Efficacy of ICT and FD in promoting manufacturing exports: Evidence from BRI developing countries

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MPHIL THESIS

QUAID-I-AZAM SCHOOL OF MANAGEMENT SCIENCES

QUAID-I-AZAM UNIVERSITY

ISLAMABAD, PAKISTAN

August, 2022

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Quaid-I-Azam School of Management Sciences

Quaid-i-Azam University, Islamabad, Pakistan

August, 2022

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Acknowledgement

At First, may all the honor and glory be extended to the ALLAH (SWT), for His help and guidance which enabled me to complete my work.

This thesis is the result of cooperation of many individuals. I feel immense pleasure in expressing my gratitude to my supervisor, Dr Wasim Abbas Shaheen for his valuable critiques and constant encouragement throughout the study.

I am very thankful to my parents for all their immense care and support though out my academic career. I am grateful that I am surrounded by my diligent siblings especially Zakia Batool who has helped and encouraged me to complete this thesis.

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List of Abbreviations

Abbreviation	Explanation
ICT	Information and Communication Technology
FD	Financial Development
HCI	Human Capital Index
GDP	Gross Domestic Product
R&D	Research and Development
EC	Energy Consumption
FDI	Foreign Direct Investment

Abstract

Manufacturing export is the important indicator of economic health as it represents the economic activities being held in the country and exports of domestic production to international market. The export volume of developing countries is relatively low in the international market. To promote exports of manufacturing sector, financial development plays a vital role to provide finance to firms having financial constraints while the adoption of ICT improves the information availability and increases the innovative activities in the manufacturing industries. Thus, the purpose of this research is to examine how information & communication technology and financial development, as well as their combined effect contributes to manufacturing exports in the developing nations participating in the Belt and Road Initiative.

The data set used in this study is panel data of selected 58 BRI developing countries for the period of 1990 to 2020. To estimate the model, generalized methods of moments and two-stage least square is used. The estimates show that both ICT and FD have significant and positive effects on the manufacturing exports which indicate that due to reliance of manufacturing industries on external source of finances, disproportionate benefits are grabbed by the industries having access to financial instruments. While internet penetration accommodate them to advance the research and development through lessening information frictions and reducing the transaction costs. The results also reveal the combined effect of FD and ICT on the manufacturing exports which implies that ICT and FD strengthen each other‘s effects.

This study urges the policymakers to make development in the financial sector by providing access to finance on easy terms for export-oriented firms and government should give ICT related subsidies to firms to increase their exports. Firms also need to update their system by adopting internet-enabled services like e-commerce etc. Due to time constrain we couldn't able to expand research at the disaggregated level. However, for future research it is suggested to extend this study by analyzing the impact of ICT, FD and their composite effect on the manufacturing exports at disaggregate level and compare the degree of effect on the basis of income-level of BRI countries.

The originality of this study is that the composite effect of financial development and information and communication technology has not been investigated on the country level manufacturing exports of BRI developing countries.

Keywords: Manufacturing Export, Financial Development, Information and Communication Technology, Generalized Methods of Moments, Two-Stage Least Square

CHAPTER 1: INTRODUCTION

1.1 Background of the Study

In today's competitive world, with a wave of increased population, globalization, industrial output, and technological advances many countries looked up to international trade to expand their share in the global market. International trade is significant for developing countries because they can get benefit from the spillover effect of trade as it brings developments to the economy, increases the rate of productivity in industries, stimulates higher employment for low and higher-skilled people, and increases income growth that eventually drives economic growth in the country.

Were (2015) holds the view that a 1% increase in average trade to GDP ratio expedites the GDP per capita growth by 0.47%. Moreover, exports exert a higher influence of 1.02 on growth as compared to imports (0.76). According to the World trade statistical review (2021), in the second quarter of 2020, manufacturing exports declined in many developing and developed countries. Total merchandise exports in Asia declined by 10 percent whereas the merchandise exports in North America fell by 32 percent while Europe faced a heavy decline in its merchandise exports by 23 percent. On the other hand, exports in South and Central America were down 19 percent, and exports in Africa, the Middle East, and the Commonwealth of Independent States were collectively down 39 percent.

Figure 1.1 Global Exports (2015-2019)

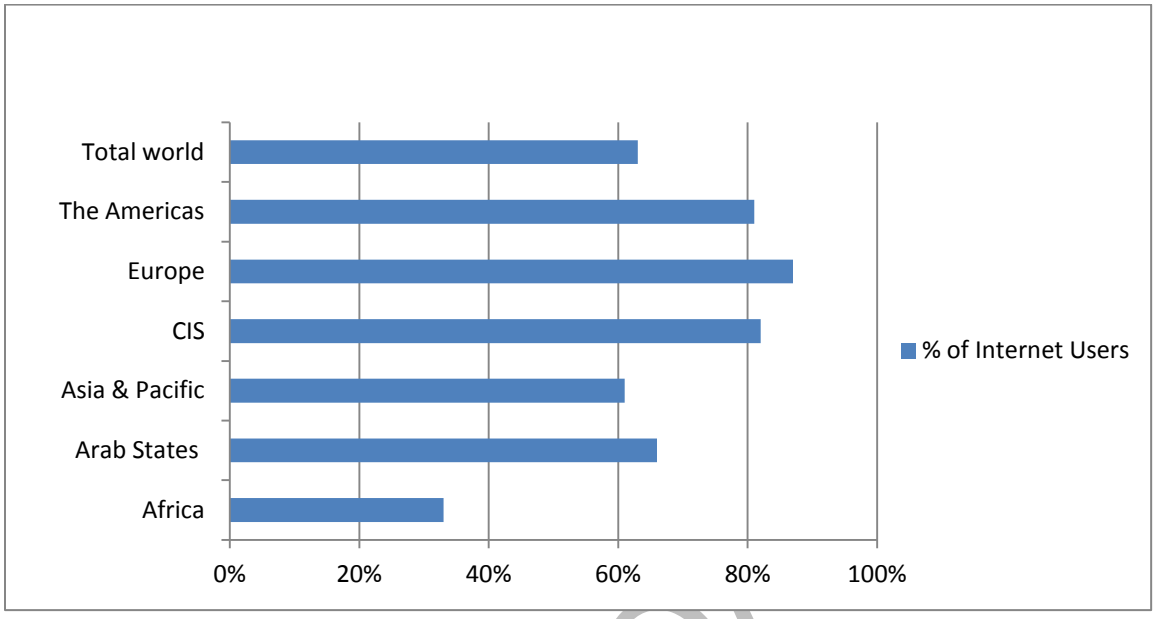
(Source: World Trade Statistical review 2021)

Many factors contribute to speeding up the production growth and increasing the export of the manufacturing sector which in turn sustains the overall economic growth. The solow-swan growth model identifies that technological advancement is the primary driver of long-term economic growth since it spurs technological innovation, improves corporate strategic decisions and reduces production costs. Therefore, Information and communication technology (ICT) is considered one of the radical determinants in stabilizing growth in the economy. However, prevailing uncertainties like COVID-19 shocks and trade frictions like trade protectionism and customs affect the level of trade. In such stance, accessibility to online platforms is crucial to overcome uncertainties that affect export competitiveness and destabilize the export. More than 50% of trade in services and 12% of merchandised trade take place on digital platforms due to increased

digitalization. The mobility of ICT-related technologies tends to increase the innovation activities for value-added production, provide marketing channels, and increases the efficacy of management system in the industries which ultimately improves the export performance of the manufacturing sector.

The development of ICT infrastructure encourages the remarkable technology that induces substructure for many other fields that assist in improving the living standards by connecting countries via telecommunications and the internet, enabling them to engage in economic activities and exchange cultures by bridging communication gaps, reducing interaction costs, and advancing information management. Among the various ICT technologies, Internet has consolidated itself as the most potent platform for communication, knowledge-based information acquisition, and online business transactions. In the last few decades, the internet has been growing drastically all over the world. The world's online population has been estimated at 63% of the total population by 2021 (International Telecommunication Union, 2021). On the other hand, number of websites significantly increased from a million in 1998 to more than 9 million in 2002, (Online Computer Library Centre, 2004). These statistics demonstrate that presence of internet users enable manufacturers to meet their customers' expectations by incorporating their recommendations and feedback and broaden the reach of their goods to a wider globe audience.

Figure 1.2: Percentage of Internet users by 2021



(Source: International Telecommunication Union)

According to the fourth industrial revolution (4.0) presented by Klaus Schwab, ICT infrastructure enable the industries to focus more on knowledge, creativity and innovation to improve the industrial structure and performance. It reduces the reliance on a larger workforce, provide economies of scale by reducing fixed and variable costs when compared to conventional or obsolescent production systems. Furthermore, the use of ICT allows the manufacturing industries to focus on distinct value-addition initiatives, resource productivity, and efficiency at each level, from raw - materials transformation to final product delivery. It is generally acknowledged that internet penetration reduces information friction and strengthens the communication within and across nations that drives industries to infiltrate new markets. Consequently, the use of ICT reduces the fixed entry cost related to acquiring information, advertising, and establishing distribution channels that helps in increasing export volume.

On the other hand, external finances are required for the industries to adopt the advanced technologies that are possible with the developed financial sector. The developed financial sector through improved resource allocation helps to increase the productivity growth of industries. In the context of developing countries, a considerable amount of investment is needed to expand the export activities to maintain sustainable economic performance but the financial health of the industries or firms resists them from export participation due to the involvement of large sunk costs. According to Manganelli and Popov (2013), the development of financial sectors provides more liquidity and financial flows to the industries dependent on external sources for production, and technology and supports them in the exporting activities to compete in the foreign competitive market. To attain that level of financing, more financial institutions, instruments, and markets are needed.

Financial development is considered an important determinant of trade and economic growth however its impact on manufacturing export performance is not discussed much in the literature. Strong financial development, that is credit expansion through banking sectors and trading markets helps in reducing credit constraints, stimulates investment in infrastructures, and spurs industrialization in the economy. According to the Heckscher-Ohlin trade model, economies where industries or sectors are dependent on external finance, a well-developed financial sector is a source of comparative advantage. Thus, the availability of liquid assets enables the manufacturing sectors to spend more on advanced technologies, as it drives innovation and adds value to products, production process, and marketing strategies, allowing the industry to compete on a global scale. According to Muuls (2008), the appropriate distribution of financial funds accompanied by higher

productivity levels facilitates the firm to increase export. Moreover, countries with developed financial sectors are the net exporters of goods with high economies of scale. A developed financial structure efficiently channelizes saving funds into the high scale and high-return projects whereas an unorganized financial sector with asymmetric information causes the problem of adverse selection and moral hazard in the market that enable them to cease providing funds even to the productive industries and cause them to lower their export volume.

There is a link between financial development and ICT in such a way that ICT development helps in shaping the financial markets through technology-enabled financial services, reducing the odds of inaccuracy in the flow of information. ICT aids in reducing the market imperfections, promoting transparency in financial functions that reduces market frictions, and upholds easy access to finance along with strong supervision over the allocation of funds through data gathering applications, allowing decentralized financial markets to function competently (Financial stability board, 2017). In the report by the World Bank (2017), new technology offers information and services that led the financial industries to combine ICT with internal process modernization and provide upgraded services i.e mobile banking, online transfers, and investment apps. Similar to ICT, The growth of the financial sector encourages resource distribution into profitable ventures, as well as leads to technology upgrades, material, and human accumulation. In the case of manufacturing industries, financial development stimulates investment and growth by lending funds, mobilizing savings, and diversifying the risk by investing in various high-performing manufacturing sectors allowing them to adopt new technologies

creating value addition to the finished goods, reducing the cost associated with production, transaction, transportation, and monitoring (Raheem et al., 2020).

1.2 Problem Statements

The importance of exports in general and manufacturing exports in particular for economic growth has been observed in different economic and financial indicators. The manufacturing sector is the engine of economic growth because manufacturing exports promote the service sector like banks, insurance companies, communication, and transportation (Cantore et al., 2017). The statistics issued by the global economy (2019) showed that the average value added by the manufacturing sector, as a percentage of GDP for 2019 based in 150 countries was 12.32 percent. A low level of manufacturing export, put pressure to lower the production wages because decreasing exports lower the productivity in the manufacturing sector which may lead to the downsizing of employees which is one of the causes of unemployment, poverty, and income inequality that provoke instability in the economy. Most of the developing countries heavily depend on primary products for exports rather than manufacturing exports which are the source of constraints in economic progress. UNCTAD's State of Commodity Dependence 2021 report highlighted that more than 100 countries including countries from Middle Africa and Western Africa, Central Asia, and South America are dependent on primary commodity exports and pointed out that these countries can suffer more from negative economic shocks like natural factors, fluctuation in commodity price, demand and supply and may remain trapped and unable to grasp the foreseeable future opportunities.

However, movement from the export of primary commodities to manufacturing exports is not easy for developing countries. The hurdles in the way of manufacturing exports,

particularly in BRI developing countries, are the lack of technological machinery, infrastructure, and financial resources. The major share of exports in low to middle-income countries comes from primary products because primary goods require less raw materials and labor per unit output and, as a result, they earn less profit. On the other hand, developed countries export processed and technology-intensive products with a longer shelf-life having a margin of large profits.

1.3 The Objective of the Study

Keeping in view the need to escalate manufacturing exports and the importance of financial development and ICT, the objectives of this study are to

- Investigate the role of ICT on manufacturing exports in BRI developing countries
- Analyze the impact of FD on manufacturing exports in BRI developing countries
- Highlight the composite impact of ICT and FD in manufacturing exports in BRI developing countries

The countries included in this study are under the One Belt and Road Initiatives because this project is considered to provide new opportunities for economies by constructing infrastructure and energy sectors, which will benefit industries, so this study analyzes either ICT and FD fuel up the exports in these countries side by side or not.

1.4 Significance of the Study

The outcomes of this study will assist academics, researchers, and policymakers in applying the research findings to policies that will improve manufacturing exports and contribute to long-term economic success. To reinforce economic growth, policymakers have to concentrate their efforts on the quality of institutional frameworks to assure the proper functioning of the financial sector as well as the adoption of the countercyclical

capital buffer that helps in making banks' resilient. Such policies are meant to promote financial depth by encouraging a high number of investments in financial sectors, which channel funds to various sectors, including manufacturing industries. Developing and under-developed economies are more sensitive to external shocks such as financial crises, oil shocks, and other factors that impede domestic and foreign investment. Under such a situation, a stable financial sector along with increased exports from the different sectors would help economies to reduce the stress of external shocks.

Our study is in line with the 10th goal of the United Nations 2030 Agenda for Sustainable Development, that is, building infrastructure, promoting sustainable industrialization, and fostering innovation in developing countries. Most developing countries are still reliant on primary products to export. These developing countries need to export manufactured goods for economic expansion, but industrialization in these nations is limited due to a lack of financial means to invest in advanced and efficient production techniques. Based on the findings, this study will suggest policymakers make policies to promote capital-intensive industrialization by encouraging ICT to access financial tools and services. For the growth of industries, credit availability at a low real interest rate and trade involvement of industries helps to provide new market opportunities through innovation due to international competitiveness. From an academic view, this study will help them to understand the relationship between financial development and manufacturing exports in the presence of ICT as well as the role of ICT on the manufacturing sector in the presence of strong financial development. The industrialist will gain knowledge related to how the enhancement of ICT in their sector will increase their exports in long term. According to figure 1.1, the manufacturing exports follow the slightly increasing trend in many

regions, however, in the 2020 quarter 2, there was an abrupt decrease in manufacturing exports due to Covid-19 and we want to find out whether the upward trend in manufacturing exports was due to ICT and FD.

CHAPTER 2: LITERATURE REVIEW

2.1 The ICT - Manufacturing Export Nexus

Wide usage of ICT and financial development are idiosyncratic features of internationalization. There are shreds of evidence that highlight the significant impact of ICT on manufacturing sector performance. The development of ICT infrastructure brings with it potential opportunities for the manufacturing sector through telecommunications, access to the larger informational database, high- level technologies for improved or efficient management, controlling, and production of goods. ICT plays a critical role in improving industry performance by facilitating internal coordination and decision-making, lowering R&D costs, reducing capital requirements, and improving production processes, machinery, and other equipment (Grazzi and Jung, 2016). ICT enables the manufacturing sectors to advance their business model to remain competitive both domestically and internationally. Internet provides the platforms and web capabilities to the firms to assure the innovative business model while at the same time, it reduces the communication and transaction cost that aid in increasing their export participation (Morgan-Thomas and Bridgewater, 2004). The inducement of internet and broadband allows the firms to have access to information database that elevate their productivity performance, along with improved communication and information exchange to develop the networks across the countries for international activities. Therefore, internet is assumed as the most substantial part of ICT having positive economic outcome. Elgin (2013) argued that the internet remunerate the economy by increasing technical productivity, attracting foreign direct investment, as well as lowering inflation and other economic and political issues. Gallego et al. (2015) used firm-level data on ICT adoption

from 3759 manufacturing firms of Colombia and discovered that technology diffusion has a positive impact on manufacturing firms that have strong human capital, an effective organizational structure, and are highly motivated to participate in innovative activities. In a similar vein, Wamboye et al. (2016) findings show that ICT penetration boosts labor productivity, entrepreneurial opportunities, and export-led growth in the country, resulting in economic growth. Therefore, Human resources act as the catalyst to increases the effect of ICT on productivity.

ICT technologies including internet use, mobile phone subscription create new communication channels to facilitate firms to establish long term relationship with existing and new customers, supplier and partners, generates information based on worldwide market trends that brings new opportunities through stimulating ideas for unique differentiation in goods and manufacturing processes as well as it increases connectivity networks across the world to uphold the firms export decision and export intensity. Moreover, inclusion of internet not only increases the exporting activities of larger firms with enrich resources but also support small or medium- size companies for export participation through shrinking fixed entry cost related to information acquisitions, shipping and time cost (Arnott & Bridgewater, 2002). In the similar vein, Allen (2014) demonstrates that developing countries face greater level of information asymmetries related to search cost in new markets in such stance internet helps to reduce the information friction. Furthermore, Freund and Weinhold (2004) also discuss the fixed cost incur while entering the new markets, includes costs related to information about a market, advertising, and establishing a distribution network. The timely information also

contributes in reduction of uncertainties involved in international transactions, increases the accuracy and efficiency of advances planning that are necessary for trade.

To sustain the competitive business, telecommunication help to reduce the communication cost among trade partners (Bankole et al., 2015). Similarly, Lin (2015) empirically studies the role of internet use in reducing the information cost and found a significant and positive effect on exports more than imports. Internet usage by trading firms helps the firms to catch the new market opportunities for products and services by relying on customer's feedback that help in reducing uncertainty about future demand (Paunov and Rollo, 2016). Using the country-level ICT data, Wang et al. (2017) demonstrate that ICT development positively affects the industries with rich R&D and helps them to export more internationally. Goldfarb and Tucker (2019) showed that digital technologies decreases the search cost through the reduction of information friction in markets.

ICT through information technology promote innovation activities that contribute for value added goods that diversify exports of manufacturing sector, therefore, government must provide subsidiaries and facilitates their manufacturing industries through public investment in infrastructure, energy sector, and telecommunication to increase their export level. ICT helps manufacturing firms to innovate and add value to their products (Aboal and Tacsir, 2018). Internet access has increase the growth of web-users and e-marketplaces that stimulate the manufacturing trade through reducing market specific fixed cost like information availability, access to new buyers around the globe, provide network externalities and advertising and marketing channel (Wang & Head, 2007). Working on the same line, Rodriguez et al. (2021) explored the effect of the internet,

broadband, and mobile phone on bilateral trade of 55 countries (34 high income and 21 middle and low income countries) using the data set from 2004-2013. He found that mobile phones have more effect on exports. Thus, ICT helps the manufacturing sector with R&D to bring innovation through knowledge sharing technologies.

Several studies in the literature have highlighted the influence of ICT on industrialized and developing countries, providing mixed results. Clarke and Wallsten (2006) found that effect of internet diffusion in developing countries is more than developed countries. The less developed countries exhibiting higher level of internet use increase the exports to rich countries because in developing countries ICT increases the connection among the enterprise as well as reduce the distance cost to enter the developed market. However, increase in internet use does not affect exports of rich countries because of already establish ICT infrastructures. Xing (2017) used panel data of 21 developing and least developing countries and 30 OECD countries to examine the effect of internet use on bilateral trade and found a positive relationship between bilateral trade and access to ICT, which implies that bilateral trade among trade partners, are subjective to the level of internet diffusion. Internet connectivity enables the firms to reorganize the production process that helps them to increase their sales through exports. Hjort and Poulsen (2019) found that broadband internet penetration in Africa increases the productivity level of firms, creates jobs, and increases exports. Internet access induces trade by allowing firms to improve their communication with buyers and ascertain their virtual presence (Fernandes et al., 2019). The internet is the cost effective method as they strengthen opportunities to enter the global market through the facilitation of communication with potential customers, reduction fixed entry cost to new markets to increase the aggregate

trade and exports (Freund and Weinhold, 2004). On the contrary, Mu et al. (2020) deploy the dataset of manufacturing firms to investigate the use of the internet on firms' export volume and findings reveals the significant positive influence of internet use in promoting firms' exports as well as increasing the export intensity. Working on the same line, Matthess and Kunkel (2020) pointed toward the importance of digitalization in developing countries by providing evidence that digitalization increases the quantity of trade through reducing transaction cost as well as presenting opportunities to the countries to diversify through trade in services as well. Rodriguez et al. (2021) used the Gravity model approach for panel data from 1996 to 2014 to assess the influence of the internet on trade in developing and developed countries. The results show the positive influence of internet usage on exports in developed countries is more than developing because of different levels of ICT stages. Moreover inducement of broadband is considered as the viable mechanism to stabilize the economic progress during uncertainty in global economic integration (Lee et al., 2022; Wen et al., 2022), as they shape the other new business forms like cross border e-commerce and digital trading platforms that helps in reducing the information friction exist in the international trade (Lv et al., 2021; Guo et al., 2022). In aforementioned studies, researchers have attempted to study the influence of ICT on overall exports, but its impact on particularly manufacturing exports of developing countries has not been extensively discussed, thus this study focuses on how ICT influences manufacturing exports in the BRI developing countries.

2.2 The Finance - Manufacturing Exports Nexus

Finance is a critical factor in the country's economic development. An economy can benefit through multiple channels by having improvement in size, stability, and

efficiency of the financial sector as well as easy access to the market. Hassan et al. (2011) suggested that the development of the financial market promotes long-term economic growth by making investments in different opportunities, assessing risk profiles, government fiscal policies, and facilitating the trade of goods. Similarly, Guru and Yadav (2019) by using panel data from five industrial countries BRICS from 1993 - 2014 found that financial development (bank and stock market) has significant and positive effect on economic growth. Economic growth is achieved through economic activities that are accelerated by export. According to the new growth theory, economic growth is derived from productivity and investment, both of which are dependent on individual desires and needs. Market failures lead to the establishment of financial institutions and markets which influence the individual's decision to invest their savings in the most promising enterprises to boost productivity-related activities.

Most of the industries rely on external finances and governments must exercise corporate governance for finance provision by lowering interest rates, facilitating easier access to credit, and using other financial instruments to nurture potential industries that have ability to engage in exporting activities. Countries with weak financial sectors, decrease total industry production and slow economic growth, whereas countries with well-functioning banks and market-oriented financial sectors increase exports by accommodating manufacturing industries. With a more developed financial system, industries' production capacity will increase, allowing them to export more to financially susceptible sectors while also benefiting from comparative advantage. Nieminen & Mika (2020) using the data from 68 countries and by deploying OLS estimator techniques found the positive effect of the development of the financial sector on the export-oriented

industries that depend on external finance. Similarly, Chen et al. (2020) using data of 260 cities of china from 1997 – 2012 he found that with the establishment of city commercial central banks (CCB), the exporting performance of domestic private firms of Chinese increased. Consequently, there is a positive significant effect of improvement in the financial market on export activities.

According to WTO (2010), during the financial crisis in 2007-2009 the magnitude of global trade decreased by around 12.2 percent. In several studies, financial limitations have been shown to harm the exports of manufacturing firms. Fan et al. (2015) using disaggregated data of china examined the influence of credit limitation on export prices. They found that credit constraints lead to low-quality items and lower their optimal prices. Moreover, Hasan & Sheldon (2016) showed that firms with limited access to credit affect the production level of firms negatively as well as they also have a negatively significant effect on investment decisions of firms. Altamonte et al. (2016) scrutinized the relationship between financial constraints, R&D expenditure, total factor productivity, exporting. The empirical analysis found that access to credit enhances the production level of firms and also increases exporting activities. Kiendrebeogo and Minea (2016) deploy the dataset of Egyptian manufacturing firms from 2003-2008 to investigate the effect of financial factors on the exporting activities of Egyptian manufacturing firms. Akram & Rashid (2018) employing the OLS techniques found firms dependent on external finance suffer more from credit constraints and negatively affect the supply and demand of UK exports. Therefore, it is concluded that financial constraints negatively affect the export volume as well as firms entry into the international market.

Some studies highlighted the impact of financial growth on manufacturing exports both in developed and developing countries. Alvarez and Lopez (2014) investigate whether credit availability increases the export of Chilean manufacturing plants using data from the time span 1995 - 2002. They found that with easy availability of finance by the banking sector helps the firms to increase their exporting activities. Financial development assists firms that are innovative and reliant on external financing by lowering credit limitations (Fauceglia, 2015). Likewise, Kumarasamy & Singh (2018) investigated the influence of financial development and access to financing on a firm ability to export using firm-level data from Asia-Pacific nations. They discovered the significant and positive effect that access to money and development of the financial sector through introducing different financial instruments stimulates a firm's access to the export market. Iacovone et al. (2019) used data of bank crisis episodes of both developing and developed countries from 1970-2012 to investigate its impact on exports. The finding shows that exporting industries that are dependent on external finances suffer more and their exports drop during the financial crisis. In the past literature, the effect of financial development has been assessed on exports but importance of financial development in stimulating exports of manufacturing sectors of BRI region is neglected.

2.3 ICT and Financial Development Nexus

Both the ICT and financial development assist the economy through easy access of credit to industries to invest in the innovative activities as well as the diffusion of technologies that helps the manufacturing firms in decision making, to reduce their production cost as well as increase the demand for their product and services. Many studies advocate that development of financial sector along with efficient resource allocation stimulates

technological innovation for the economic progress. Sassi and Goaied (2013) in their study found that combined effect of financial development and ICT have significantly positive influence on economy. It implies that economies can reap benefit from financial development until it reaches the threshold of ICT development. Tee et al. (2014) deploy the panel dataset from the period 1998 -2009 of seven East Asian countries to determine how financial development affects the innovative activities of firms and they found that there exists a significant and positive effect of financial market on the technological innovation. Similarly, Hsu et al. (2014) also found that industries that rely on external funds and are technology-intensive make the most from the development of the financial market.

On the contrary, ICT advancements promote the financial technology over traditional financial institutions. Internet technology through the use of mobile phones, personal computer, mobile application, debit/credit cards and other facilitates bring forth the improvement in the financial transaction across the world. Internet technology restructures the financial institutions through innovations that increase the efficiency and financial inclusion in developing countries. Development of ICT infrastructure promotes e-finance that help in reducing cost associated with acquiring broader information and allowing efficient distribution of funds in productive investments (Sassi and Goaied, 2013). Fintech companies work in the same way as banks, providing financial services to enterprises, company owners, and clients ranging from financial operations to asset management. Allen et al. (2002) and Domowitz (2002) highlighted importance of e-finance technologies that increases the accuracy of information between buyers and sellers and also reduces the cost of data processing. Furthermore, Shamim (2007)

demonstrates that diffusion of finance technologies have emphatic influence on financial depth that increases the countries resilient and expands the economic growth. She further found that the presence of correlation between internet technology and financial development is based on the idea that internet accessibility reduces the information frictions and cost of processing of financial services. Using panel data from 61 developing nations, Claessens et al. (2002) discovered that encouraging internet use helps in strengthening the financial sectors of emerging countries. Internet enhance the financial activities by providing investors with access to a vast amount of information that allows them to seek for opportunities while lowering transportation costs, and time. As a result, the financial markets are able to deliver a significant amount of services to industries for innovative projects.

ICT technologies including internet and mobile usage also affect the financial sector. Jiang et al. (2020) investigate the role of internet technology on the financial industry using the ten-year Chinese provincial dataset. The findings demonstrate that internet penetration aids in the reduction of asymmetric information in the securities market and financial industry by offering convenient avenues for investor to have easy access to information related to different areas of the financial industry that assist in reducing asymmetric information. They also discovered that investing in internet technology benefits impoverished provinces more because they receive more information from developed regions that cause the leap forward development in these areas. Similarly, Boateng et al. (2018) explained that ICT helps to keep the transparency and accountability in the financial sectors to eliminate the probability of adverse selection and moral hazards through efficient and accurate information exchange between lenders and

borrowers which improve the financial development. Furthermore, Nguyen et al. (2020) using nine indices of financial development to investigate the internet and mobile usage's effect on financial development and found that internet penetration has a significant and positive influence on the financial market but it harms financial institutions. On the other side, mobile usage positively affects the both financial market and financial institutions. Internet usage enhances investment activities. Lowering the bank loans increase the trading activities, and monitors the efficiency of the financial sector. Advancement in financial sectors encourages the industries to adopt modern technologies for effective and efficient production, which in return drives economic growth (Raheem et al., 2020).

To the best of our knowledge, the interactive role of ICT and FD on manufacturing export is not assessed in the literature. This study aims to bridge this gap by analyzing the combined effect of FD and ICT on manufacturing export in BRI developing countries.

2.4 Other Control Variables and Manufacturing Exports

2.4.1 Foreign Direct Investment and Manufacturing Exports

Manufacturing is identified as the most important factor in economic development. Manufacturing industries demand capital investments in order to maintain their growth and achieve better economic development performance. In this stance, foreign direct investors must be attracted for the injection of resources that are not only restricted to capital. FDI through transfer of technology and knowledge sharing, marketing advantages, increase competitiveness and human assets and upgrades technological, executive and managerial effectiveness in the host country. These resources accompanied by FDI inflows, promote the export and economic activity for the countries with comparative advantage in industries (Wu and Buckey, 1999). Many economists believe

that FDI contributes to the total productivity and income growth of developing and emerging economies (Kudina & Pitelis, 2014). Developing countries that reached the certain level of development in education, infrastructure, health and technology are able to reap the full advantage of foreign direct investment. Transfer of technology in the host country shows to be a prerequisite for industrialization development. Investments by the MNCs allow host countries to conduct costly research in their industries, which speed up the creation of higher-value-added whereas innovation in manufacturing sector also enhance the economic activity of other sectors. Flow of foreign investments in manufacturing sectors generate more revenue from exports of higher value added products as come to the primary exports (Mantey, 2021). Using data from 1990-2018, Rahmaddi and Ichihashi (2013) deployed the fixed effects panel data methods to analyze the effect of FDI on the manufacturing exports of different Indonesian industries. They find the positive significant effect of FDI inflows on the performance of manufacturing exports of industries with capital-intensive, technology-intensive and human-capital intensive industries. FDI is the cross border mobility of both tangible and intangible assets that promote international trade. FDI facilitate the international technology transfer and its spillover effect increases the productivity rate of local firms (Liu 2008; Liang, 2017). Endorsement of technology not only increases the exporting activities of export oriented industries but also induce the non-exporting industries for export participation through minimizing fixed export costs. Similarly, Karpaty and Kneller (2011) investigate the impact of FDI on the manufacturing firms of Sweden from the year 1990 to 2001. Using two-stage probit techniques, they find that FDI has significant positive correlation with Swedish manufacturing exports.

However, the impact of FDI may not always positive in promoting exports. According to the Dependency theorists, hostile behavior of developing countries towards the FDI increases the dependency of the domestic firm on their financial investments (Boswell & Dixon, 1990). Dependence on international investments is seen as a developmental dead end, as it has a negative impact on developing country industrialization (Boswell & Dixon, 1990; London & Smith, 1988). In the same vein, according to Bornschier et al. (1978) in developing economies, FDI promotes economic development in the short run, while this effect impede in the long run due to long-term reliance on overseas investors. Dependency theory analyzed that MNCs headquarters are in the home country and these establish the branches in the host country exploiting their resources like labor or natural resources. MNCs work in the host country for the interest of their parent country and share holders therefore, development is impossible in such economies as they are subservient to the developed countries. Moreover, presence of MNCs with huge capital, technology and human capital increases the cost of productions which make trouble for domestic firms to compete with them. Thus, MNCs exports increases while crowded out the exports of domestic firms, hence FDI negatively affect the exports of domestic firms (Karpaty and Kneller, 2011; Melitz, 2003; Ruane and Sutherland, 2005). Thus, FDI may impede the economic growth through hampering economic and human development (Mencinger, 2003; Nunnenkamp & Stracke, 2008).

2.4.2 Energy Consumption and Manufacturing Exports

Energy (renewable and non- renewable energy consumption) plays the key role the growth of economy. Several studies have been conducted to study the relationship between these two variables and the findings are inconsistent. Alam and Butt

(2002) using the variety of econometric techniques and the sample data from 1960 to 1980 investigate the causal relationship between energy consumption and economic growth in Pakistan. They also find the existence of bidirectional causality between energy consumption and economic growth. Lee and Chang (2007) examined the energy consumption - economic growth nexus in Taiwan. They deployed the co-integration, Granger causality, VECM test and covering the time span from 1955 to 2003. The findings exhibit the presence of unidirectional causality running energy consumption to economic growth indicating that when there is the low level of energy in the region, the increase in energy consumption stimulates the economic growth. While, Belloumi (2009) using sample data from Tunisia from period 1971-2004 and employed the VECM and Granger causality test found that in the long run both the economic growth and energy consumption cause each other at the same time while in the short run energy consumption effect the economic growth. Furthermore, Sari and Soytas (2007) re-examine temporal link between energy consumption and economic growth in six developing countries using the consistent data from 1971 to 2002. They employed the generalized impulse response, generalized variance decompositions techniques, and found that in all countries energy is the essential input having significant effect on the production level. Even in some countries, it is considered as more important than other factor like capital and labor.

Therefore, it rejects the hypothesis of no causal relation between energy consumption and economic growth in developing countries. Moreover, Chontanawat et al. (2008) scrutinize the causal relationship between energy consumption and economic growth for the 30 OCED and 78 non-OCED countries for the annual year data from 1971 to 2000. They found that energy use is more prevalent in OECD developed countries than OECD

developing countries and the policy implications for reducing energy consumption may cause the OECD developed countries to suffer more from instable economic growth.

Energy is used by all the sectors of the economy especially industrial sector. In comparison to traditional agriculture or basic manufacturing, industrialization consumes more energy (Sadorsky, 2014). Production in the industrial sector cannot be achieved merely through the use of components of production such as labor and capital because they are all dependent on energy, which is the most important input for production. The expansion in production is linked with energy demand as well as also helps in trade balance by stimulating exports. Exporting manufactured goods or raw materials is linked with the demand for energy and fuel as it is used from machinery and equipment that are used for production, processing and transportation. Sadorsky (2011) using data from 8 Middle Eastern countries from the period 1980 to 2007 examined the trade and energy consumption nexus. He used short run dynamics to illustrate that increase in exports increases the demand of energy, since exporting industries used more energy for production and fuel for transportation. As a result, shrinking of energy inputs can impede the export growth. A decrease in energy demand could also be due to a price component, as economic theories suggest that as energy price goes up, the demand of energy should fall, assuming all other factors remain constant. However, Bernstein and Griffin (2005) claimed that energy demand cannot be changed in response to price changes, particularly in the short run, due to dependence of household, transportation, and industry on gas and energy usage. However, Furuoka (2007) using regression model and time series dataset from 1970-2004 found that oil price shocks in 1974 and 1981 weaken the exporting activities of Malaysia.

Erkan et al. (2010) analyzed the effect of domestic energy consumption on the exports of Turkey. Using the data from 1970 to 2006, employing granger casualty test they found that energy contributes in economic development through increasing exports. Thus, we can say that exports enhance the economic activity in the economy which results the increase in energy consumption. Although Energy consumption is linked with economic and social development, production and helps in balancing the trade but it has also environment consequences. Lean and Smyth (2010) examined the causal link between aggregate output, energy consumption, and exports using a Malaysian dataset from 1971 to 2006. Using granger causality test, results indicate the unidirectional causality flows from export to aggregate output and bidirectional causality between aggregate output and energy consumption. Likewise, Thapa-Parajuli et al. (2021) also demonstrated that energy consumption stimulates economic growth via export. Therefore, energy consumption is the essential input in production process, the increase in energy consumption exerts the positive effect on the aggregate output. While increased aggregate output promote the export of goods to the international markets hence increased the foreign reserves that assist in stabilizing the economy through growth and investments in productive sectors.

2.4.3 Human Capital and Manufacturing Exports

Along with the external factors, there are many internal factors that contribute in the competitiveness of the industries to compete in international market. There are several studies that emphasize on the human capital as one of the main constituent in upbringing the production performance. Initially, the concept of human capital was introduced by Mincer and Becker. As Mincer (1958) considered training and education as the most

significant dimension of human capital whereas Becker (1964) argues that useful skills and abilities are the main constituent of human capital that can be improved through investment on training and education. Therefore, difference in individual incomes and productivity of the firms are the cause of disparity in Human capital. Moreover, Dzinkowski (2000) identified human capital as building block for organizational and customer capital. He further describes human capital as the collection of knowledge, competencies and skills that increases the economic value. Human capital is the specific resource that brings innovation in product or production process that cannot be imitated easily and let the firms to survive in the competitive market. Resource based view theory also stress that firms with the specific resources or capabilities tend to increase performance and provide distinctive comparative advantage to the firm. Therefore firms should make decisions and action that are build on strategic resources to attain the sustainable competitive advantage and meet the customers interest that are difficult to replicate nor can be substituted. According to Barney (1991) firms is pool of both tangible and intangible resources, with the invisible or intangible resources being of higher importance as they are scare, valuable and difficult to imitate. One of such intangible resources is human capital (e.g skills, knowledge and experience) that drive our focus to analyze its impact on the export performance of manufacturing sector. Based on theoretical prospective of RBV, firm's specific resources that are drivers of competitive advantages that may help to explain export performance differences across firms (Dhanaraj and Beamish, 2003; Ferreira and Simoes, 2016). Likewise, Van Dijk (2002) used 28 industries data to investigate the determinant of export performance in Indonesia. Among other factors, he found human capital as crucial determinant in

shaping the export behaviors of firms in Indonesia. He emphasized those skilled and knowledgeable employees that are scares and expensive have the significant positive influence on the export performance. Furthermore, Arbache & De Negri (2005) investigates the competitive advantage of Brazilian exporting firms. They found that employee's education, experience and tenure have positive effect on the exporting potential of Brazilian firms. Export increase the industries performance through entry the foreign market and provoke them to find the different ways for efficient and effective production methods and to increase the innovative activities through investment on research and development and human capital. Lopez Rodriguez and Serrano Orellana (2020) investigate the impact of human capital on the Spanish manufacturing firm's exports. They found that manufacturing firm can achieve the superior export performance through investing more on general human capital (having higher levels of tertiary and university education) and specific human capital (accumulation of high level of experience). Similarly, Mubarik et al. (2020) investigate the role of human capital on the export performance of small and medium enterprises in manufacturing sector of Pakistan. Using 586 SMEs data from manufacturing sector and structural equation modeling (SEM) econometric techniques they found human capital play major role in increasing the export performance of the SEMs. They also indicated that all the dimensions of human capital matters for export performance except education and training that have the greater effect of the sampled SMEs export performance.

2.4 Research Questions

In our study, we will answer the following research questions

Although handsome amount of research has been conducted to study the influence of ICT on overall exports, but its impact on particularly manufacturing exports of developing countries has not been extensively analyzes. Thus, this study focuses on how ICT influences manufacturing exports in the BRI developing countries. And the research question will be

Q1-What is the effect of information and communication technology on the manufacturing exports?

Conversely, the effect of financial development has been assessed on exports but impact of financial development on manufacturing of BRI region is neglected. Therefore, our research question is

Q2- What is the effect of financial development on the manufacturing exports?

The interactive role of ICT and FD on manufacturing export is not assessed in the literature. The current research aims to bridge this knowledge gap by analyzing the combined effect of FD and ICT on manufacturing export in BRI developing countries. Hence our next research question is

Q3- What is the composite impact of FD and ICT on the manufacturing exports?

CHAPTER 3: METHODOLOGY

3.1 Variables

3.1.1 Dependent Variable

Manufacturing exports are taken as the dependent variable in our study. Kalaitzi & Cleeve (2018) demonstrate the causal relationship between manufacturing exports and economic growth whereas in our study we are investigating the role of ICT and financial development on manufacturing exports because competitiveness promote trade expansion in the country. Manufactured products have more value addition that increases the possibility of reaching the international market.

3.1.2 Independent Variables

Financial development is the independent variable. Xu et al. (2021) used financial development to investigate its moderating role on firm innovation and productivity. However, in this study we are assessing the impact of financial development on manufacturing exports. The development of the financial sector encourages the industries to improve their export performance by providing financial assistance for capital-intensive activities that augment the production level as well as improve the product quality which plays a vital role in stimulating exports.

ICT is another independent variable used in the model. Racela & Thoumrungroje (2020) investigate the utilization of ICT on the export performance of the emerging economies. In our study, we are using ICT to examine its effect on manufacturing exports. ICT is intended to fulfill information processing and communications functions that result in reducing costs improving decision making, risk management, and increasing the

productivity of the industries. The increased output level, product differentiation, and production capabilities help the industries to export more to the international market.

3.1.3 Control Variables

In order to control the effect of external factors we have used different control variables including energy consumption, human capital index and foreign direct investment.

Energy consumption was employed by Nnaji et al. (2013) to highlight the relationship between energy consumption and exports. In our study, we are using energy consumption to examine the effect on exports of the manufacturing sector. Energy is used extensively in the industrial sector to operate electrical machinery and equipment, as well as to transport raw materials and finished goods from point of origin to point of destination in one form or another. It is the pivotal factor used inefficient utilization of other factors of production and improves the firm's competitiveness in the international market, resulting in improved export performance.

Human capital index used by Liu et al. (2017) to determine the effect of human capital on the export - firm innovation nexus, while we are using HCI to examine its impact on manufacturing exports. Human capital through education, innovation diffusion, and strategic decision-making in business models leads to increased industrial production, which in turn positively increases industrial penetration in international markets.

Foreign direct investment used by Cabral & Alvarado (2021) to investigate its impact on export performance of Mexican states and we are also investigating the influence of on manufacturing exports of developing countries of Belt and Road initiatives. FDI brings with it capital, technology, technical know-how and management skills to the country

that enhances the efficiency level and product excellence of the manufacturing sector hence, it is an important driver in export amelioration.

Table 3.1: List of Variables

Variables	Description of Variables	Definition	Data Source
Dependent Variable			
Manufacturing Exports	% of Merchandise export	Manufacturing sector promote the trade expansion in the economy through innovation and competitiveness that increases the productivity growth and increase the involvement of manufacturing sector towards exports (Kalaitzi & Cleeve, 2018)	WDI
Independent Variables			
Financial Development	Financial development index	Financial development promotes the innovation in firms through allocation of resources for research and development exerting positive influence on the output level (Xu etal., 2021).	IMF
Information and Communication Technology	Internet users as a percentage of population	Statistics Canada (2008) defined the ICT as the technologies including desktop, laptop, software, mobiles and internet connection that are anticipated to carry out information processing and communications functions.	WDI

Control Variables			
Energy Consumption	kg of oil equivalent per capita	Nnaji et al. (2013) defined energy as binding input for the production of all goods and services.	WDI
Foreign Direct Investment	Net inflows of foreign direct investment (% of GDP)	According to Cabral, & Alvarado, (2021) the inflows of foreign investment in the reporting economy provides the resources to the manufacturing firms for technological investment as well as facilitate the knowledge accumulation to enhance the product sophistication	WDI
Human Capital Index	HCI is calculated by per person years of schooling and educational return	Liu et al. (2017) describe human capital as the conveyors of knowledge and technology acquisition that stimulates innovation in the firm, producing distinct products creating economic value.	FRED

3.2 Data Composition and Data Collection

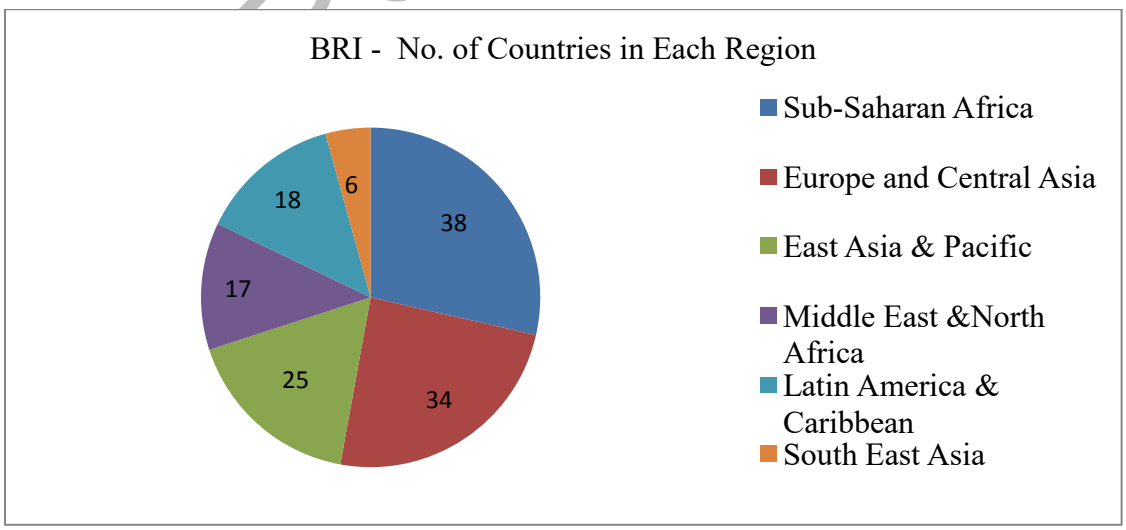
To empirically analyze the impact of FD and ICT and their joint effect on manufacturing exports, panel data from the period of 1990-2020 is used. Data on the required variables

have been collected from World Development Indicators (WDI) and Federal Reserve Economic Data (FRED). The target population of our study is developing countries of Belt and Road Initiatives. And the breakdown of BRI countries are as following

Table 3.2: List of Regions in BRI

Serial no.	Region	No. of countries
1	Sub-Saharan Africa	38
2	Europe and Central Asia	34
3	East Asia & Pacific	25
4	Middle East & North Africa	17
5	Latin America & Caribbean	18
6	South East Asia	6
Total		**138**

Figure 3.1 Pie chart of BRI countries



There are total of 138 countries in Belt and Road Initiatives[1], based on data availability we selected 58 developing countries, and while dealing with numerous countries and different indicators, we encountered the problem of missing values. To deal with missing data, this study takes different measures. The first measure is to exclude the countries having less than 25% of data available over the required period (lin, monga, and standaert, 2019). Applying this measure, we left with only 58 developing countries of BRI. Secondly, use of method of linear interpolation to estimate the missing values of the variable that shows the linear trend (lockwood and Redonao, 2005), we have done this measure for the manufacturing exports and the internet. For energy, following the study of Gygli et al. (2019) who also use linear interpolation method for missing values whereas to treat ending and starting missing observations we used carrying non-missing observations backward and forward respectively. For the FDI and HCI, we used the geometric measure calculated by dividing the available current value by the previous value.

In this study, manufacturing exports is expressed as a percentage of merchandised export. For financial development, we will use the financial index by IMF. However, internet users as a percentage of the population are used for ICT (Raheem et al., 2020). For energy consumption, energy use in kg of oil equivalent per capita is used (Belloumi, 2009). To measure the impact of FDI on manufacturing exports, net inflows of foreign direct investment (% of GDP) are used (Hussain and Haque, 2016). HCI per person is based on years of schooling and returns to education and it is used by (Osiobe, 2020). The data for these variables are sourced from World Development Indicators and Federal Reserve Economic Data.

[1] https://green-bri.org/countries-of-the-belt-and-road-initiative-bri

3.3 Theoretical Framework

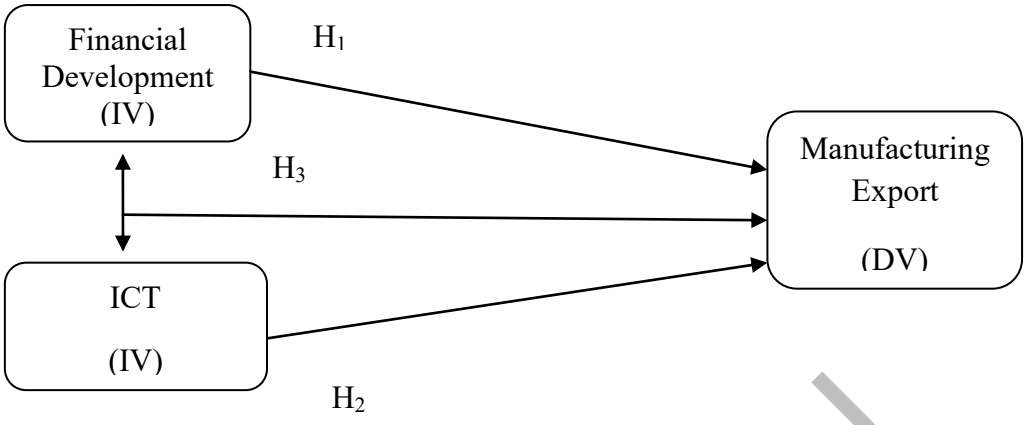
In developing nations, the challenges faced by the manufacturers are that due to low-quality products they cannot compete in the international market. To capture a share in the international market, they need innovation that improves productivity through investment in research and development (R&D). However, industries required financial resources to invest in innovative activities and rely on an outside source. According to Levine (2005) developed financial system makes credit availability easy through the establishment of financial intermediaries, introducing different financial instruments in the stock and bond market, as well as it minimizes the information cost of acquisition related to firms and market conditions to the investors. With the established financial system, easy access to finance to industries encourages them to invest in R&D, risk management, high-tech machinery, etc to amplify innovative activities that consequently spur the overall firm's performance and productivity. The association between financial development and manufacturing exports is supported in the theoretical literature by the Heckscher–Ohlin model, which emphasizes that an economy's endowment of the element of production (land, labor, and capital) determines comparative advantage. In terms of capital, the more opaque and easier transfer of funds to industrial sectors that are heavily reliant on external financing empowers them to invest in production technology, reduce the cost of export activities, and diversify risk for more equitable growth and development. Kletzer and Bardhan (1987) scrutinize the link between financial development and international trade. They found that countries with better financial systems through access to external finance to the manufacturing sectors generate

comparative advantage through specialization in the production of goods that lower the opportunity cost than other countries and provide them gains through trade.

Information and communication technology (ICT) also contributes to the increase in the volume of manufacturing exports. Internet usage increases the level of R&D in the manufacturing firms that bring innovation in products (that increase sales through enhanced demand) and processes (allowing firms to compete effectively and capture share in the international market) as well. Internet usage also helps the firm to acquire information related to international competitors as well as reduces the asymmetric information that prevailed in the international market (Lv et al., 2021; Guo et al., 2022). Industries with superior ICT infrastructure focus on e-commerce which reduces the variable cost and assists in sharing product knowledge globally, whereas industries with poor ICT infrastructure lack platforms to market their products in foreign markets (Ma & Fang, 2021). ICT has a greater impact on the manufacturing sector than on the primary goods market. That is why we are incorporating ICT in our study.

There exists an inter-related link between ICT and financial development. ICT promotes information sharing in the financial sector that reduces the probability of a moral hazard and adverse selection endorsing transparency and accountability that improves the financial market structure. Internet-based technologies like mobile money and new banking service enhance credit availability. Hence, ICT aids manufacturers' access to a variety of financial services. On the other hand, with a developed financial sector, industries can improve their product quality, also shifts to e-commerce, and update their systems, which will aid manufacturers in increasing their exports in the international market.

Figure 3.2 Theoretical Framework



(Source: Author's derivation)

The resource-based approach also emphasizes the relevance of information and communication technology (ICT) for worldwide expansion. This approach has included three main domains that determine productivity growth and international expansion i,e organizational and managerial resources, entrepreneurial resources, and technological resources (Dhanaraj & Beamish, 2003). Resources tend to be classified as tangible and intangible assets. Intangible assets like human capital, reputational capital, and technological capital that are immobile and difficult to imitate enable the firms to generate and sustain competitive advantage. With the availability of resources, the proper utilization of capabilities plays a key role to reflect heterogeneity in industries as well as competing in the marketplace is identified as "human capital" (Barney et al., 2011). Centering on the technological resources that exist in both forms of tangible (High tech machinery and equipment) and intangible assets (information and knowledge-based) facilitate the firms to bring distinctive innovation in their goods and manufacturing process. The exploitation of such resources facilitates the organizations to touch the edge

of competitive advantage as well as to achieve superior performance through enhancing innovation that is difficult to imitate (Amit and Schoemaker, 1993). The technological capacity of the firms through competitive ability exerts a positive influence on them to participate in export activities and increase the export intensity of firms that are already involved in exports (Rodriguez and Rodriguez, 2005). Likewise, the capabilities approach in the presence of advanced resources assists the firm to acquire, analyze, and develop the new form of knowledge resources, increasing the potential opportunities in foreign markets to increase their export activities (Shetewy et al., 2022).

3.4 Hypothesis

Depending on the existing literature review, following are the hypotheses to be investigated in this study.

Financial development facilitates the economic activities through mobility of capital into infrastructure development and industrial sector. Thus, our first hypothesis is testing that whether financial development influences exports of manufacturing sector.

H_{10}: Financial development doesn't affect manufacturing exports.

H_{11}: Financial development does affect manufacturing exports.

Another factor essential for increased manufacturing exports in today's economy is the penetration of ICT. Through the technological adaptability, management and communication efficiency, ICT reduce the uncertainty and traditional cost associated with exports. For that reason, our second hypothesis is to check whether ICT influence the manufacturing exports of developing countries of BRI positively.

H_{20}: ICT doesn't affect manufacturing exports.

H_{21}: ICT does affect manufacturing exports.

Based on the assumption that both ICT and FD strengthen each other effect, our third hypotheses is to verify whether interactive affects the manufacturing exports or not.

H_{30}: The interaction of FD and ICT doesn't affect manufacturing exports.

H_{31}: The interaction of FD and ICT does affect manufacturing exports

3.5 Econometric Model

This study makes use of panel data, which allows it to consider cross-national disparities and reflect the variations in independent variables over time. It is preferred to use panel data for empirical analysis due to several advantages. Panel data provide more number of observations that increase the sample variability and reduce the co-linearity, resulting in a more accurate sample picture. Through increasing variability and more degree of freedom, panel data provides more accurate econometric estimates (Hsiao et al., 1995). Furthermore, it also allows a researcher to tackle the influences of heterogeneity across time and cross-sections, as well as control the effect of omitted variables and uncovers the dynamic relationships (Hsiao, 2007; Raj & Baltagi, 2012).

To check the proposed hypotheses, based on the model given by Shetewy et al., (2022), the following model has been formulated.

$$ME_{it} = \alpha_0 + \alpha_1 FD_{it+} \alpha_2 ICT_{it} + \alpha_3 Z_{it} + \varepsilon_{it} \quad \text{.....(3.1)}$$

Where manufacturing exports is the dependent variable which is denoted by ME. α_0 is the intercept of the model. FD and ICT are the independent variable, which represent the financial development and information and communication technology respectively. Z is the vector of control variables.

$$ME_{it} = \alpha_0 + \alpha_1 FD_{it} + \alpha_2 ICT_{it} + \alpha_3 FD*ICT_{it} + \alpha_4 EC_{it} + \alpha_5 FDI_{it} + \alpha_6 HCI_{it} + \varepsilon_{it...} \quad (3.2)$$

Eq 3.2 along with DV and IV represents the control variables that are used in the study i.e. EC that is energy consumption, FDI is the foreign direct investment and HCI that is human direct investment. The multiplicative interaction term (FD*ICT) is also introduced in the model because FD affects ICT and vice versa. While εi is the error term used in the model that is assumed to independently and identically distributed , that is $\varepsilon_{it} \sim iid\ (0,\sigma^2)$. The subscript i is used to indicate the country and t shows time.

The interaction term used in equation 3.1 and 3.2 can be explained as follows

$$\frac{\partial ME}{\partial FD} = \alpha_1 + \alpha_3 ICT \quad \text{.....(3.3)}$$

$$\frac{\partial ME}{\partial ICT} = \alpha_2 + \alpha_3 FD \quad \text{.....(3.4)}$$

The derivative equation given in equation 3.3 show the conditional effect of financial development on the manufacturing export at different levels of ICT. However, the conditional effect of Information and communication technology on the manufacturing exports given optimal level of financial development is shown in equation 3.4. The parameter can take on various sign, for example, if α3 in equation 3.3 and 3.4 have the same positive sign then it can interpret as financial development and ICT will enhance the positive effect of each other on manufacturing exports. While if they have the same negative sign then it means that both financial development and ICT will enhance the negative effect of each other on manufacturing exports.

3.6 Analytical Techniques

3.6.1 Cross Sectional Dependence

Due to interdependence in term of global and economic interaction, common policies, culture etc across countries, there might be the issue of cross-sectional dependence and heterogeneity in panel data analysis. Thus, Lagrange Multiplier (LM) test was established by Breusch and Pagan (1980) to discover the dependency of cross sectional units over time in panel data, and the equation is as follows:

$$LM_{BP}=T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \widehat{\rho_{ij}} 2$$

However, when cross sectional units are larger than time intervals, it generates asymptomatic biased outcomes. Pesaran (2004) devised the CD test by correcting the bias in the LM test. According to Pesaran (2007), the results produced can be inconsistent and biased without checking the cross- sectional dependence and heterogeneity. Therefore, it is important to check whether cross section dependence exists. The following is the CD mathematical equation:

$$CD= \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \widehat{\rho_{ij}}\right) \sim N(0,1)$$

Where, sample size and time period is represent b N , i and p is the coefficient of cross section correlation.

3.6.2 Panel Unit Root Test

To impede the spurious regression, we see the level of stationary of the economic variable used in the panel data estimation. Thus, we have applied cross-sectional

augmented Im-Pesaran-Shin (CIPS) and cross-sectional augmented Dickey-Fuller (CADF) unit root tests introduced by Pesaran, (2007). The rationale of using second generation unit root test is the issue of CD. CADF is calculated using the mathematical expression:

$$\Delta Y_{it} = \alpha_i + \gamma_i Y_{it} + \delta_i \overline{Y}_{t-1} + \sum_{j=0}^{k} \delta_{ij} \Delta \overline{Y}_{i,t-j} + \sum_{j=0}^{k} \theta_{ij} \Delta Y_{i,t-j} + \varepsilon_{it}$$

Whereas, by averaging the CADF we obtain CIPs

$$CIPS = \frac{1}{N} \sum_{i=1}^{N} CADF$$

3.6.4 Panel Cointegration test

In this study, to examine the long run relationships between dependent and independent variable we have applied the cointegration test proposed by Westerlund (2007) that account for cross section dependence through bootstrap method. This test is constructed on an error estimation model, with group statistics (Gs, Ga) and panel statistics (Ps, Pa). The null hypothesis (Ho) for this test is no cointegration among variables of panel data.

$$\Delta Y_{it} = \acute{\delta} d_t + \propto_i \left(Y_{i,t-1} - \acute{\beta}_i x_{i,t-1} \right) + \sum_{j=1}^{\rho_i} \alpha_{ij} \Delta Y_{i,t-j} + \sum_{j=-q}^{\rho_i} \gamma_{ij} \Delta x_{i,t-j} + \varepsilon_{it}$$

In the equation above, d stands for deterministic components, which include linear and steady trends, while pi and qi is used for lags and lead respectively. In panel data analysis, rejection of the null hypothesis implies the presence of co integration among variables.

3.6.4 Panel Causality Test

If the cointegeration test produces significant values then we can further proceed with causality test. Therefore, in this study we have applied Dumitrescu-Hurlin Panel Causality tests to observe the causal relationship among the variables in panel data. The linear representation of heterogeneous model is

$$Y_{it}= \omega_i+\sum_{i=1}^{z} \rho_i^k Y_{i,t-k}+\sum_{i=1}^{z} B_i^{(z)} X_{i,t-k}+\varepsilon_{it}$$

The two statistics W-bar and Z-bar in the test are used to reject the null hypothesis that assumes no causation (Bi=0). This implies that there are three possibilities: a unidirectional causal relationship between variables, a bilateral causality relationship between variables, or no causality.

3.7 Dynamic Panel Data Estimation

As our data is panel of 58 countries (list of countries given in Appendix table) for the period 1990-2020. As our independent variables are not purely exogenous, that's why instead of OLS we have adopted the GMM panel data estimation method (Leszczensky & Wolbring, 2022). The aim of choosing this estimation is to control the issues of simultaneity, endogeneity and heteroskedasticity. The generalized method of moment was proposed by Arellano and Bond (1991) and Blundell and Bond (1998) to check the cause and affect relationship of underlying phenomena that are generally dynamic over time. As a result, GMM incorporates the lags of the dependent variable as an explanatory variable to address the problem of dynamic panel data. GMM employs the appropriate test to overcome the serial correlation between error term and explanatory variables, it also used different instruments from lagged endogenous and explanatory variables. In the

presence of unobserved heterogeneity, simultaneity, and dynamic endogeneity, the GMM provides coherent outcomes (Wintoki, Linck, & Netter, 2012). Beside this, it also controls cross-sectional dependence and restricts over identification (Tchamyou, 2019). According to Arellano and Bond (1991) and Arellano and Bover (1995) the regression equation is as follows;

$$ME_{i,t} = \alpha ME_{i,t-1} + \beta_1 FD_{i,t} + \beta_2 ICT_{i,t} + \beta_3 Z_{i,t} + \mu_t + \eta_i + \varepsilon_{i,t} \quad \text{.....(3.5)}$$

Where, μ_t and η_i represents the time specific effect and country specific effect while inclusion of lag shows persistency in exports

The above equation can be rewrite as;

$$ME_{i,t} = (\alpha - 1)ME_{i,t-1} + \beta_1 FD_{i,t} + \beta_2 ICT_{i,t} + \beta_3 (FD*ICT)_{i,t} + \beta_4 Z_{i,t} + \mu_t + \eta_i + \varepsilon i_{,t} \quad \text{.....(3.6)}$$

The above equation is transformed into first differences to remove the country-specific effects.

$$ME_{i,t} - ME_{i,t-1} = a(ME_{i,t-1} - ME_{i,t-2}) + \beta_1 (FD_{i,t} - FD_{i,t-1}) + \beta_2 (ICT_{i,t} - ICT_{i,t-1}) + \beta_3 (Z_{i,t} - Z_{i,t-1}) + \beta_1 (FD_{i,t} - FD_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \quad \text{.....(3.7)}$$

Arellano and Bond (1991) suggest to use the lagged values of regressors as an instrument to deal the issue of simultaneity and endogeneity in the model. Thus, GMM estimator uses the moment conditions as given below and called as differenced GMM estimator.

$$E[ME_{i,t-s}.(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \text{ for } s \geq 2;\ t = 3, ..., T$$

$$E[FD_{i,t-s}.(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \text{ for } s \geq 2;\ t = 3, ..., T$$

$$E[ICT_{i,t-s}.(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \text{ for } s \geq 2;\ t = 3, ..., T$$

$E[Z_{i,t-s}.(\varepsilon_{i,t}-\varepsilon_{i,t-1})] = 0$ for $s \geq 2$; $t = 3, ..., T$

Whereas, Acemoglu and Robinson (2008) found that if past value exhibits little information for future changes, it will arise weak instrument problem in the differenced series. This might be the case in the presence of institution variable. However, Arellano and Bond (1991) and Blundell and Bond (1998) suggests amalgam of level and differenced equation to improve the efficiency through bias reduction. They proposed the system–GMM estimator that employ following moments;

$E[(ME_{i,t-s} - ME_{i,t-s-1}).(\eta_i+\varepsilon_{i,t})] = 0$ for $s = 2$

$E[(FD_{i,t-s} - FD_{i,t-s-1}).(\eta_i+\varepsilon_{i,t})] = 0$ for $s = 2$

$E[(ICT_{i,t-s} - ICT_{i,t-s-1}).(\eta_i+\varepsilon_{i,t})] = 0$ for $s = 2$

$E[(Z_{i,t-s} - Z_{i,t-s-1}).(\eta_i+\varepsilon_{i,t})] = 0$ for $s = 2$

These moments are employed under the premise that the error term has no serial correlation with the dependent variable and the instruments are valid. We also use the *Hansen's J* test to check the validity of over-identifying restriction developed by Arellano and Bover (1995) and Blundell and Bond (1998). This test indicates that the instruments are determined to be valid and that the model is well-defined when null hypothesis is not rejected.

CHAPTER 4: DESCRIPTIVE ANALYSIS

4.1 Descriptive Statistics

The statistical summary of the final data used for regression analysis is given in table 4.1. The statistical description of the data includes number of observations, mean, standard deviation, minimum, and maximum value. This study has taken 58 developing countries of BRI from 1990 to 2020 resulting in a total of 1740 observations. Mean is a measure of central tendency, and it indicates a numerical value that represents the whole set of values of a variable. Standard deviation is a measure of dispersion, and it shows the variation of each value around the mean value of the variable. The minimum and maximum are the smallest and largest value in a data set respectively and gives an idea about the range of data. The average value of manufacturing exports 45.05 while the standard deviation is 30.05. The minimum and maximum values are 13.54 and 100.5 respectively. The mean value of the financial development is 0.29 whereas the value of the standard deviation is 0.17 which indicates that there is somewhat deviation around the mean value.

Table 4.1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
FDI	1740	4.986	19.731	-40.291	449.083
HCI	1740	2.463	.674	0.107	4.493
ME	1740	45.059	30.055	13.546	100.519
FD	1740	.296	.175	0	.803
EC	1740	2375.387	3056.743	118.898	22120.43
ICT	1740	24.877	28.851	0	112.105

Note: FD is Foreign Direct Investment, HCI is Human Capital Index, ME is Manufacturing Exports, FD is Financial Development, EC is Energy Consumption and ICT is Information And Communication Technology.

The minimum and maximum values are observed to be 0 and 0.8 respectively showing a least level of dispersion in the data. The mean value of the ICT is 24.87. The value of the standard deviation is 28.85 while the minimum and maximum values are 0 and 112 respectively. The human capital index has a mean value of 2.46. The value of standard deviation is 0.67 showing values are clustered around mean and the minimum and maximum values of 0.1 and 4.49 respectively shows a moderate level of dispersion. The average value of the energy is 2375.3 whereas the standard deviation is 3056.743 whereas minimum and maximum values of energy are 118.898 and 22120.43 respectively. In contrast, the mean value of the FDI is 4.98 and the standard deviation is 19.71 which show a significant deviation of the values around the mean value. The minimum and maximum values of FDI are -40.29 and 449.08 respectively.

4.2 Correlation Matrix

The pair-wise correlation matrix of the variables in the regression analysis is shown in table 4.2. The correlation coefficient measures the direction and strength of linear relationship between the variables. The manufacturing exports are positively correlated with all the variables except negative energy consumption. Correlation between financial development and all the variables are positive but in the case of FDI, the correlation coefficient is small. The values of correlation coefficient of ICT with all the other variables are small except the human capital because without human skills, knowledge and capability, the adaption of advance technologies neither be possible nor beneficial. There exist the weak but positive linear relationship between energy consumption and human capital index while negative correlation coefficient between energy consumption

and foreign direct investment. Foreign direct investment is found to be weakly positively correlated with human capital index with the value of 0.09.

Table 4.2 Matrix of Correlations

Variables	ME	FD	ICT	EC	FDI	HCI
ME	1.000					
FD	0.362 (0.00)	1.000				
ICT	0.137 (0.00)	0.513 (0.00)	1.000			
EC	-0.138 (0.00)	0.369 (0.00)	0.303 (0.00)	1.000		
FDI	0.071 (0.00)	0.136 (0.00)	0.109 (0.00)	-0.0004 (0.00)	1.000	
HCI	0.368 (0.00)	0.438 (0.00)	0.519 (0.00)	0.265 (0.00)	0.093 (0.00)	1.000 (0.00)

CHAPTER 5: EMPIRICAL RESULT AND DISCUSSION

The correlation matrix given in the previous Chapters helps us to understand the relationship between dependent variable and independent variables. However, this chapter discussed in detail the estimation results of the impact of ICT and FD on manufacturing exports as well as to inspect the interactive role of FD and ICT on manufacturing sector export performance.

5.1 Cross Sectional Dependence Test

As we are using panel data having cross sections that may raise the issue of cross sectional dependence among the countries. The dependence among the countries may be caused by the common factors that are culture, ethnicity, sharing borders, trade agreement and spillover effects etc. For this purpose, this study employs the Pesaran (2004) CD test with null hypothesis of cross sectional independence in the panel data.

Table 5.1: Results of CD-tests

Variables	Pesaran CD Test	P-value
ME	24.770	0.000***
FD	142.230	0.000***
ICT	244.720	0.000***
EC	43.950	0.000***
FDI	41.360	0.000***
HCI	239.590	0.000***
Notes: ME= Manufacturing Exports, FD= financial development, ICT=information and communication technology, EC =energy consumption, FDI= foreign direct investment, HCI=human capital investment. ***, **, * indicates significance level at 1%, 5% and 10% respectively.		

Table 5.1 shows the CD results with the p-value less than 0.05 that reject the null hypotheses and indicate the presence of cross sectional dependence among BRI selected developing economies.

5.2 Unit Root Test

Unit root tests are used to determine if the variables are stationary. First generation unit root tests are not acceptable since the CD test shows the existence of cross sectional dependency. Hence, we used the second generation unit root test (CIPS and CADF) that account for cross sectional dependence while checking the order of integration (Pesaran, 2007).

Table 5.2: CADF and CIPS Unit Root Results

Variables	CADF		CIPS	
	Level	1st difference	Level	1st difference
ME	-2.054***	-4.268***	-2.252***	-5.359***
FD	-2.130***	-4.107***	-2.372***	-5.473***
ICT	-1.692	-2.531***	-1.231	-3.587***
EC	-1.939**	-3.717***	-2.003	-5.086***
FDI	-2.699***	-4.949***	-3.466***	-5.701***
HCI	-1,483	-2.559***	-1.060	-3.213***
FD*ICT	-1.089	-2.256***	-1.172	-3.587***

Notes: ME= Manufacturing Exports, FD= financial development, ICT=information and communication technology, EC =energy consumption, FDI= foreign direct investment, HCI=human capital investment. ***, **, * indicates significance level at 1%, 5% and 10% respectively.

The results of CADF in table 5.2 rejected the null hypothesis of unit root test as manufacturing exports(ME), financial development(FD), energy consumption(EC) and foreign direct investment(FDI) are stationary at level while other variables are integrated at order 1. However, CADF also shows that ME, FD and FDI is integrated at level while other under considered variables are stationary at first difference.

5.3 Cointegration Test

Next, to discover the long run relationship among the primary variables, we utilized the co-integration test by westerlund, (2007). The reason to use this co integration test is that it considers the issues of cross-sectional dependence and overcome the degree of heterogeneity.

Table 5.3: Result of Westerlund Panel Cointegration Test

Statistic	Value	Z-value	p-value
Gt	-3.002	-3.077	0.001***
Ga	-3.556	11.423	1.000
Pt	-20.569	-0.925	0.177
Pa	-3.128	8.102	1.000
Notes: The null hypothesis (H_0) is no cointegration; lags and lead are automatically selected by AIC (Akaike's Information Criterion) with Bartlett-Kernel window width set according to $4(T/100)^{2/9}$			

The outcome of westerlund co-integration test displayed in table 5.3 demonstrates that the statistics of the group mean statistics rejects the null hypothesis of no cointegration at the significance level of 1% that means significant cointegration exist between manufacturing exports, financial development, information and communication technology, energy consumption, foreign direct investment and human capital index.

5.4 Causality Test

Further, Dumitrescu-Hurlin panel causality test is used to demonstrate the direction of relationship between variables as well as to address the issue of heterogeneity in panel data. A bi-directional causality relationship is found between the financial development and manufacturing exports. A well-developed financial sector channelizes the investment into high return industries that suffer credit limitation and encourages them enhance the

exports volume and export intensity through value added goods (Nieminen, 2020). Whereas, increase in exports increases domestic production that eventually increases the demand for financial development (Wamboye and Mookerjee, 2014).

Table 5.4 Dumitrescu-Hurlin Granger causality test

Sr.No	Causal relationship	W-stat	Zbar-stat
1	FD→ME	2.279***	6.828***
	ME→FD	5.339***	7.209***
2	ICT→ ME	6.324***	10.246***
	ME≠ICT	3.654	2.0183
3	EC→ ME	5.204***	6.7948***
	ME≠EC	3.6201	1.9113
4	FDI→ ME	4.6318***	5.0295***
	ME→FDI	4.3238***	4.080***
5	HCI→ ME	7.0725***	12.552***
	ME→HCI	7.7696***	14.701***
6	ICT→FD	10.165***	22.086***
	FD→ICT	5.7822***	8.5752***
7	EC→FD	6.097***	9.5481***
	FD→EC	5.8525***	8.7920***
8	FDI→FD	4.8035***	5.5589***
	FD→FDI	24.737***	67.000***
9	HCI→FD	3.4678***	15.897***
	FD→HCI	2.7896***	11.345***
10	EC→ICT	4.3501***	4.1613***
	ICT→EC	6.8221***	11.780***
11	FDI→ICT	5.9664***	9.1429***
	ICT→FDI	4.9825***	6.1106***
12	HCI→ICT	9.3323***	19.517***
	ICT→HCI	12.240***	28.482***
13	EC→HCI	10.567***	23.323***
	HCI→EC	4.7199***	19.859***
14	FDI→EC	3.5765***	1.7768***
	EC→FDI	6.2420***	9.9925***
15	HCI→FDI	5.2308***	6.8758***
	FDI→HCI	14.348***	34.976***
Note: As for Table 5.1			

A unidirectional causality from information and communication technology to manufacturing export suggest that ICT through cost effective methods of communication and knowledge based information sharing over internet promote the innovation and development to sustain the industrial production growth as well as through reducing their fixed exports cost increase their export performance (Liu & Nath, 2013).

A unidirectional causality running from energy consumption to manufacturing exports has been observed. As energy is the important source in the industrial sector due to dependence of all the production operations. The rise in energy consumption is linked with increased productivity as well as other economic activities that improve the export performance of the energy intensive industries. This result is in line with (Nnaji et al., 2013; Erkan et al., 2010). A bilateral causality exists between FDI and manufacturing exports that is consistent with the findings of Pfaffermayr (1996) and Babu (2018). A bidirectional relationship between human capital and manufacturing exports is observed because education and skills are the essential component of human capital as it accelerates the productivity rate through engagement in innovative activities that required efficient and effective utilization of resources thus, human capital promotes the export performance in manufacturing sector (Rodríguez & Orellana, 2020). Whereas increase in exports brings with it technology transfer, diffusion of technical knowledge and production skills competitive thus causes increase in ICT (Chuang, 2000). The bidirectional causality among ICT and FD indicates that ICT dispersion in financial sectors has a profound influence on the development of financial sectors as the introduction of advance ICT services like mobile banking reduce the transaction cost through branchless financial institution, with the use of electronic gadgets reduces the

information asymmetries prevail in the markets through efficient exchange of information among banks and to shareholder (Alimi & Adediran, 2020). Therefore, developed financial sector calls for an up-to-date installment of internet and mobile technologies to further advance the function of financial intermediaries (Ibrahim et al., 2021).

The bi-directional causality exist between FD and energy consumption such that with developed financial sector individual and industries have access to credit for investment in the energy intensive goods and equipment's thus increasing overall energy consumption (Topcu & Payne, 2017). While increase in energy consumption push for the loans and other financial services that influence the financial development (Dan & Lijun, 2009; Ma and Qiang Fu, 2020).

There exists the two way causality between financial development and foreign direct investment. The developed financial sector helps in relaxing the liquidity constraints faced by the local manufacturing sectors and promote growth in manufacturing sectors that has the agglomeration effect on the inward FDI (Desbordes & Wei, 2017) it gives the signal of sound financial sector as the foreign firms in the host country required external finance to meet upfront fixed cost (Islam et al., 2020).on the other hand , FDI also has the spillover effect on domestic stock market as it stimulate capitalization if the MNCs are listed on the stock market (Ramirez, 2018). Table 5.4 shows that bi directional causality running from human capital to financial development and vice versa, that is in line with the results of (Hong Vo et al., 2021). ICT and energy use are found to be correlated in both directions. The penetration of ICT prompt the adoption of technological machinery and electronic devices that increase the intensity of energy consumption and this result is align with (Salahuddin and Alam, 2015; Ahmed and Ozturk, 2018). Conversely,

increased energy consumption diverts the attention of the economies toward adopting the high-technologies to lessen the energy demand through efficient operational activities as well as to shift to the renewable energy systems (Niyibizi & Komakech, 2013). A bidirectional causality between FDI and ICT show that ICT through transparency in information of markets, production efficiency and reduce cost of production and transaction cost attracts the FDIs (Addison and Heshmati, 2004) while FDI inflow also accelerate the ICT investment to facilitate the potential production in developing countries (Gholami et al., 2005). The bidirectional relationship between human capital and ICT shows that inducement of advance technologies demand for highly educated and skilled workers (Chun, 2003; Acemoglu and Zilibotti, 2001) while human capital has the significant contribution in adopting innovation and technologies due to digitalization and reduces the manual work burden and encourage them to polish their skills through online research materials (Cosar, 2011). There exists a bi-directional relationship between energy consumption and human capital. Energy consumption in health and educational sectors improves the capabilities of human capital that in turn aids in the economic growth process (Fang and Chang, 2016; Nain, et al., 2017). On the other hand, through research and development human capital promote new energy technologies to meet the energy requirement in an effective way (Fang & Wolski, 2021).The bidirectional relationship also exists between human capital and FDI because FDI through spillover effect spur the domestic knowledge and technical know-how that consequently promote human capital that improve the existing activities through R&D environment in an economy (Fredriksson, 2020). In the same way, accumulation of skilled and educated workforces attracts more FDI inflows as MNCs need trained and skilled workforce to

handle the use of technologies and resources efficiently (Sadeghi et al., 2018). Again, the bidirectional causality between FDI and energy consumption is observed in table 5.1.4 that is consistent with studies (Kuo et al., 2012; Kakar, 2016).

5.5 Dynamic Panel Data Estimation

Panel data estimation techniques used in this study include GMM and 2SLS to analyze the impact of ICT, FD, and their interactive role on the manufacturing exports of BRI developing countries.

In case of GMM, lag value of manufacturing exports is significant and positive, that is, a 1 % increase in manufacturing exports in the last year increases the exports of current year by 0.9% which shows the persistency of manufacturing exports.

Results of all of the models indicate that financial development has a positive and significant effect on manufacturing exports. The GMM model show that one percent increase in financial development will result in a 0.05 percent increase in manufacturing exports while in case of 2SLS, it will cause 0.37% increase in manufacturing exports. It leads to the conclusion that a sound financial sector and easy access to finance helps to improve the capital structure of manufacturing industries. Developed financial sector through the provision of credit, working capital, investment, innovative ideas bring developments in manufacturing sectors through structural changes that can prominently manifest in increased output level. Whereas, exporting industries face the demand of large upfront fixed cost due to internal and external country-specific factors that restricts them from entry into foreign markets thus, liquidity availability pushes the manufacturing sector to increase its exports. This result is in line with the Rilwanu (2021) and Caporale

et al. (2022), which shows that a developed financial system boosts industrial production through efficient distribution of financial resources at low cost of capital and helps in export diversification to increase the export volume. The productive investment by the financial sector attracts a large number of investors to mobilize savings, which plays role in the financial sector's stability.

Table 5.5: Impact of Financial Development and Information and Communication Technology on Manufacturing Exports

Variables	GMM	2SLS
L.ME	0.905***	
	(0.00585)	
FD	0.0503**	0.374*
	(0.0228)	(0.213)
ICT	0.0381***	0.226**
	(0.00771)	(0.112)
EC	-0.0659***	-0.580***
	(0.00672)	(0.0498)
FDI	0.0288***	0.0773***
	(0.00432)	(0.0263)
HCI	0.0391***	0.884***
	(0.00729)	(0.0544)
FD*ICT	0.0285***	0.123**
	(0.00497)	(0.0603)
Constant	0.790***	5.324***
	(0.0953)	(0.863)
No. of Obs.	1450	1390
Number of pid	58	58
R-squared		0.367
AR(2)	0.509	
Hansen J Test	0.768	0.484

Note: The dependent variable ME is manufacturing exports. FD is financial development. ICT is information and communication technology. EC is energy consumption whereas FDI and HCI are foreign direct investment and human capital index respectively. FD*ICT is the interaction term. While Hansen-J test suggests that instruments are valid. P-values are given in paraenthesis.*, **, *** are 10, 5 and 1 percent levels of significance respectively.

Table 5.5a: Impact of Financial Development given Information and Communication Technology Levels

ICT	GMM	2SLS
P25=0.41	0.058 (0.000)	0.379 (0.000)
P50=2.52	0.164 (0.001)	1.169 (0.008)
P75=3.82	0.230 (0.004)	1.655 (0.021)
Note: ***, **, * are 1, 5 and 10 percent level of significance respectively. P25, P50 and P75 are the 25th, 50th and 75th percentiles respectively.		

To capture the effect of financial development given ICT, the 25th, median, and 75th percentile value of the ICT is considered. The models of GMM and 2SLS shows a significant and positive impact of financial development on manufacturing export at all levels of ICT that leads to the conclusion that ICT contributes to the effectiveness of banking and financial markets by reducing market friction and transaction cost making them efficient. Thus, developed financial sector enables the transparent deployment of financial funds into profitable industrial investments, enhancing productivity and overall export volume.

The results shown in table 5.5 indicate that the availability of ICT has a significant and positive influence on manufacturing exports. In case of GMM model, 1% increase in ICT will expand the volume of manufacturing exports by 0.038% while in 2SLS model, manufacturing export increases by 0.226% respectively. This implies that the embracement of ICT such as the internet allows the manufacturing sectors to have access to information related to potential markets, suppliers, customer presence and quality standard. It reduces the costs incurred due to information friction, transportation, communication, and transaction, which are all elements that ease the entry of industries

into the international market to bring up the export revenues. On the other hand, by increasing the productive capacity of all the sectors, ICT ensures the growth of the economy. This result is consistent with the empirical findings of Kotnik & Hagsten (2018) and Zhou et al. (2022) that there is a positive correlation between ICT (internet and broadband) and exports. According to them, strengthening ICT infrastructure helps industries adopt technological changes in a competitive market to grow exports in the global market. The impact of ICT on exports varies according to the level of development of ICT, the more developed an ICT infrastructure a country has more it will benefit the exports of all sectors.

Table 5.5b: Impact of Information and Communication Technology Given Financial Development Levels

FD	GMM	2SLS
P25=0.218	0.055 (0.012)	0.403 (0.045)
P50=0.235	0.059 (0.005)	0.427 (0.025)
P75=0.36	0.065 (0.002)	0.455 (0.011)
Note: ***, **, * are 1, 5 and 10 percent level of significance respectively.		

To analyze the impact of information and communication technology given financial development, 25th, median, 75th percentile value of the financial development have been considered and the results are given in table 5.5b. Given the low level of financial development, GMM and 2SLS models indicate that 1% increase in ICT causes manufacturing exports to increase by 0.05% and 0.40% respectively. However, it is observed that effect of ICT on manufacturing exports increases with increase in level of FD. Given the high level of financial development, GMM and 2SLS models indicate that 1% increase in ICT causes manufacturing exports to increase by 0.065% and 0.445%

respectively. At high level of financial development, liquidity availability facilitates manufacturing firms to move towards technological infrastructure and internet capabilities and increases their access to the foreign markets through virtual exports platforms.

The control variables foreign direct investment, human capital and energy consumption has a significant and positive impact on industrial exports. The GMM model reveals that a 1% increase in FDI causes a 0.028 percent rise in manufacturing export whereas, 2SLS model show a 0.077% increase in manufacturing export. Foreign investment improves industrial sectors of developing countries through spillover effect of transfer of knowledge, technology, and managerial skills. The foreign investors invest in the host countries' manufacturing sector and help to improve countries' current account by raising export volume. In such a scenario, FDI through inflow of capital help in the growth of economy. FDI enables industries to invest more in R&D to bring novelty to existing products and encourage them to target the un-captured product lines and market and builds confidence in host nation industries to compete in a competitive market. This finding is in line with results of (Prasanna, 2010; Anwar & Sun, 2018).

According to table 5.5, the energy consumption coefficient is statistically significant and has a negative impact on manufacturing exports in case of both GMM and 2SLS model. A higher level of energy consumption reduces exports by 0.06% and 0.58% respectively, indicating that energy consumption in the industrial sector is high due to heavy machinery and equipment. Initially, higher energy consumption contributes to higher output level in industries to meet the production demand of both domestic and foreign market. On the contrary, once it reaches its diminishing marginal productivity, there

would be no addition to the production growth, but only environmental consequences and depreciation of energy resources that will ultimately affect the production level. It will also cause the developing countries to become more dependent on the other countries to fulfill the demand of energy. This result is in line with Nguyen et al. (2020) and Safi et al. (2021) that finds the negative effect energy consumption on trade balance and exports.

Result in table 5.5 show that industries with higher levels of human capital have a positive and statistically significant impact on their export performance. The GMM and 2SLS models show 1% increase in human capital will cause manufacturing export to increase by 0.04% and 0.88% respectively. In today's fast-paced world, the fusion of various technological advances in industries has compelled for increase in human capital (education, skills, and management) to handle the technical complexity as well as to make effective managerial decisions to bring innovation to preserve their competitive advantage. Therefore, human capital is considered as the prime factor of production due to its invulnerability and imitated, and contributes to increased manufacturing exports through higher productivity and competitive advantage (Rodríguez & Orellana, 2020; Eickelpasch & Vogel, 2011).

Since both the models show significant impact of independent variables on dependent variables which ensures the rejection of the null hypotheses of this study. There is a slight difference in the coffecient values of the both models.

To determine the validity of GMM estimator, we run the Hansen J for the weak instruments and Arellano-Bond test for the serial correlation. P-value higher the 0.05

denote the absence of weak instrumental variables and second-order serial correlations respectively.

5.7 Robustness Check

In this study we employed GMM panal estimation technique but for the robustness check we have used 2SLS regression keeping in mind the endogenity issue. The effect of independent variables on dependent variables is same in both techniques with slight changes in the cofficient values (see Table 5.5). However the p-value of *Hansen's J* statisctic indicates that instruments are valid in both models.

CHAPTER 6: CONCLUSION AND POLICY IMPLICATIONS

6.1 Conclusion

This chapter concludes the findings of this study. One of the main objectives of this dissertation is to contribute to the existing literature through analyzing the influence of the combined effect of financial development and ICT (particularly internet) on the manufacturing exports of developing countries of Belt and Road initiatives. We have also examined the impact of ICT and financial development on manufacturing exports of BRI developing countries that is neglected.

The main findings of our empirical analysis are firstly, financial development has positive and higher significant contribution in promoting industrial export performance of selected BRI developing countries, since industries are dependent on external finances. Thus, the development of financial sectors involves the functional efficiency and expansion in size of financial intermediaries, introduction of innovations in financial instruments and markets, alleviating the market distortion and improve the investment decision through channelizing the finances into the larger-scale projects and high return industries at low cost. Thus, it aids in eliminating the liquidity constraints faced by manufacturing sector, improve the manufacturing sector structure through comparative advantages, and ensure the growth of high-quality value added manufactured goods to be exported in competitive foreign market. Secondly, internet also positively contribute in increasing the export of the manufacturing sector as it improves the information efficiency in international market, reduces the transaction cost and promote the technological innovation in industries.

Thirdly, there is the significantly composite effect of FD and ICT on the manufacturing exports. The presence of ICT upgrades the financial industry through the technological and innovative process that increase the efficiency by reducing the cost related to information acquisition, transaction, enforcement contracts and improve the capital allocation, trading diversification, monitor firms, exerting corporate governance and reduce the risk management that stimulate the smooth mobilization of savings and investment into the manufacturing sectors to increase the export volume. On the other hand, financial investments are need for the development of ICT that facilitate the manufacturing sectors and others through reduction in cost of information exchange, cost of entry to international market as well as increase the innovation activities through knowledge spillover that increase the productivity and also support the industries to increase the export intensity.

6.2 Policy recommendation

The findings suggest that government policies in developing countries should focus on improving the macroeconomic environment, developing infrastructure, particularly subsidizing the IT sector, and investing in ICT expansion in an economy to accelerate economic growth through internet-enabled services such as e-government to closely monitor institutional quality and performance, combating corruption, and removing trade barriers. Along with the provision of information and communication facilities, government should also consider the export-oriented policies to reduce the tax, tariff and allow the free mobility of capital that play major role in exports growth.

On the other hand, central bank should employ expansionary monetary policy and target the interest rate to stimulate capital access to the manufacturing sector to increase their

real output performance. As well as focus on strengthening and upgrading the ICT applications in financial sector as it has altered the timing and location of our use of financial services, increase number of transactions shifting to mobile payments, close supervision of administration reforms and personal-to-personal (P2P) financing. ICT ensure the presence of banking services omnipresent, to cater consumers' demands and serving as the major engine of national economic activity.

On the other side, industries must pay attention on adoption of internet technologies as it makes possible to achieve the policy objective of stabilizing and diversifying exports even under the circumstances of de-globalization and trade protection. It also contributes in increasing the efficiency to cater the product demand and stimulate the economic development.

The measures aimed at building a more accessible and transparent financial sector, as well as developing ICT infrastructure will support in generating financial inclusion for manufacturing sector that in turn, eliminate poverty and encourage economic growth.

6.3 Limitation and Scope

The limitation of this study is that due to time constraint and data unavailability, we have analyzed the impact of ICT and FD on manufacturing exports of BRI developing countries only. However, for the further research it is suggested to investigate the impact of ICT, FD, and their composite effect on exports at disaggregate level and compare the degree of effect on the basis of income level of BRI countries.

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Annexure

Table A1: List of Countries

Albania	Kyrgyz Republic
Algeria	Malaysia
Armenia	Moldova
Bahrain	Morocco
Bangladesh	Mozambique
Bolivia	Oman
Brunei Darussalam	Pakistan
Bulgaria	Panama
Burundi	Philippines
Cameroon	Poland
Côte d'Ivoire	Qatar
Croatia	Romania
Dominican Republic	Russian Federation
Ecuador	Saudi Arabia
Egypt, Arab Rep.	Senegal
El Salvador	South Africa
Ethiopia	Sri Lanka
Ghana	Togo
Hungary	Trinidad and Tobago
Indonesia	Tunisia
Iran, Islamic Rep.	Turkey
Jamaica	Uruguay
Kazakhstan	Vietnam
Kenya	
Kuwait	

Table A2: Result of Fixed Effect

Variables	FE
fd	0.989
	(11.10)
internetofpopulation	0.0234
	(0.0774)
inter	-0.288*
	(0.167)
energy	0.000343
	(0.000465)
hci	14.23***
	(4.994)
fdibopcurrentus	0
	(0)
Constant	11.10
	(11.13)
Observations	1710
Number of pid	58
R-squared	0.054

Table A3: Result of Random Effects

Variables	RE
fd	3.862
	(10.94)
internetofpopulation	0.0195
	(0.0766)
inter	-0.289*
	(0.168)
energy	9.20e-05
	(0.000422)
hci	14.41***
	(4.581)
fdibopcurrentus	0
	(0)
Constant	10.51
	(10.02)
Observations	1710
Number of pid	58

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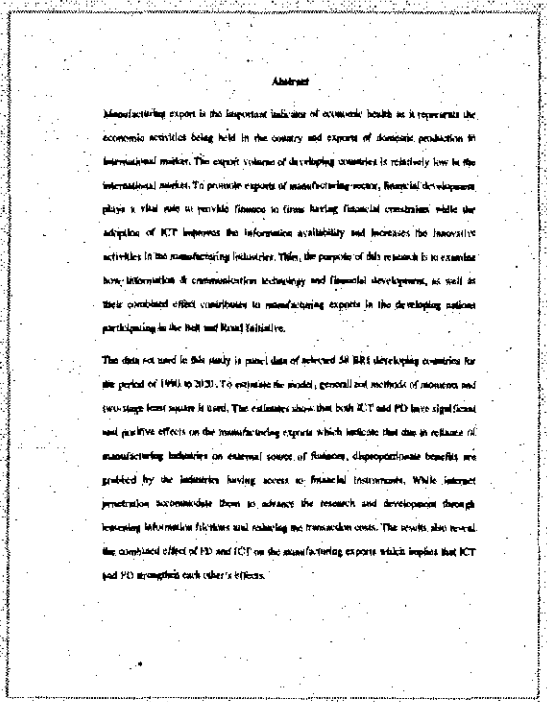

Abstract

Manufacturing export is the important indicator of economic health as it represents the economic activities being held in the country and exports of domestic production in international market. The export volume of developing countries is relatively low in the international market. To promote exports of manufacturing sector, financial development plays a vital role to provide finance to firms having financial constraints while the adoption of ICT improves the information availability and increases the innovative activities in the manufacturing industries. Thus, the purpose of this research is to examine how information & communication technology and financial development, as well as their combined effect contributes to manufacturing exports in the developing nations participating in the Belt and Road Initiative.

The data set used in this study is panel data of selected 50 BRI developing countries for the period of 1990 to 2020. To estimate the model, generalized methods of moments and two-stage least square is used. The estimates show that both ICT and FD have significant and positive effects on the manufacturing exports which indicate that due to reliance of manufacturing industries on external source of finances, disproportionate benefits are grabbed by the industries having access to financial instruments. While internet penetration accommodate them to advance the research and development through lowering information frictions and reducing the transaction costs. The results also reveal the combined effect of FD and ICT on the manufacturing exports which implies that ICT and FD strengthen each other's effects.