be shallow (UNCTAD, 2023).

More recent works are focusing on the idea of mission-oriented or smart industrial finance, in which the government coordinates fiscal policy, credit policy, and venture capital around strategic industries (Mazzucato, 2018). In pharmaceuticals, such things are tax credits on R&D, government research grants, biotech incubators, export credit insurance, and blended finance. The instruments are useful in bridging the gap between research at the early stages and commercialization in the global market.

In this context, we can compare China and Bangladesh. A good example of state-coordinated innovation financing that has produced successful upgrading effects in the pharmaceutical exports in China is China. In Bangladesh, however, with TRIPS flexibilities, it is still, to a large extent, reliant on generic production and there is little integration of finance and innovation. According to the literature, unless structural financial reform is implemented, the late-industrializing countries can be in the low-value segments (World Bank, 2023).

This paper is based on the following theoretical knowledge to explore how financial instruments can be strategically supported by pharmaceutical R&D to promote sustainable export growth, especially in the backdrop of the post-LDC transition of Bangladesh.

2.2 China: Strategic Financial Architecture and Pharmaceutical Innovation Upgrading

The Chinese pharmaceutical transformation has been aided not only by the increased investment in research and development but also by the conscious building of a comprehensive financial-innovation system. The literature points out that the success of China is anchored in the coordination of policies, the long-term capital allocation, and the alignment between the institutions of science, finance, and the promotion of exports (Hu and Mathews, 2021; OECD, 2023).

2.2.1 Expansion of R&D Investment and Fiscal Incentives

In 2023, China had a gross domestic expenditure on R&D of about 2.65% of GDP, which makes China one of the highest R&D investors in the world (World Bank, 2023). Under this, the pharmaceuticals and biotechnology have been cited as strategic areas with regard to national innovation plans, such as the Medium- and Long-Term Science and Technology Development Plan (2006-2020) and subsequent Five-Year Plans.

The payment of corporate income tax at a lower rate (15 percent rather than the usual 25 percent) to encourage R&D by Chinese firms and subsidies on R&D, referred to as the super-deduction, have been one of the major characteristics of the Chinese strategy. These steps greatly reduce the actual cost of innovation and promote reinvestment in pipelines.

China contrasts with other developing countries, where tax incentives are under-exploited, and has actually instituted these policies with clear eligibility criteria and a certification system for high-tech firms. This generated predictable financial indicators that minimized uncertainty among the pharmaceutical firms that had lengthy development processes.

2.2.2 Public Funding, State Guidance Funds, and Venture Capital

In addition to tax incentives, China has marshaled significant government funds towards diminishing the risk of innovation. State-backed "Guidance Funds" were set up by both central and provincial governments that co-invest with venture capital in strategic sectors, such as biopharmaceuticals. They are catalytic investors, and they use public resources to crowd in private capital.

Of particular importance is the emergence of venture capital in the biotech ecosystem of China. However, in the 2010s, China emerged as a top destination for venture capital in biotech globally. Science parks in cities like Shanghai, Shenzhen, and Beijing were government-supported and formed clusters where start-ups could obtain access to laboratory facilities, seed financing, and regulatory advice.

These scholars state that this type of financial architecture, which is organized in the form of a cluster, minimizes the costs of transactions and promotes commercialization (Hu and Mathews, 2021). Using a combination of incubators, government-owned research centers, and a network of venture capital, China reduced the laboratory research-to-export pharmaceutical products channels.

2.2.3 Regulatory Reform and Capital Market Integration

Regulatory modernization was added to the financial support. National Medical Products Administration restructuring hastened drug approval schedules and harmonized local standards with international standards. Simple procedures facilitated better investor confidence because the companies could expect more lucid business-making schedules.

Parallel to this, the reforms in the capital markets increased the channels of finance. In 2019, the biotech companies could get access to equity financing largely before they reached profitability, as the Shanghai Stock Exchange launched the STAR Market (Science and Technology Innovation Board) with a significant break from the conventional listing definition. This process enabled pharmaceutical companies that are research-intensive to raise long-term capital without the use of bank credit alone.

According to the literature, diversified financing (the synergies of public grants, venture capital, and stock markets) decreased the reliance on short-term debt and better aligned the risk profile of pharmaceutical R&D (OECD, 2023).

2.2.4 Export Upgrading and Global Integration

The integration of financial innovations in China was converted into quantifiable export upgrading. Although the nation is still a leading exporter of active pharmaceutical ingredients (APIs), larger proportions of more value-added finished formulations and novel biologics have been exported.

Pharmaceutical companies in China have been gradually penetrating into the regulated markets as a result of adhering to the international standards, e.g., Good Manufacturing Practice (GMP) certification that is accepted in the EU and the US. Programs of providing financial support assisted firms in upgrading facilities to qualify them for these standards. UNCTAD (2023) explicitly states that the growth of China's pharmaceutical exports in the last 10 years is a result of structural upgrading and not necessarily an increase in volume.

Besides, outward foreign direct investment (OFDI) and cross-border mergers and acquisitions have enabled Chinese companies to gain access to sophisticated technologies and distribution systems. These international expansion strategies were supported by state-supported financing mechanisms, which enhanced the competitiveness of exports even more.

2.2.5 Institutional Coordination and Long-Term Policy Orientation

One of the common themes evident in the literature is that the model of China is institutional coordination. Financial instruments were not applied in a vacuum; it was incorporated in larger industrial policies such as Made in China 2025, which placed biomedicine as a strategic sector.

Continuity in policies through the five-year plans ensured that there was a long-term commitment and less uncertainty in policy for investors and firms. This is important, especially in pharmaceuticals, where R&D may take over 8-10 years.

Nonetheless, researchers also note that when financing is led by the state, it can create inefficiencies such as the misallocation of resources and uneven distribution of the quality of innovation across regions (Hu and Mathews, 2021). Despite these disadvantages, there is empirical evidence that strategic coordination of financial structure in China has enabled technological potential and the quality of exports to be advanced enormously.

3. Descriptive Statistics: China

3.1 Overview of Data and Context

China has become a major global exporter of pharmaceutical products, underpinned by robust investment in research, rapid innovation, financial sector depth, and sustained macroeconomic output. Between 2020 and 2025, China’s pharmaceutical trade has shown resilience despite global pandemic disruptions and shifting international regulations, evolving from primarily low-cost chemical exports to higher-value products and increasingly sophisticated biotechnology outputs. This transition reflects broader industrial strategy shifts toward innovation-driven growth and the strengthening of export channels.

This section presents descriptive statistics for four core indicators from 2020–2025: (1) pharmaceutical exports; (2) R&D expenditure as a share of GDP; (3) domestic credit to the private sector as a share of GDP; and (4) GDP growth rate. The analysis identifies structural characteristics and trends relevant to China’s sustainable export growth pathways.

Dataset (2020–2025)

Year	Pharmaceutical Exports (USD Billion)	R&D % of GDP	Credit % of GDP (Private)	GDP Growth %
2020	11.8	2.41	179.1	2.3
2021	13.7	2.43	173.6	8.1
2022	15.3	2.56	181.8	3.0
2023	16.4	2.60	189.6	5.2
2024	17.2	2.65	194.2	5.0
2025*	18.0	2.70	196.0	4.8

The export figures reflect a steady increase in aggregate pharmaceutical trade, consistent with reports of expanding product categories and diversification of export markets.

3.2 Descriptive Statistics

Descriptive measures summarize the key features of China's dataset:

Variable	Mean	Min	Max	Std. Dev.
Pharmaceutical Exports	15.4	11.8	18.0	2.32
R&D (% GDP)	2.56	2.41	2.70	0.11
Credit (% GDP)	185.7	173.6	196.0	8.3
GDP Growth %	4.73	2.3	8.1	1.97

4. Trend Dynamics: Indicators Explained

4.1 Pharmaceutical Exports

China's pharmaceutical exports increased monotonically over the study period. The sector's export value rose from an estimated USD 11.8 billion in 2020 to approximately USD 18 billion in 2025, exhibiting sustained outward growth despite global volatility. Annual export growth rates peaked in 2021 ($\approx 16.1\%$) and gradually moderated thereafter while remaining positive. This pattern reflects both demand recovery post-COVID-19 and structural export diversification into higher-value product groups and markets.

4.2 R&D Expenditure

R&D expenditure as a percentage of GDP remained stable and relatively high compared with other emerging economies, rising from 2.41% in 2020 to an estimated 2.7% in 2025. This reflects sustained investment in innovation ecosystems, clinical research, and biotech capacity, consistent with industry reports documenting rapid growth in new drug approvals and innovation output.

4.3 Domestic Credit to the Private Sector

China's domestic credit to the private sector remained exceptionally high ($>170\%$ of GDP), indicating deep financial market penetration and broad access to capital for private enterprises, including pharmaceutical manufacturers. Such credit depth supports investment in production scaling, technology adoption, and export capacity enhancement.

4.4 Macroeconomic Growth

China's GDP growth trajectory was affected by the COVID-19 lockdown effects in 2020, with lower growth ($\approx 2.3\%$) followed by a strong rebound and normalization in subsequent years. Stable economic performance provides a conducive backdrop for structural sector expansion.

4.5 Structural Interpretation and Pathways

China's pharmaceutical export growth reflects a composite structural pathway driven by three interrelated dimensions:

1. **Innovation-Led Capacity:** High and increasing R&D intensity has enabled Chinese pharmaceutical firms to transition from volume-led exports to value-added products, including biologicals, specialty formulations, and technologically complex drug classes. This aligns with national efforts to deepen domestic scientific capabilities and strengthen global competitiveness.
2. **Financial Infrastructure:** The substantial depth of domestic credit to the private sector facilitates firm-level investment in technology, capacity expansion, and global market entry strategies. Such financial underpinnings are critical for sustaining long-term export growth without reliance on short-term external funding constraints.
3. **Export Resilience and Market Diversification:** China's export profile shows robust resilience and diversification across product categories and destination markets. While established raw materials remain significant, there is growing penetration into Western markets with higher-value pharmaceutical products, suggesting upgrading along global value chains.

Collectively, these structural features indicate a sustainable R&D pathway that is increasingly rooted in innovation, financial robustness, and macroeconomic stability — prerequisites for continued pharmaceutical export growth.

5. Literature Review: Pharmaceutical Industry and R&D in Bangladesh

The pharmaceutical industry in Bangladesh has been widely acknowledged in academic and policy literature as one of the most essential manufacturing sectors in the country, playing a pivotal role in an import-dependent country in achieving self-sufficiency. Several studies illustrate that the pharmaceutical industry in Bangladesh has been meeting the domestic demand, which amounts to 97 to 98 percent every year.

5.1 The Historical Evolution and Policy Foundation

Multiple factors have driven the historical evolution and emergence of the pharmaceutical industry in Bangladesh, and the National Drug Policy of 1982, which is persistently identified as one of the most pivotal steps in bringing the pharmaceutical industry on board, has been deemed a transformative step in policy.

According to eminent economist Rehman Sobhan, the policy created a strategic protection mechanism for the pharmaceutical industry that has been propelling them to establish their footing and enabling them to get rid of multinational dominance and embolden the indigenous capacity, and arguing that the policy itself has been a great boon for industrial development and facilitates moving firms from simple assembly to full-scale manufacturing hubs.

5.2 Dominance of Generic Pharmaceuticals and the Role of TRIPS Flexibilities

Bangladesh's pharmaceutical industry has made a huge breakthrough in terms of specialization in generic pharmaceuticals and the TRIPS Agreement Waiver for LDCs. According to Carlos Cornea, a Venezuelan activist, the TRIPS agreement has facilitated and allowed countries like Bangladesh to circumvent legally patent restrictions that will foster and accelerate rapid industrial growth and development. Based on Bishwajit Dhar's conclusive argument and opinion, it has been inferred that Bangladesh has efficiently utilized this provision to reverse-engineer drugs and has thrown its hat into the ring, competing globally in terms of price determination. On the one hand, it can be conjectured that Jean Lanjouw, an American economist specializing in intellectual rights and property, emphasized that overly relying on the generic pharmaceutical industry can result in innovation stagnation and may encounter limited financial incentives to invest in original drug discovery.

5.3 Export Performance and International Competitiveness

In terms of export performance and international competitiveness, the literature consistently acknowledges the fact that pharmaceutical exports are one of the most significant revenue sources contributing to and strengthening the economy in Bangladesh. On the other hand, the pharmaceutical industry has been showing its readiness in terms of pharmaceuticals, which represent a knowledge-intensive manufacturing activity with higher value addition and stronger technological spillover effects. Studies have shown and indicated that the Bangladesh pharmaceutical exports have successfully expanded and augmented by the low cost of pricing, growing manufacturing ability, and most importantly, the industry has been demonstrating its caliber in different regions of the world across different continents, for example, Asia, Europe, and Africa, which pharmaceutical products have been receiving with graceful acceptance.

Nevertheless, scholars have been harping on the fact that exports in the pharmaceutical industry have been solely concentrating on low-value products and less-regulated markets. Access to highly regulated and stringent environments, such as the USA and the European Union, has been quite challenging and limited for Bangladesh. Research scholars reiterated that obtaining essential and fundamental certifications can pave the way for Bangladesh's pharmaceutical industry to enter these highly regulated markets with the most stringent policies. Hence, it can be stated that export competitiveness and its development depend on technological advancement and invest on more research and innovation with an aggressive mindset.

5.4 Research and Development Constraints in Bangladesh

One of the most critical concerns lies in the research and development impediment in Bangladesh, which has been primarily obstructing Bangladesh's pharmaceutical industry's path towards greater excellence and technological advancement to compete globally with all agility and competitiveness. The local firms have predominantly reined in generic production and investment in advanced production, and it remains limited compared to other countries. According to studies, it has been shown that Bangladesh allocates around 0.2 percent of its GDP to R & D compared to China, which is around 2.65 percent right now. The structural issues and loopholes in Bangladesh's pharmaceutical industry have been nothing but a matter of great concern for Bangladesh's sustainable development. Limited access to funding and financing, weak collaboration between universities and industries, has led to a lack of skilled researchers, which still hampers the development of the Bangladesh pharmaceutical industry.

Several studies have identified weak university–industry collaboration as a major obstacle to pharmaceutical innovation in Bangladesh. Rahman and Bari (2022) argue that research institutions and pharmaceutical firms operate largely in isolation, limiting knowledge transfer and reducing opportunities for collaborative drug discovery and product development. Similarly, Ahmed and Islam (2021) found that most pharmaceutical firms prioritize production expansion and regulatory compliance over long-term investment in innovative research activities.

The patent landscape has been a reflection of these deeply ingrained structural issues. According to the World Patent Organization (WPO), it has been stated that the performance of Bangladesh's track record in terms of patent registration is relatively unimpressive compared to other regional sectors. On the other hand, this sector has been depending on reverse engineering and generic manufacturing facilitated by TRIPS flexibilities, which, while commercially advantageous, may discourage investment in original drug development and advanced biotechnology research.

Industry reports also highlight and showcase noticeable shortcomings and deficiencies in laboratory infrastructure, clinical research capacity, and skilled human capital. The Bangladesh Pharmaceutical Association (BPO) argues that many local firms lack access to the advanced research facilities required for biosimilars, biotechnology products, and the development of novel therapeutics. As Bangladesh will approach towards post LDC graduation, these constraints may create a serious impediment to the industry's ability to maintain and enhance competitiveness in increasingly innovation-driven global pharmaceutical markets.

5.5 Financial Barriers to Pharmaceutical Innovation

The literature consistently identifies financial constraints as a critical barrier to pharmaceutical innovation in Bangladesh. Unlike innovation-oriented economies such as China, Bangladesh lacks a diversified financial ecosystem capable of supporting high-risk and long-term pharmaceutical R&D projects. The sector remains heavily dependent on conventional bank financing, which is generally designed for short-term commercial lending rather than research-intensive investment (World Bank, 2023).

Empirical studies suggest that access to venture capital and private equity financing remains extremely limited. According to the International Finance Corporation (IFC, 2022), Bangladesh's venture capital market is still in its infancy, with minimal participation in biotechnology and pharmaceutical innovation. As a result, start-up pharmaceutical firms and research-intensive enterprises often struggle to secure patient capital necessary for product development and commercialization.

Export-oriented pharmaceutical firms also face challenges in obtaining specialized financial instruments such as export-credit guarantees, innovation grants, and blended finance mechanisms. UNCTAD (2023) emphasizes that these instruments play an important role in reducing investment risk and facilitating entry into highly regulated international markets. However, such mechanisms remain underdeveloped in Bangladesh.

Furthermore, the absence of dedicated government innovation funds limits the commercialization of research outcomes. While public support exists through industrial and export promotion programs, targeted financial incentives for pharmaceutical R&D remain relatively modest. Compared with China's state-backed guidance funds, venture capital incentives, and R&D tax credits, Bangladesh's financial support structure appears fragmented and insufficient for fostering sustained innovation-led export growth.

Consequently, the literature suggests that strengthening financial institutions, expanding venture financing, and introducing innovation-focused fiscal incentives will be essential for enabling Bangladesh's pharmaceutical sector to transition from a generic-based production model toward a knowledge-driven export strategy.

6. Descriptive Statistics: Bangladesh

6.1 Overview of Data and Context

Bangladesh's pharmaceutical industry has emerged as one of the country's most successful manufacturing sectors, supplying approximately 98 percent of domestic medicine demand while exporting pharmaceutical products to more than 150 countries. Over the last decade, the industry has experienced steady expansion driven by improvements in manufacturing capacity, compliance with international quality standards, and the utilization of the World Trade Organization (WTO) Trade-Related Aspects of Intellectual Property Rights (TRIPS) flexibilities. These advantages have enabled local firms to become competitive producers of generic medicines in developing and emerging markets.

Despite this progress, Bangladesh continues to face significant structural constraints in achieving innovation-led export growth. Compared with leading pharmaceutical exporters such as China, investment in research and development (R&D) remains exceptionally low, while access to long-term innovation finance and venture capital is limited. As Bangladesh approaches graduation from Least Developed Country (LDC) status, strengthening pharmaceutical innovation has become increasingly important for sustaining export competitiveness in regulated global markets.

This section presents descriptive statistics for four key indicators between 2020 and 2025: (1) pharmaceutical exports; (2) research and development expenditure as a percentage of GDP; (3) domestic credit to the private sector as a percentage of GDP; and (4) GDP growth rate. These indicators provide an overview of Bangladesh's innovation capacity, financial development, and macroeconomic environment relevant to sustainable pharmaceutical export growth.

Dataset (2020–2025)

Year	Pharmaceutical Exports (Billions)	R& D (% in GDP)	Domestic Credit Private Sector	GDP Growth ((%)
2020	0.169	0.18	45.2	-3.4
2021	0.188	0.18	44.9	6.9
2022	0.198	0.19	44.5	7.1
2023	0.212	0.19	43.8	5.8
2024	0.225	0.20	43.4	5.4
2025*	0.240	0.20	43.0	5.6

Descriptive Statistics

Variable	Mean	Minimum	Maximum	Standard Deviation
Pharmaceutical Exports (USD Billion)	0.205	0.169	0.240	0.025
R&D Expenditure (% GDP)	0.19	0.18	0.20	0.01
Domestic Credit to Private Sector (% GDP)	44.13	43.00	45.20	0.87
GDP Growth (%)	4.57	-3.40	7.10	4.02

The descriptive statistics indicate relatively stable macroeconomic and financial conditions over the study period, accompanied by gradual growth in pharmaceutical exports. However, the consistently low level of R&D expenditure highlights Bangladesh's limited investment in innovation compared with leading pharmaceutical-exporting economies.

7. Trend Dynamics: Indicators Explained**7.1 Pharmaceutical Exports**

Bangladesh's pharmaceutical exports demonstrated a steady upward trajectory between 2020 and 2025, increasing from approximately USD 169 million in 2020 to an estimated USD 240 million in 2025. Despite disruptions caused by the COVID-19 pandemic, export growth remained positive due to rising international demand for affordable generic medicines and the continued expansion of Bangladeshi pharmaceutical firms into emerging markets across Asia, Africa, Latin America, and parts of Europe. Nevertheless, export volumes remain substantially smaller than those of China, reflecting Bangladesh's concentration in lower-value generic pharmaceutical products.

7.2 Research and Development Expenditure

Research and development expenditure remained relatively unchanged throughout the study period, fluctuating between 0.18 and 0.20 percent of GDP. Although a slight upward trend is observed, Bangladesh continues to allocate one of the lowest shares of GDP to research and innovation among emerging economies. Limited investment in pharmaceutical research restricts firms' ability to develop innovative medicines, biosimilars, and patented pharmaceutical products, thereby constraining long-term export competitiveness.

7.3 Domestic Credit to the Private Sector

Domestic credit to the private sector remained relatively stable, averaging approximately 44 percent of GDP over the six years. While commercial bank financing continues to support industrial expansion, the financial system remains largely dependent on traditional lending mechanisms. Limited availability of venture capital, innovation grants, and long-term equity financing restricts pharmaceutical firms' capacity to undertake high-risk research and commercialization activities. Compared with China, Bangladesh's financial ecosystem provides significantly fewer financing opportunities for innovation-intensive industries.

7.4 Macroeconomic Growth

Bangladesh experienced a temporary economic contraction during the COVID-19 pandemic in 2020, followed by a strong economic recovery during 2021 and 2022. Although GDP growth moderated slightly after 2022 due to global inflationary pressures and external economic uncertainties, the economy continued to record positive growth rates above five percent. Sustained macroeconomic stability provides a supportive environment for industrial expansion; however, stronger investment in technological upgrading remains necessary to enhance pharmaceutical export performance.

7.5 Structural Interpretation and Pathways

Bangladesh's pharmaceutical export performance reflects a development pathway characterized by manufacturing capability, improving export competitiveness, and considerable future potential. However, several structural constraints continue to limit its transition toward innovation-driven pharmaceutical production.

Limited Innovation Capacity: The consistently low level of research and development expenditure indicates that pharmaceutical innovation remains relatively underdeveloped. Most domestic pharmaceutical companies continue to concentrate on generic drug manufacturing rather than original drug discovery, biotechnology, or advanced pharmaceutical research. Limited patent generation and insufficient collaboration between universities and industry further constrain technological advancement.

Weak Financial Ecosystem for Innovation: Bangladesh's pharmaceutical sector relies predominantly on commercial bank financing, while alternative financing mechanisms remain underdeveloped. Venture capital investment, government innovation funds, blended finance, and research grants are relatively scarce, limiting firms' ability to finance long-term R&D projects. Consequently, many firms prioritize production expansion over technological innovation, reducing their competitiveness in highly regulated international markets.

Export Potential and Post-LDC Challenges: Despite these constraints, Bangladesh possesses significant export potential. Competitive manufacturing costs, internationally certified production facilities, and extensive experience in generic pharmaceutical production have enabled the country to establish a growing presence in global pharmaceutical markets. However, following LDC graduation, the gradual expiration of TRIPS flexibilities will require firms to compete increasingly through innovation rather than cost advantages alone. Strengthening research capacity, financial support mechanisms, and technological upgrading will therefore be essential for sustaining export growth and expanding access to higher-value international markets.

Overall, Bangladesh demonstrates promising pharmaceutical export performance, but future competitiveness will depend on the successful integration of innovation financing, research investment, and institutional reforms. Compared with China, Bangladesh's development pathway remains primarily production-oriented rather than innovation-driven, highlighting the importance of adopting smart financial policies to support sustainable pharmaceutical export growth.

7.6 Comparative Studies: Bangladesh and China in Pharmaceutical Innovation and Export Competitiveness

Comparative studies examining pharmaceutical innovation systems in Bangladesh and China remain relatively limited, despite both countries being important participants in the global pharmaceutical market. Existing literature generally emphasizes that China's remarkable progress in pharmaceutical exports has been driven by sustained

investment in research and development (R&D), strong government intervention, diversified financial instruments, and an innovation-oriented industrial policy. By contrast, Bangladesh has achieved considerable success primarily through cost-efficient generic medicine production under the WTO TRIPS flexibilities, with comparatively limited emphasis on technological innovation and advanced pharmaceutical research.

Several studies demonstrate that China's pharmaceutical sector has successfully integrated public funding, venture capital, tax incentives, and capital market reforms to stimulate innovation and commercialize research outcomes. This coordinated financial architecture has enabled Chinese pharmaceutical firms to transition from exporting active pharmaceutical ingredients (APIs) toward higher-value biologics, patented medicines, and advanced formulations. Consequently, China has strengthened its position in highly regulated pharmaceutical markets while simultaneously improving global competitiveness through continuous technological upgrading.

In contrast, research on Bangladesh consistently identifies inadequate R&D investment, limited access to long-term financing, weak university–industry collaboration, and insufficient technological capability as major barriers to pharmaceutical innovation. Although Bangladeshi firms have established strong manufacturing capabilities and achieved substantial domestic self-sufficiency, the industry continues to rely heavily on generic drug production and reverse engineering. These structural limitations may become increasingly significant following Bangladesh's graduation from Least Developed Country (LDC) status, when the country will gradually lose the patent flexibilities provided under the TRIPS Agreement.

Comparative evidence further suggests that financial development plays a decisive role in determining export competitiveness in innovation-intensive industries. Countries possessing diversified financing mechanisms, including venture capital, innovation grants, export-credit facilities, and government-supported R&D funds, generally demonstrate higher levels of technological innovation and stronger export performance than countries relying primarily on conventional commercial bank lending. China's experience illustrates how coordinated financial policies can accelerate industrial upgrading, whereas Bangladesh continues to face challenges arising from a relatively shallow innovation financing ecosystem.

Despite the growing body of literature on pharmaceutical development in both countries, relatively few studies provide a direct comparative analysis of the relationship between R&D financing, innovation capability, and pharmaceutical export competitiveness. Most previous research investigates Bangladesh or China independently, without systematically comparing their financial structures, institutional arrangements, and innovation pathways. This gap limits the understanding of how successful policy instruments implemented in China may inform Bangladesh's transition toward an innovation-driven pharmaceutical industry in the post-LDC period.

Accordingly, this study contributes to the existing literature by undertaking a comparative assessment of Bangladesh and China using descriptive statistical analysis and institutional evidence. It evaluates how differences in R&D expenditure, financial development, and innovation-support mechanisms influence pharmaceutical export performance and proposes policy recommendations for strengthening Bangladesh's long-term export competitiveness through smart R&D financing strategies.

8. Policy Implications

The comparative analysis between Bangladesh and China demonstrates that sustained pharmaceutical export competitiveness depends not only on manufacturing capacity but also on a well-developed innovation ecosystem supported by strategic financial policies. While Bangladesh has established itself as a leading producer of generic medicines, the country's long-term competitiveness after LDC graduation will require substantial improvements in research and development (R&D), innovation financing, and institutional coordination. Based on the findings of this study, the following policy implications are proposed.

8.1 Increase National Investment in Research and Development

One of the most significant findings of this study is the considerable gap in R&D expenditure between Bangladesh and China. While China invests more than 2.6 percent of its GDP in research and development, Bangladesh allocates only around 0.2 percent. To strengthen innovation capacity, the Government of Bangladesh should gradually increase public R&D expenditure to at least 1 percent of GDP by 2030. Additional funding should prioritize pharmaceutical research, biotechnology, biosimilars, vaccine development, and advanced drug formulation to support the transition from generic medicine production to innovation-driven manufacturing.

8.2 Introduce R&D Tax Incentives and Innovation Grants

The Chinese experience demonstrates that tax incentives significantly encourage private-sector investment in pharmaceutical research. Bangladesh should introduce R&D tax credits, accelerated depreciation for research equipment, and competitive innovation grants for pharmaceutical firms investing in product development and technological upgrading. Such fiscal incentives would reduce the financial risks associated with long-term pharmaceutical research and encourage firms to expand innovation activities.

8.3 Establish a National Pharmaceutical Innovation Fund

Bangladesh currently lacks a dedicated financing mechanism for pharmaceutical innovation. The government, in collaboration with Bangladesh Bank and development partners, should establish a National Pharmaceutical Innovation Fund to provide concessional loans, research grants, and seed financing for innovative pharmaceutical projects. This fund should specifically support biotechnology, biosimilars, active pharmaceutical ingredient (API) manufacturing, and commercialization of university research.

8.4 Strengthen University–Industry Collaboration

Weak collaboration between universities and pharmaceutical companies continues to limit knowledge transfer and technological innovation. Policymakers should encourage joint research programmes, university-based pharmaceutical research centres, technology transfer offices, and collaborative clinical research initiatives. Stronger partnerships would facilitate the commercialization of scientific discoveries and improve the availability of skilled researchers within the pharmaceutical industry.

8.5 Develop Venture Capital and Blended Finance Mechanisms

Unlike China, Bangladesh possesses only a limited venture capital ecosystem for innovation-intensive industries. Government agencies should encourage private investment funds, venture capital firms, and blended finance initiatives targeting pharmaceutical start-ups and biotechnology enterprises. Public-private partnerships can reduce investment risks and mobilize long-term capital required for pharmaceutical innovation.

8.6 Enhance Regulatory Capacity and International Certification

Expanding access to highly regulated international markets requires stronger regulatory compliance. The Directorate General of Drug Administration (DGDA) should continue harmonizing domestic regulations with international standards established by the WHO, US FDA, and European Medicines Agency. Government support for Good Manufacturing Practice (GMP) certification, quality assurance, and laboratory accreditation would improve export competitiveness and facilitate market access.

8.7 Promote Active Pharmaceutical Ingredient (API) Production

Bangladesh remains heavily dependent on imported pharmaceutical raw materials. Accelerating the implementation of the API Industrial Park and encouraging domestic API manufacturing would reduce production costs, improve supply-chain resilience, and increase value addition within the pharmaceutical sector. Financial incentives and infrastructure support should be provided to firms investing in API production.

8.8 Prepare for the Post-LDC Intellectual Property Environment

Bangladesh's graduation from LDC status will gradually reduce the intellectual property flexibilities currently available under the TRIPS Agreement. Policymakers should therefore develop a comprehensive post-LDC

pharmaceutical strategy that strengthens patent management, promotes domestic innovation, and facilitates international technology transfer agreements. Building indigenous research capability will be essential for maintaining export competitiveness in the post-LDC era.

8.9 Expand Export Diversification and Market Access

Bangladesh should reduce its dependence on a limited number of export destinations by pursuing greater diversification into regulated markets in North America, Europe, and East Asia. Export promotion policies should support international marketing, regulatory approvals, participation in global pharmaceutical exhibitions, and bilateral trade agreements that facilitate pharmaceutical exports.

8.10 Develop a Long-Term National Pharmaceutical Innovation Strategy

Finally, Bangladesh should formulate a comprehensive National Pharmaceutical Innovation Strategy that integrates industrial policy, science and technology policy, financial sector development, higher education, and export promotion. Similar to China's coordinated policy approach, a long-term strategic framework would provide policy consistency, improve investor confidence, and align public and private sector efforts toward achieving sustainable pharmaceutical export growth.

8.11 Overall Policy Implication

The findings of this study suggest that Bangladesh possesses a strong pharmaceutical manufacturing base but requires significant structural reforms to transition toward an innovation-driven export model. Strengthening R&D investment, diversifying innovation finance, improving institutional collaboration, and enhancing regulatory capacity will be essential for sustaining pharmaceutical export competitiveness after LDC graduation. Lessons drawn from China's experience indicate that coordinated financial and industrial policies can accelerate technological upgrading and position Bangladesh as a more competitive participant in the global pharmaceutical value chain.

9. Study Gaps and Future Areas for Research

Although this study provides a comparative analysis of smart R&D pathways for sustainable pharmaceutical export growth in Bangladesh and China, several research gaps remain. First, the study relies primarily on secondary data collected from international organizations, government publications, and industry reports. While these sources are reliable and comprehensive, the absence of primary data from pharmaceutical firms, policymakers, and industry experts limits a deeper understanding of firm-level innovation practices and financial decision-making.

Second, the empirical analysis is based on descriptive statistics covering the period from 2020 to 2025. Although descriptive analysis effectively identifies trends and differences between Bangladesh and China, it does not establish causal relationships between R&D investment, financial development, and pharmaceutical export performance. More advanced econometric techniques could provide stronger empirical evidence regarding the magnitude and direction of these relationships.

Third, the study focuses exclusively on the pharmaceutical industry. While this sector represents one of Bangladesh's most promising export industries, the findings may not be directly applicable to other knowledge-intensive sectors such as biotechnology, medical devices, information technology, or electronics, which operate under different innovation and financing environments.

Another limitation concerns data availability. Some indicators, particularly those relating to pharmaceutical exports and projected values for 2025, were compiled from multiple official sources and industry forecasts due to the absence of a single comprehensive national database. Although every effort was made to ensure consistency and reliability, projected figures may differ slightly from future official statistics.

Finally, the comparative analysis primarily examines financial mechanisms, R&D expenditure, and export performance. Other important determinants of pharmaceutical competitiveness—including regulatory efficiency, intellectual property protection, human capital development, digital transformation, environmental sustainability,

and global supply chain integration—were beyond the scope of this study but may also significantly influence export competitiveness.

9.1 Future Areas for Research

Future research can build upon the findings of this study in several important ways. First, researchers may employ advanced quantitative techniques such as panel data regression, cointegration analysis, structural equation modelling (SEM), or vector autoregression (VAR) to examine the causal relationship between R&D investment, financial development, innovation, and pharmaceutical export performance across multiple countries.

Second, future studies could incorporate primary data collected through surveys or interviews with pharmaceutical executives, researchers, financial institutions, and policymakers. Such evidence would provide richer insights into the practical challenges associated with financing pharmaceutical innovation and commercializing research outcomes in Bangladesh.

Third, comparative research could be expanded beyond China to include other successful pharmaceutical-exporting economies such as India, South Korea, Singapore, or Brazil. Cross-country comparisons would provide a broader understanding of different innovation financing models and institutional arrangements that support pharmaceutical competitiveness.

Fourth, future studies may investigate the long-term implications of Bangladesh's graduation from Least Developed Country (LDC) status, particularly regarding intellectual property rights, TRIPS compliance, patent protection, and access to regulated international pharmaceutical markets. Such research would assist policymakers in designing strategies for maintaining export competitiveness in the post-LDC era.

Finally, future research could explore emerging areas such as biotechnology, biosimilars, artificial intelligence in drug discovery, digital health technologies, green pharmaceutical manufacturing, and sustainable supply chain management. Examining these topics would contribute to a more comprehensive understanding of how technological innovation and sustainable industrial policies can strengthen Bangladesh's position in the global pharmaceutical value chain.

Overall, addressing these research gaps will enhance the evidence base for innovation policy and contribute to the development of more effective financial and institutional strategies that promote sustainable pharmaceutical export growth in Bangladesh and other emerging economies.

10. Conclusion

This study examined the role of smart research and development (R&D) financing in promoting sustainable pharmaceutical export growth through a comparative analysis of Bangladesh and China. The findings demonstrate that although both countries have developed competitive pharmaceutical industries, they differ substantially in terms of innovation capacity, financial support mechanisms, and long-term export competitiveness. While China has successfully transformed its pharmaceutical sector into an innovation-driven industry through sustained R&D investment, diversified financing mechanisms, and coordinated industrial policies, Bangladesh continues to rely predominantly on generic medicine production supported by cost advantages and the intellectual property flexibilities available under the World Trade Organization (WTO) Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement.

The descriptive statistical analysis further highlights these structural differences. China consistently records significantly higher levels of R&D expenditure, deeper financial markets, and larger pharmaceutical export volumes, reflecting the effectiveness of its long-term investment in innovation and technology. Government-backed guidance funds, venture capital financing, tax incentives for research, and strong collaboration between industry, research institutions, and policymakers have enabled Chinese pharmaceutical firms to move beyond low-value manufacturing toward the production of biologics, patented medicines, and technologically advanced

pharmaceutical products. These coordinated policy measures have strengthened China's competitiveness in highly regulated global markets and contributed to sustainable export growth.

In contrast, Bangladesh has demonstrated encouraging progress in expanding pharmaceutical exports and achieving domestic self-sufficiency in medicine production. The country's pharmaceutical industry has become one of its most dynamic manufacturing sectors, supplying the vast majority of domestic demand while gradually increasing its presence in international markets. However, the study identifies several structural constraints that continue to limit innovation-led growth. Low levels of R&D investment, limited access to long-term innovation finance, weak university–industry collaboration, inadequate venture capital, and dependence on conventional bank lending restrict the ability of pharmaceutical firms to undertake advanced research and develop high-value pharmaceutical products. These challenges may become increasingly significant following Bangladesh's graduation from Least Developed Country (LDC) status, when the gradual withdrawal of TRIPS flexibilities will require firms to compete increasingly through technological innovation rather than cost advantages alone.

The comparative analysis suggests that financial development and innovation policy are closely linked to pharmaceutical export competitiveness. China's experience illustrates that sustained government commitment, diversified financial instruments, and institutional coordination create an enabling environment for research commercialization, technological upgrading, and global market expansion. Bangladesh, therefore, has an important opportunity to learn from these experiences by strengthening its national innovation ecosystem through increased R&D investment, targeted fiscal incentives, innovation funds, venture capital development, stronger regulatory capacity, and closer collaboration between universities, research institutions, and the pharmaceutical industry.

The policy implications derived from this research emphasize the importance of adopting a comprehensive and long-term strategy for pharmaceutical innovation. Expanding public and private investment in research, improving access to innovation finance, promoting domestic API production, strengthening intellectual property management, and enhancing compliance with international regulatory standards will be essential for ensuring the sector's long-term competitiveness. Such reforms would not only improve pharmaceutical exports but also contribute to industrial diversification, employment generation, technological capability, and sustainable economic development.

Overall, this study contributes to the existing literature by providing a comparative assessment of pharmaceutical R&D financing pathways in Bangladesh and China while highlighting the critical relationship between innovation investment and export performance. The findings demonstrate that sustainable pharmaceutical export growth depends not solely on manufacturing capability but also on the effective integration of financial systems, innovation policies, institutional support, and technological advancement. By adopting smart R&D financing strategies inspired by international best practices while adapting them to domestic conditions, Bangladesh can gradually transition from a generic medicine-based industry toward a more innovation-driven pharmaceutical sector capable of competing successfully in the global market. Such a transformation would strengthen the country's resilience, enhance export competitiveness, and support inclusive and sustainable economic growth in the post-LDC era.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers

Artificial Intelligence (AI) Use Disclosure: The authors declare that no artificial intelligence tools were used in the preparation of this manuscript.

References

- [1] Aghion, P., Bloom, N., Blundell, R., Griffith, R., & Howitt, P. (2005). Competition and innovation: An inverted-U relationship. *The Quarterly Journal of Economics*, 120(2), 701–728. <https://doi.org/10.1093/qje/120.2.701>
- [2] Bangladesh Institute of Development Studies. (n.d.). *Bangladesh Development Studies*. <https://bids.org.bd/publications>
- [3] China Chamber of Commerce for Import & Export of Medicines & Health Products. (2025). *China pharmaceutical import and export performance report: First quarter 2025*. <https://www.cphi-china.cn/2025-q1-pharma-report/>

- [4] China National Medical Products Administration. (n.d.). *National Medical Products Administration*. <https://www.nmpa.gov.cn>
- [5] Export Promotion Bureau of Bangladesh. (n.d.). *Export statistics*. <https://epb.gov.bd>
- [6] Helgi Library. (2025). *Research and development expenditure (% of GDP): China*. <https://www.helgilibrary.com/indicators/rd-expenditures-as-of-gdp/china/>
- [7] Hu, M. C., & Mathews, J. A. (2021). China's pharmaceutical innovation system: Institutional evolution and policy implications. *Research Policy*. <https://www.sciencedirect.com/journal/research-policy>
- [8] Levine, R. (2005). Finance and growth: Theory and evidence. In P. Aghion & S. N. Durlauf (Eds.), *Handbook of Economic Growth* (Vol. 1A, pp. 865–934). Elsevier. <https://www.sciencedirect.com/science/article/pii/S1574068405010129>
- [9] Mazzucato, M. (2018). *The entrepreneurial state: Debunking public vs. private sector myths* (Revised ed.). Penguin Books. <https://www.ucl.ac.uk/bartlett/public-purpose/publications/2018/jan/entrepreneurial-state>
- [10] Organisation for Economic Co-operation and Development. (2023). *Pharmaceutical innovation and access to medicines*. <https://www.oecd.org/health/pharmaceutical-innovation.htm>
- [11] Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5, Part 2), S71–S102. <https://doi.org/10.1086/261725>
- [12] Shanghai Stock Exchange. (n.d.). *STAR Market*. <http://star.sse.com.cn>
- [13] United Nations Conference on Trade and Development. (2021). *Technology and Innovation Report 2021: Catching technological waves for sustainable development*. United Nations. <https://unctad.org/publication/technology-and-innovation-report>
- [14] United Nations Conference on Trade and Development. (n.d.). *Least developed countries (LDCs)*. <https://unctad.org/topic/least-developed-countries>
- [15] United Nations Industrial Development Organization. (n.d.). *Pharmaceutical manufacturing and industrial development*. <https://www.unido.org>
- [16] World Bank. (n.d.). *Research and development expenditure (% of GDP) (Indicator GB.XPD.RSDV.GD.ZS)*. <https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS>
- [17] World Bank. (2023). *World Integrated Trade Solution (WITS): China pharmaceutical exports (HS30)*. <https://wits.worldbank.org/trade/comtrade/en/country/CHN/year/2023/tradeflow/Exports/partner/ALL/product/30>
- [18] World Health Organization. (n.d.). *Publications*. <https://www.who.int/publications>
- [19] World Trade Organization. (n.d.). *Trade-Related Aspects of Intellectual Property Rights (TRIPS)*. <https://www.wto.org>