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Impact of global innovation indicator on China's exports development

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Abstract: This research is intended to study the impact of global innovation indicators on Chinese exports development, through describing and analyzing impact the seven innovation indicators on the Chinese exports as well as impact of the key innovation indicator on the Chinese exports, and getting to know the concept of innovation, types of innovation , as well as importance of innovation in achieving economic development, offering job opportunities, contributing to finding innovative solutions for problems, in addition to referring to the seven innovation indicators, which are institutions, human capital, research, infrastructure, market development, business development, knowledge outputs and creative outputs. The research is also intended to study innovation development in China, as China adopted implementation of an innovation-based economic development strategy in 2006, so it took the initiative to set up high- tech zones, technology parks, innovation clusters and funds to support creative projects. China now ranks first worldwide in terms of number of patent applications submitted to the national patent agencies. The Chines government has been keen to increase spending on research, development and innovation to boost exports and thus drive the economic development process. Statistical analysis tools such as simple linear regression, correlation coefficient and coefficient of determination will be used to measure impact of the seven global innovation indicators as independent variables and gross exports as a dependent variable. Outcomes of statistical analysis showed that there is a direct correlation between human capital index and the Chinese researches and exports, while there is no direct correlation between business environment development index and the Chines exports, indicating that business environment in China needs more government efforts to be exerted to improve and develop business environment which includes knowledge businesses, innovation links and knowledge absorption.

Keywords: *China, Development, Exports, GDP, Innovation.*

1. Introduction

Innovation is considered one of the most important sources of making fortune and driving economic and social development process. The global innovation indicator is intended to measure economic performance in the field of innovation. and it contributes to evaluating the progress achieved annually in the field of innovation. China moved to implement the innovation-based economic development strategy in 2006, which required improving efficiency of the national innovation system. setting up the basic structure needed for innovation and implementing an array of procedures to reform the financial and banking system. While expanding the scope of market mechanisms and stimulating creativity at the micro level. China has not overlooked the macroeconomic levers required to achieve the strategic goals. China has become a serious competitor in the world of innovation, through increasing spending on research and development (as a measure of innovation inputs) and doubling patents in the domestic market (as a measure of innovation outputs). These achievements contradict the common belief that China's international competitiveness basically depends on labor low costs and high levels of investment in the physical capital. Innovation significantly impacts exports.

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Significance of the research stems from getting to know the impact of innovation on the Chinese exports development, particularly after China has ranked eleventh in the global innovation index, as well as the role of the Chinese government in innovation development. This research is intended to study the impact of global innovation indicators on Chinese exports development. Through describing and analyzing impact the seven innovation indicators on the Chinese exports as well as impact of the key innovation indicator on the Chinese exports. By relying on the descriptive and analytical approach, the concept of innovation, its types and importance will be identified, in addition to identifying the development of innovation in China and The relationship of innovation to Chinese exports. Statistical analysis tools such as the correlation coefficient, linear regression and coefficient of determination will be used to test the study hypotheses and measure the impact of global innovation indicators on China's total exports during the period (2011-2022), and the impact of institutions, human capital, research, infrastructure, market development, business development, knowledge outputs and creative outputs as independent variables on Chinese exports as dependent variables, in addition to studying the impact of the main innovation index on Chinese exports. Outcomes of statistical analysis showed that there is a direct correlation between human capital index and the Chinese researches and exports, while there is no direct correlation between business environment development index and the Chines exports, indicating that business environment in China needs more government efforts to be exerted to improve and develop business environment.

2. Theoretical Framework of the Study

2.1. Importance of Research

Significance of the research stems from getting to know the impact of innovation on the Chinese exports development, particularly after China has ranked eleventh in the global innovation index, as well as the role of the Chinese government in innovation development. The significance of the research also stems from measuring impact of the seven innovation indicators (institutions, human capital, electronic information, market development, businesses development, knowledge outputs and creative outputs) as independent variables on the gross exports as a dependent variable, in addition to measuring impact of China's key innovation index on China's gross exports.

2.2. Hypotheses of the Study

There is a statistically significant relation between institutions index and gross exports.

- There is a statistically significant relation between human capital and gross exports.
- There is a statistically significant relation between infrastructure and gross exports.
- There is a statistically significant relation between markets development index and gross exports.
- There is a statistically significant relation between businesses environment development index and gross exports.
- There is a statistically significant relation between knowledge outputs index and gross exports.
- There is a statistically significant relation between creative outputs index and gross exports.
- There is a statistically significant relation between innovation key index and gross exports.

2.3. Methodology

The research design is regarded the conceptual framework through which the research is conducted, and it is also regarded the basic and important step in collecting, measuring and analyzing data (Thomran & Alshammari, 2023). The descriptive approach contributes in analyzing the phenomenon deeply, enabling access to accurate and clear outcomes (Kemp et al., 2018). It also contributes to guiding products developers to develop innovative products and helping them analyze rivals effectively Schobert et al., 2018). The analytical approach is one of the most significant scientific research methods as it depends on analyzing and linking information through providing profound details to identify causes and impacts of phenomena and attain the best possible solutions for the research problem. It also

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includes using descriptive and analytical methods. Research objectives can be quantitatively addressed through correlation analysis which provides information on the strength and direction among variables. The correlation measures relation among variables: should the volume of a variable changes, a change in the volume of another variable follows, either in the same direction (positive correlation) or in the opposite direction (negative correlation). The term of correlation is often used when the relation between two continuous variables is being studied (Schober et al., 2018). Data and information were collected from the World Bank and the World Intellectual Property Organization (WIPO), and literatures and scientific references were reviewed to study the impact of global innovation indicators on China's exports development. There is a need for a descriptive approach and an analytical approach, and this is conducted through getting to know the concept, types and significance of innovation, in addition to getting familiar with innovation development in China. Statistical analysis tools such as correlation coefficient, linear regression and coefficient of determination will be used to measure the impact of global innovation indicators on China's gross exports during the period (2011-2022), impact of institutions, human capital, research, infrastructure, markets development, businesses development, knowledge outputs, creative outputs as independent variables on the Chinese exports as dependent variables, in addition to studying impact of the innovation key index on the Chinese exports.

2.4. Innovation Concept

Innovation depends on actual implementation of the ideas or new technologies to create a new value in ways that are essentially different from the past. Innovation is no longer related to creating the value for an individual or organization, rather its final target is to create a smart future that is able to provide new potentials for stakeholders in the society, which requires developing the basic structure of research in science, technology and engineering, such as information technology, communications, biological technology, materials, robots and artificial intelligence, upgrading research and development centers, joint research parks and supporting creativity, developing applied researches centers for innovation, supporting small and medium firms that are based on technological innovations, and achieving social justice, law sovereignty, accountability and transparency. (Lee& Trimi, 2018). According to Martin (2016), innovation in the 1960s was exclusively associated with manufacturing in developed countries, based on technology, involved prior research and development and was developed by large companies on the basis of the research and development conducted in their own laboratories and often involved patents. Innovation is considered an inclusive term that includes a large number of innovation types. Innovation is not only "technological", rather it is "social", "cultural", "institutional", "inclusive", "green", "ecology", "user-paid", "agile", "low-cost", "ground-based", "general" and "transformational". Innovation is the introduction of "Something new" that produces change, however, innovation also refers to the "process" (way) in which change occurs and goes on over time. Innovation includes both the revolutionary changes (internet) and small gradual changes (Dodgson, 2018). In light of what is mentioned above, innovation can be defined as generating creative ideas, implementing them successfully and transforming them into goods and services. Innovation is the implementation of a new product (goods or service) that is significantly improved, a new marketing method or a new organizational method in business practice.

2.5. Types of Innovation:

2.5.1. The Technological Innovations

Which require a radical change in the technology and science used in products, the matter which needs new research and development resources. Companies need to develop new markets and advanced marketing skills. The new technological waves such as mobility, cloud computing, internet of things, artificial intelligence, augmented reality and big data contribute in achieving the future of "everything is smart", which benefits companies, consumers and the whole society (OECD, 2017). Existing technological gaps among countries are likely to increase in the future, as headquarters of the world 2000 largest research and development companies are concentrated in a few economies, particularly the

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United States, Japan and China, and 70% of their expenditure that spent on research and development is concentrated in the 200 largest companies (OECD, 2017). No doubt that demand on innovation is firmly associated with development and sustainability (Pansera & Owen, 2018). The need for studying innovation exceeds western models, rather it expands to emerging economies such as China and India (Chen et al., 2018).

2.5.2. Innovation In Services

Services are very essential for economic development given its role in labor and production. Service innovations focus on solving problems through intangible processes that include persons and materials. Service innovations include fields such as mobility, logistics, information, knowledge, foods, healthcare and education. Technological innovations such as cloud computing, banking services and self-service technologies have developed to enhance those services. Services sector is historically regarded the basis of social innovation and is often associated with technological innovations. (Edwards-Schachter, & Wallace, 2017).

2.5.3. Innovation In Products

Innovation in products is considered the most common, as it has been defined as a new product or a product that its proprieties and uses are significantly improved. Innovators, either companies or consumers, are able to achieve their innovations themselves, and protecting those innovations as intellectual properties is important (Gault, 2018). Innovation in products and innovation in processes are mutually associated, as one generates need for the other. Flexible manufacturing and innovating manufacturing processes are regarded new methods of innovation with limited resources, especially in light of the rapid technological development (Halova& Sims, 2016).

2.5.4. Innovation In Processes

Innovation in services creates need for innovation in processes and vice versa, i.e. innovation in processes generates need for a product (Halova& Sims, 2016). Reichstein & Salter (2006) define innovation in processes as "new elements introduced to processes of production or services in the organization – input materials, specifications of tasks, mechanisms of workflow and the equipment used to produce a product or offering a service with the aim of achieving a lower cost and a higher quality for the product. Marketing methods to increase organizational productivity are regarded one of the components of innovation in processes.

2.5.5. Innovation In Businesses Model

Innovation in businesses model includes modifying the existing model or setting up a new model that meets individuals' needs better and improves work performance. Regulatory and marketing innovations play a crucial role to achieve this uniqueness and excellence in businesses models. (Gault, 2018) defines regulatory innovation as implementation of new or significantly modified methods in business practices, business administration and foreign relations. Platforms of cooperative and multiple-sector innovation, such as digital social innovations, contribute in introducing new markets into developing countries and accessing to base-of-the-pyramid clients, and focus on developing social and technological innovations rendered to poor and deprived categories, in order to maximize value and reduce costs, while heading towards sustainability through ecological and green business models. (Dentchev et al, 2016).

2.5.6. Social Innovation

It means solving societal needs through changes in social practices and developing non-technological innovations. There is another side which is "who innovates", and it is a prerequisite for civil society, social activists, social movements, social entrepreneurs and no-governmental organizations' participation, in order to contribute in social change process and changing production as

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well as consumption patterns towards sustainable development and offering service innovations. Social innovations might become more important (lundvall, 2016). Technological innovation and innovation in services might produce social welfare, but they are stimulated through expected profits, while social innovations give priority to social benefits and seek to empower deprived populations. Indicators related to social impact offer distinction between social innovations and other types of innovation (Mulgan et al, 2013).

2.6. Importance of Innovation

Innovation is considered one of the most important sources of making fortune and driving economic and social development process. Innovation is also regarded the most important means to increase competitiveness, particularly improving productivity of institutions and the services rendered to consumers, thus, importance of innovation is attributed to the role it plays in developing the society. Importance of innovation varies in various sectors of which the following are the most important (Dereli, 2015):

- **Economic growth**: innovation contributes to improving efficiency of exploiting economic resources, thus, boosting sustainable economic growth.
- **Creating job opportunities**: innovation leads to developing new products and services, thus, creating new job opportunities in all economic sectors.
- **Improving the quality of life**: through innovating new and sophisticated products that contribute to raising the standard of living and welfare of society.
- **Solving problems**: innovation contributes to finding innovative solutions for the existing challenges in different sectors, particularly economic, environmental and social challenges.

2.7. Concept of the Global Innovation Indicator

The global innovation indicator is intended to measure economic performance in the field of innovation, and it contributes to evaluating the progress achieved annually in the field of innovation. The innovation indicator involves 130 countries and there are seven global innovation indicators as follows:

- **Institutions indicator**: it includes political environment, organizational environment and business environment.
- **Human capital and research indicator**: it includes education, intermediate education, research and development.
- **Infrastructure indicator**: it includes information and communication technology, public infrastructure and energy.
- **Markets development indicator**: it includes credit, investment, trade and market size.
- **Business development indicator**: it includes knowledge business, innovation links and knowledge absorption.
- **Knowledge outputs indicator**: it includes creating knowledge, impact of knowledge and knowledge
- dissemination.
- **Creative outputs indicator**: it includes intangible assets, creative goods and services and online creativity.

3. Innovation Development in China

Since the 1970s, the Chinese government has paid attention modernization of science and technology, particularly in the sector of industry and agriculture which formed the basis of reform and openness. Then, China moved to implement the innovation-based economic development strategy in 2006, which required improving efficiency of the national innovation system, setting up the basic

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structure needed for innovation and implementing an array of procedures to reform the financial and banking system. While expanding the scope of market mechanisms and stimulating creativity at the micro level, China has not overlooked the macroeconomic levers required to achieve the strategic goals, so China took the initiative to set up high-tech zones, technology parks, clusters of creativity and funds to support creative projects. Science and production have also been integrated into the process of forming large companies, large industrial companies have become a key link in the Chinese economic system and China now ranks first worldwide in terms of number of patent applications submitted to the national patent agencies. (Babenko et al, 2020).

One of the most important companies that focus on research, development and innovation is Huawei

Technology in the electronic industries field, and which ranks third in the smart phones market after Apple and Samsung. Baidu, Ali Baba and Tencent are regarded among the most important companies which have set up platforms to provide services on mobile phones, contributing to developing digital economic systems as well as the " Super Apps" paid via mobile phones and which allow a person to be excluded from payment process, contributing to offering innovative services such as motorbikes sharing systems, automatic restaurants, automatic car parks, in addition to the Chinese innovations in the industrial production field, which depend on developing supply chains, such as drugs industry, communications and information technology as well as medical and industrial equipment (Babenko et al, 2020).

The turning point was in 2006 when China officially released the medium and long-term plan for science and technology development (2006-2020), a milestone in China's economic transformation. This strategy is intended to globally make China a flagship country in innovation field through developing its innovative economy. The essence of this strategy in particular is to boost the local innovation models which include the following three sides: introducing technology through digestion and absorption, integrating innovation and promoting original innovation. (Chen et al, 2018). Implementing the medium and long-term plan for science and technology development strives to ensure that China's prosperity will be shared in the future by all population through comprehensive development (Liu et al, 2017).

China's spending on research and development amounted $139.7 billion, representing 1.83% of Gross Domestic Product (GDP) in 2011, and increased to $456 billion, representing 2.55% of GDP in 2022 (NBS, 2023), indicating the huge increase in Chinese spending on research and development, as it increased by 226% during the period (2011-2022), which asserts the Chinese government's keenness to depend on research, development and innovation to drive the economic development process. The successful economic reforms formed the basis to move from the group of poor countries to the middle-income countries category, rather, China is striving to move to the economically developed high-income countries .Worth noting is that China has topped the list of leading countries in attracting foreign direct investment, and this is attributed to continuous workers flow into labor market, injecting huge investments in the infrastructure, increasing the industrial capacities, in addition to workers' low wages, meaning lower cost and higher volume of production, which contributes to transform small and medium-sized companies to large ones that enjoy a competitive advantage in global markets. Those companies have gained experience and knowledge in emerging markets, and witnessed gradual development and transformed from technology-imitating companies to creative and innovative ones (Li et al, 2020).

4. Innovation and Exports in China

Innovation is a key driver of exporting, particularly in emerging countries like China, which strives to boost its technological industry to maintain its competitiveness in the international market. In recent years, China enhanced its capacity to innovate in industries with dense capital and technology. Studies showed that local research and development efforts exerted to boost innovation have positive effects on exports. The Chinese government has set motivational policies such as the national medium-term and long-term plan for science and technology development (2006-2020), "internet strategy", "Chinese Road

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Map 2025", intended to build up China as an innovation-driven country by 2020s, although direct foreign investment is hesitant to bring sophisticated technology. China should depend on its own efforts to enhance technological advancement, while benefiting from foreign aids when needed, as capacity undoubtedly plays a vital role in benefiting from local and foreign innovations. Developing countries can increase benefits of importing technology if they select the appropriate technologies that are easy to be adopted and accommodated. China should set up its own technological innovation system through associating local innovation efforts with importing the technologies selected from industrialized countries (Rauf et al.,2023).

Building smart cities could enhance urban innovation through improving the standard of urban informatics, increasing governmental investment in science and technology and improving the industrial skeleton. Impact of smart cities on urban innovation varies upon city size, geographical location and standard of science and education. Innovation impact of building smart cities is more obvious in bigger cities, the cities located in eastern region and the cities with low standard of science and education, in particular (Ji et al., 2024).

China has become a serious competitor in the world of innovation, through increasing spending on research and development (as a measure of innovation inputs) and doubling patents in the domestic market (as a measure of innovation outputs). These achievements contradict the common belief that China's international competitiveness basically depends on labor low costs and high levels of investment in the physical capital. Innovation significantly impacts firm's exports, indicating that firms need to strategically indulge in innovation and benefit from the innovative outputs to improve exporting performance. Innovation offers means for Chinese firms to catch up and it is the key driver of exports success. Should firms wish to become innovation-led exporters, innovation becomes a must not a burden (Wu et al., 2021).

Implementing a comprehensive innovation strategy requires improving national innovation system efficiency, setting up the infrastructure needed for innovation and implementing a package of measures to reform the financial and banking system. The study found that national innovation system in China has become an important factor in economy, science and technology development, enabling China to become one of the major economic and scientific countries in the world. Recently, while expanding the scope of market mechanisms and stimulating innovation at the micro level, the Chinese leadership has not overlooked the macroeconomic levers required to achieve strategic goals. The country took the initiative to set up high-tech zones, technology parks, innovation clusters and funds to support innovative enterprises, as science and production have integrated in the major firms forming process which organizationally and economically combined strong production and scientific and technological potentials for a certain industry. Major industrial companies have become a key link in China's economic system. China is still ranking first worldwide in terms of number of patent applications filed with national patents agencies. Today, more applications are being submitted to PRC Patents Bureau comparing to patents organizations in both the US and Japan together (Babenko et al, 2020). Pilot governance in large industrial parks significantly boosts creative production through boosting cooperation between companies, universities and research centers. Moreover, pilot governance impact extends to neighboring cities, as pilot governance at the high-tech integrated industrial parks helps with understanding and explaining rise of innovation in China, in the context of transition from planned economy to market economy. Own interest's groups often hinder full or main reforms, as while the central government controls employees, local governments run bulk of the economy (Zheng & Li., 2020).

Direct financial incentives were associated with increasing patents and nominal publications and not with real innovation. Financial incentives such as tax waivers could be more effective in boosting innovation, as they are less likely to create distortions through selecting winning industries comparing to direct funding plans. Although the recent measures taken by the federal government are still insufficient, direct financial incentives might be more effective in boosting innovation. The decision made by the Chinese Science & Technology Society on combating fraudulence in the academic

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publications represents a positive step, but the academic corruption is largely a result of the state's visible and ubiquitous role in the research system, therefore, radical social and political reform is necessary in order for China to be a wide-ranging producer of pioneering innovations. The study is divided into the following sections: introduction, literatures review, methodology and research methods, results, discussion and deductions (Schmid & Wang, 2017).

5. Literature Review

A study conducted by (Aghion, et al., 2024) addressed the heterogeneous impact of market size on innovation: evidences from exports at the French company level proved that market size is the key driver of innovation and growth, as demand on the company's products increases its incentives to innovate thanks to the potential growing revenues. First, companies respond to increment of market size though increasing innovation, and this occurs three to five years after the trauma takes place. Second, studies have shown that this positive impact of market size on innovation is fully driven by French companies with above-average initial labor productivity within their sectors. This response is significantly skewed and dominated by companies with a relatively higher productivity within each sector.

A study conducted by (Pertichino, 2023) addressed the phenomenon of the sophisticated technological clusters in Israel as well as dynamics of globalization and innovation. The government played a vital role in developing the innovation ecosystem through two key stages: the first (1970-1990) focused on disseminating research and development in labor sector, and the second (since 1990) has been marked with developing the ecosystem through specific programs such as Yzoma and incubators. Israel's success is attributed to giving a national priority to innovation through the Research & Development Act of 1984, and implementing long- term strategies. The study presents a thorough analysis of super technological clusters, and sheds light on government programs such as Magnet and incubators. It also highlights the capacity of entrepreneurship, human capital and government assistance to stimulate economic progress. The lessons learnt from Israel's experience can be applied in developing technological clusters in other regions to enhance economic growth through innovation and technology.

A study conducted by (Bottega & Romero, 2021) addressed innovation, exporting performance and trade flexibility across various sectors. Results of the study asserted that technological competitiveness has a bigger impact on high-tech exports comparing to low-tech exports. In spite of significance of technological competitiveness, flexibility of income remains positive and important, and it is more important in high technology sector. Results of regression show that price competitiveness is more important in the low technology sector. The results also assert significance of transforming towards producing high-tech products to achieve a higher export growth.

A study conducted by (Gürler, 2021) addressed impact of spending on researchers, research and development, as innovation inputs, on granting patents and high-tech exports as innovation outputs in the Organization of Economic Cooperation and Development (OECD) and emerging countries particularly the BRICS group. Results of the study concluded that high-tech exports are positively and strongly associated with patents, direct foreign investment and expenses of research and development. The OECD member states enjoy a higher positive correlation between super technology exports and patents comparing to emerging countries which enjoy a higher positive correlation between super technology exports and research and development expenses comparing to OECD member states. Patents are positively and strongly associated with super technology exports, research and development expenses, number of researchers and foreign direct investment. As globalization of countries is growing through foreign direct investment, increment of research and development leads to increment of patents and high-tech exports in international markets. Capital shortage is recompensed in emerging markets through direct foreign investment, as research and development expenses along with researchers constitute key inputs of innovative production, finally resulting in increasing super technology exports in international markets.

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A study conducted by (Sharma et al.,2021) addressed foreign competition and domestic innovation: evidences form American patents. The study concluded that over long term, exports diversification, technological innovation and capital formation contributed to expanding the scope of renewable energy consumption in BRICS group countries, as expansion (in the new products exports) led to reducing renewable energy consumption, while intensive expansion (traditional products exports) contributed to increasing the use of renewable energy solutions over long term. Growing technological innovation also helped enhance using clean energy solutions.

Alnafrah & Bogdanova, (2020) study addressed national innovation system and its role in increasing per capita of gross domestic production (evidences from Russia). The study showed that the institutional and political structure of national innovation system in Russia was the weakest link in the system, therefore, this structure should be strengthened through creating a good legal environment that is favorable for innovation activities, in addition to adopting a clear innovation strategy that involves a group of political and institutional frameworks which stimulate intensive-knowledge economic activities, contributing to developing innovation system in Russia, taking into account that national institutions play a systematic role in boosting innovation activities, as capacity to catch up with developed countries depends on constructing a strong innovative environment that effectively contributes to transforming to knowledge economy, finally resulting in improving Russian citizen's standard of living.

Chalioti, et al, (2020) Study which addressed innovation, patents and trade, an analysis at the company's level. The study concluded that as competition among exporters of non-innovative products intensifies, innovative companies enjoy the advantage of larger exports comparing to their non-innovative rivals, particularly in remote markets. This prediction has been strongly confirmed in our data, as innovative companies compete over market share against several non-innovative rivals. Worth noting is that patents grant a limited-time monopoly on the invention (usually 20 years from date of filing application) in return for full disclosure of the invention. Companies, therefore, seek to protect their innovations through patents when their shares exceed a specific limit.

Autor et al, (2020) study addressed foreign competition and domestic innovation: evidences from American patents, which provided a thorough analysis on the impact of growing competition on the Chinese imports on innovation activities in the United States, as growing competition by Chinese imports negatively influences innovation at companies and technology level. This influence is manifested in both outputs (patents) and inputs (research and development expenses). This negative influence also applies to producing patents in the private sector, but it does not include university or governmental patents, in line with competitive market's response. But, it leads, at the end, to setting weak companies aside and introducing new strong innovators. Results, however, show that response to innovation by American companies, that were more vulnerable to China's intensifying competition, was dramatically and clearly negative.

Durmaz & Yildiz, (2020) study addressed impact of innovation in the high-tech exports process: an analysis of BRICS countries. The study concluded that there is a significant positive relation between number of patents in countries and exporting high-tech products. Therefore, innovation is regarded an important factor in boosting BRICS high-tech exports, and that innovation activities should be paid great attention to create a high added value in those countries. Technological transformation, labor market with high stock of human capital and economic and political stability are the basis on which economic growth rates recently achieved by some countries are based on. This position required countries to increase their high-tech exports through focusing on research and development activities, intending to implement sustainable economic growth policy and fill the gap with developed countries.

5.10. Véganzonès-Varoudakis, & Plane, (2019) study which addressed innovation, exports, productivity and investment climate. The study is based on data at the level of Indian manufacturing companies, and indicated that recognizing the great role played by production systems and the priority given to general policy prompted us to investigate the key factors that stimulate innovation in Indian manufacturing companies, and extent of the impact of exporting density, research and development and

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capital density on innovation in both public companies and dense-capital companies. The study also revealed that training employees plays an important role in innovation activities in manufacturing sector in general. Indian manufacturing companies can focus more on investment in research and development, supporting or setting up more research and development incentives scheme which would significantly boost innovation activities. Indian companies should also focus not only on investment in research and development projects, but also on improving penetration into foreign market through boosting exports and imports.

Lopez-Bazo & Motellon, (2018) Study which addressed company's exports, innovation and regionalism in Spain. This paper showed that innovative companies are more inclined to export than similar un-innovative companies across all regions are, and that differences in export costs across Spanish regions might cause regional disparities in exports response to innovation. Innovation contributes in raising company's productivity in the future and getting more attractive products, making it easier for companies to encounter export additional costs, achieve higher levels of productivity and increase competitiveness, as while innovation benefits allow companies in some regions to cover export costs, it is not the same in other regions. The policies intended to stimulate innovation, and which are likely to be effective in boosting exports through increasing the number of exporting companies, will not have the same impact on exports across all Spanish regions. Therefore, the pre-assessment of innovation policies should involve the expected positive impact on exporting performance, taking into account that geography and some geographical locations might affect these policies according to the nature of each region.

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Table 1:
China's innovation indicators development during the period (2011-2022).

Index ____ Year	Institutions 1	Human capital & research 2	Infrastructure 3	Market development 4	Business development 5	Knowledge outputs 6	Creative outputs 7	Global innovation index In China	Global Innovation Index ranking in China	China's gross exports ($ trillion)*
2011	51.7	39.9	35.4	54.1	49.3	52.7	40.9	46.4	33	2.01
2012	39.1	31.4	44.3	47.8	50.9	61.8	34.4	45.4	34	2.18
2013	48.3	40.6	39.8	54.2	42.9	56.4	31.9	44.7	35	2.35
2014	48.3	43.4	45.0	50.5	41.8	59.0	35.7	46.6	29	2.46
2015	54.0	43.1	50.5	49.2	44.9	58.0	35.1	47.5	29	2.36
2016	55.2	48.1	52.0	56.6	53.8	53.3	42.7	50.6	25	2.20
2017	54.8	49.2	57.9	54.7	54.5	56.4	45.3	52.5	22	2.42
2018	59.4	47.8	56.8	55.6	56.0	56.5	45.4	53.9	17	2.66
2019	63.0	47.6	58.7	58.6	55.4	57.2	48.3	54.6	14	2.63
2020	64.6	49.4	52.1	58.5	52.9	55.1	47.0	55.7	14	2.73
2021	64.4	50.6	54.6	61.5	54.3	58.5	46.5	57.5	12	3.55
2022	64.8	53.1	57.5	56.0	55.9	56.8	49.3	56.6	11	3.71

Source: (WIPO) https://www.wipo.int/portal/en/index.html , (world bank) https://data.worldbank.org/ *

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Bayraktutan & Bidird, (2018) study which addressed innovation and high-tech exports in developed and developing countries. The study indicated that developing countries should implement strategic, stable and long-term science and technology policies instead of instable short-term approaches to improve technological development index. Given that trade conditions incline to vary between high-tech goods and low-tech goods, technological development performance has a basic importance, not only for foreign trade size, but also for national welfare gains. It is necessary to set policies and mechanism intended to allocate more funds from national income to research and development, and set educational regulations to train highly- qualified laborers (human capital) needed for research and development sector. Initiatives should be taken to protect intellectual property rights in order to encourage innovative activities and implement incentives policies to attract direct foreign investments which produce goods with dense technology. In addition, investments in the physical infrastructure, which is essential to support scientific and technological infrastructure, research and development institutions in any country, should be increased. Private sector share in research and development should be also increased through coordination and information exchange between public and private sectors.

6. The Relationship between Innovation Indicators and China's Total Exports

Global innovation indicators development: global innovation indicator value in China rose from 46.4 in 2011 (WIPO, 2011) to 56.6 in 2022 (WIPO, 2022), an increase of about 22% during the period (2011-2022). China also advanced in the global innovation index from the 29th rank in 2011 (WIPO, 2011) to 11th rank in 2022 (WIPO, 2022), advancing 18 ranks during the same period, which indicates the great attention paid by China to innovation indicators development and competing with the developed industrialized countries.

6.1. Institutions Index

Institutions index value in China rose from 51.7 in 2011 (WIPO, 2011) to 64.8 in 2022, the highest value of this index during the period (2011-2022) through which China ranked 42nd globally, indicating China's interest in developing institutions index which includes political environment index ranked 44th , regulatory environment ranked 101st , a very low rank, while business environment ranked 13th in 2022 (WIPO, 2011), a globally advanced rank shows China's keenness to develop business environment to attract more foreign investments, and thus drive innovation-based economic growth.

6.2. Human Capital & Research Index

Human Capital & Research Index value rose from 39.9 in 2011 (WIPO, 2011) to 53.1 in 2022, the highest value of this index, through which China ranked 20th globally, demonstrating the great attention China pays to develop human capital and research index, which includes education index ranked 7th, a very globally advanced rank, high education index ranked 92nd , a very low rank, in addition to research and development index ranked 70th (WIPO, 2022), a very globally low rank comparing to global innovation indicators.

6.3. Infrastructure Index

Infrastructure index value rose from 34.5 in 2011(WIPO, 2011) to 57.5 in 2022. The highest value of that index was 58.7 in 2019, as China proceeded from the 29th rank in 2018 to 26th rank in 2019, driven by the great improvement in the public infrastructure, as it ranked globally second in this sub-index (WIPO, 2019). China ranked globally 25th in the infrastructure index of 2022, indicating China's growing interest in developing infrastructure which includes information and communications technology ranked 20th, a globally good rank but it shows this index decline comparing to 2019, the public basic infrastructure ranked 13th globally (WIPO, 2022), at the forefront of global innovation indicators, in addition to the environmental sustainability ranked 54th , a globally average percentage.

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6.4. Market Development Index

Markets development index value rose form 54.1 in 2011 (WIPO, 2011) to 56.0 in 2022, while the highest value of that index was 61.5 in 2021, as China ranked first globally in trade, competition and market size index. The value of this index rose form the 19th rank in 2020 (WIPO, 2020) to the 16th rank in 2021 (WIPO, 2021). China ranked 12th globally, a very advanced index globally, showing China's great interest in market development, which includes credit ranked 25th globally, investment ranked 26th, trade and diversification of market size ranked third (WIPO, 2022), a very prestigious and advanced rank globally, which demonstrates China's success in market development, particularly in trade and market size diversification that has placed it among advanced industrialized countries.

6.5. Business Development Index

The value of capital and research index rose from 49.3 in 2011(WIPO, 2011) to 55.9 in 2022, the highest value of that index during the same period, through which China ranked 12th globally, showing the great attention China pays to develop business environment, which includes the workers in knowledge field ranked first worldwide, creative links ranked 30th globally, in addition to knowledge absorption ranked 8th globally (WIPO, 2022), indicating great interest in advanced technology absorption through attracting foreign direct investment, increasing creative links and promoting number of Chinese inventions and innovations.

6.6. Knowledge & Technology Outputs Index

Value of knowledge and technology outputs index rose from 52.7 in 2011 (WIPO, 2011) to 56.8 in 2022, while the highest value of that index was 58.5 in 2021, as China ranked fourth globally in knowledge creation sub-index and ranked fifth in knowledge impact sub-index (WIPO, 2021). China ranked sixth globally in knowledge and technology outputs index in 2022, which includes knowledge creation ranked fourth, knowledge impact ranked fourth too, in addition to knowledge dissemination ranked 19th (WIPO, 2022), which shows China's progress in some indicators and its decline in others. China, however is working on developing knowledge and technology outputs index through stimulating patents, protecting intellectual property and promoting exports of sophisticated technology as well as information and communications technology (WIPO, 2022).

6.7. Creative Outputs Index

Value of creative outputs index rose from 40.9 in 2011 (WIPO, 2011) to 49.3 in 2022, the highest value of that index along the research duration. China ranked 11th globally in this index which includes intangible assets ranked second globally, goods and creative services ranked 33rd, a globally good rank, in addition to online creativity ranked 77th, a globally low rank (WIPO, 2022), indicating China's great interest in trademarks and industrial designs, while online creativity index needs more attention to occupy an appropriate rank for China in the global innovation indicator.

7. Results and Discussion

7.1. The Impact of the Institutional Index on China's GDP.

Table 2:
Simple linear regression coefficient between institutions index and China's gross products.

Data	Correlation coefficient	Coefficient of determination R square	F value	Regression coefficient B	Significance level
Institutions	0.71	0.51	10.32	0.046	0.009

The table shows the relation between institutions index and China's gross exports. Results of statistical analysis showed that there is a direct statistically significant correlation between institutions

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index and China's gross exports, as correlation coefficient amounted (0.71) and the coefficient of determination amounted (0.51) respectively. The calculated value (F), which amounted (10.32), asserts existence of a direct correlation at significance level of (0.009) and it is a function at the significance level (0.05), which means that each increase in the institutions index leads to an increase in China's gross exports. That conforms to (Alnafrah & Bogdanova, 2020) study which pointed out that adopting a clear innovation strategy that involves a group of political and institutional frameworks stimulates economic activities with intensive knowledge, contributing to innovation system development, taking into account that national institutions play a systematic role in promoting innovation activities and increasing exports, and that capacity to catch up with developed countries depend on building a strong innovative environment that effectively contributes to transforming towards knowledge economy.

7.2. The Impact of Human Capital and Research Index on China's Total Exports.

Table 3:
Simple linear regression coefficient between human capital and research index and China's gross exports.

Data	Correlation coefficient	Coefficient of determination R square	F Value	Regression coefficient B	Significance level
Human Capital & Research	0.69	0.47	8.89	0.06	0.014

The table shows the relation between human capital and research index and China's gross exports. Results of statistical analysis showed that there is a direct statistically significant correlation between human capital and research index and China's gross exports, as correlation coefficient amounted (0.69) and the coefficient of determination amounted (0.47) respectively. The calculated value (F), which amounted (8.89), asserts existence of a direct correlation at significance level of (0.014) and it is a function at the significance level (0.05), which means that each increase in human capital and research index leads to an increase in China's gross exports. That conforms to (Durmaz, & Yıldız., 2020) study which pointed out that a strong positive relation exists between number of patents and exporting high-tech products. Therefore, innovation is regarded an important factor in promoting exports of high-tech products to BRICS countries, and innovation activities should receive a great attention to create a high added value in those countries. It also agrees with the study (Safarov et al., 2022) whose results confirm the existence of a positive relationship between the impact of ICT exports on the human capital index. It also conforms to (Galindo-Rueda & OECD, 2020) study which asserted that it is necessary to set policies and mechanisms intended to dedicate more funds from national income for research and development sector, and set educational regulations to train highly-qualified workers (human capital) needed for research and development sector. Initiative should be also taken to protect intellectual property rights to promote innovative activities and implement incentives policies to attract direct foreign investment in order to produce dense-technology exports.

7.3. The Impact of Infrastructure Index on China's Total Exports

Table 4:
simple linear regression coefficient between infrastructure index and China's gross exports.

Data	Correlation coefficient	Coefficient of Determination R square	F value	Regression coefficient B	Significance level
Infrastructure	0.49	0.24	3.11	0.035	0.11

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The table shows the relation between infrastructure index and China's gross exports. Results of statistical analysis showed that there is not a direct statistically significant correlation between infrastructure index and China's gross exports, as correlation coefficient amounted (0.49) and the coefficient of determination amounted (0.24) respectively. The calculated value (F), which amounted (3.11), asserts absence of a direct correlation at significance level of (0.11) and it is not a function at the significance level (0.05), which means that increase in infrastructure index does not affect the increase in China's gross exports. Which is inconsistent with the study (Babenko et al., 2020) which concluded that implementing a comprehensive innovation strategy requires improving the efficiency of the national innovation system, establishing the necessary infrastructure for innovation, and implementing a set of measures to reform the financial and banking system. China has taken the initiative to establish high-tech zones, technology parks, innovation clusters, and funds to support innovative projects, integrating science and production into the process of forming large companies, thus increasing the competitiveness of China's exports.

7.4. The Impact of the Market Development Index on China's Total Exports

Table 5:
Simple linear regression coefficient between market development index and China's gross exports.

Data	Correlation coefficient	Coefficient of determination R square	F value	Regression coefficient B	Significance level
Market development	0.57	0.32	4.69	0.074	0.056

The table shows the relation between market development index and China's gross exports. Results of statistical analysis showed that there is not a direct statistically significant correlation between market development index and China's gross exports, as correlation coefficient amounted (0.57) and the coefficient of determination amounted (0.32) respectively. The calculated value (F), which amounted (4.69), asserts absence of a direct correlation at significance level of (0.056) and it is not a function at the significance level (0.05), which means that increase in market development index does not affect the increase in China's gross exports. This is consistent with the study (Carpenter & Whitelaw, 2017) where markets play an important role in supporting economic growth in China. However, China is at a pivotal stage in its development as it attempts to transition from a state-controlled economy to a more market-oriented one. The study (Guo et, la., 2020) revealed that the Chinese economy still faces many challenges in its transition from a government-directed system to a market economy.

7.5. The Impact of the Business Environment Development Index on China's Total Exports

Table 6:
simple linear regression coefficient between business environment development index and China's gross exports.

Data	Correlation coefficient	Coefficient of determination R square	F value	Regression coefficient B	Significance level
Business environment development	0.45	0.20	2.51	0.045	0.14

The table shows the relation between business environment development index and China's gross exports. Results of statistical analysis showed that there is not a direct statistically significant correlation between business environment development index and China's gross exports, as correlation

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coefficient amounted (0.45) and the coefficient of determination amounted (0.20) respectively. The calculated value (F), which amounted (2.51), asserts absence of a direct correlation at significance level of (0.14) and it is not a function at the significance level (0.05), which means that increase in business environment development index does not affect the increase in China's gross exports. That conforms to (Reçica et al., 2019) study which indicates that business environment factors such as political instability and weak law sovereignty have a significant negative impact on firms exports, and that governments should facilitate introducing innovation into products at companies level through designing incentive-based mechanisms that could increase companies participation in introducing new products. It is likely that facilitating innovation gradual introduction or supporting companies to upgrade their products could be effective in the countries which have lagged behind, through business environment reforms.

7.6. The Impact of Knowledge Output Index on China's Total Exports

Table 7:
Simple linear regression coefficient between knowledge outputs index and China's gross exports.

Data	Correlation coefficient	Coefficient of determination R square	F value	Regression coefficient B	Significance level
Knowledge outputs	0.19	0.036	0.37	0.040	0.55

The table shows the relation between knowledge outputs index and China's gross exports. Results of statistical analysis showed that there is not a direct statistically significant correlation between business environment development index and China's gross exports, as correlation coefficient amounted (0.19) and the coefficient of determination amounted (0.036) respectively. The calculated value (F), which amounted (0.37), asserts absence of a direct correlation at significance level of (0.55) and it is not a function at the significance level (0.05), which means that increase in knowledge outputs index does not affect the increase in China's gross exports. Through revising table No.1, it gets clear that although China is ranking at forefront of knowledge outputs indicator, as it ranked 6th worldwide in the knowledge and technology outputs indicator in 2022, which includes knowledge creation ranking fourth globally, and knowledge impact ranking fourth globally too, yet, it ranked 19th globally in knowledge dissemination indicator (WIPO, 2022). This indicator grew by only 7.8% during the period (2011-2022), while exports grew by 84% during the same period, the matter that conforms to statistical analysis results that no correlation exists between knowledge outputs and exports.

7.7. The Impact of the Creative Production Index on China's Total Exports.

Table 8:
Simple linear regression coefficient between creative outputs index and China's gross exports.

Data	Correlation coefficient	Coefficient of determination R square	F value	Regression coefficient B	Significance level
Creative outputs	0.73	053	11.31	0.041	0.007

The table shows the relation between creative outputs index and China's gross exports. Results of statistical analysis showed that there is a direct statistically significant correlation between creative outputs index and China's gross exports, as correlation coefficient amounted (0.73) and the coefficient of determination amounted (0.53) respectively. The calculated value (F), which amounted (11.31), asserts existence of a direct correlation at significance level of (0.007) and it is a function at the significance

level (0.05), which means that each increase in creative outputs index leads to an increase in China's gross exports. that conforms to (Sukma et al., 2018) study which indicates that increasing exports of creative products from fashion and handcrafts sectors helped promote Indonesian economy through increasing added value, income and labor absorption, meaning that increasing exports from both sectors is likely to accommodate more labor as both sectors belong to creative industry subsectors which depend on intensive labor, thus, creative sectors firmly relate to export sectors.

7.8. The impact of China's Global Innovation Index on China's total exports.

Table 9:
Simple linear regression coefficient between global innovation index in China and China's gross exports.

Data	Correlation coefficient	Coefficient of determination R Square	F value	Regression coefficient B	Significance level
Relation between global innovation index in China and China's gross exports.	0.78	062	16.13	0.087	0.002

The table shows the relation between global innovation index in China and China's gross exports. Results of statistical analysis showed that a strong direct statistically significant correlation exists between global innovation index in China and China's gross exports, as correlation coefficient amounted (0.78) and the coefficient of determination amounted (0.62) respectively. The calculated value (F), which amounted (16.13), asserts existence of a direct correlation at significance level of (0.002) and it is a function as it is less than the significance level (0.05), which means that each increase global innovation index in China leads to an increase in China's gross exports. These results conform to (Wu et al., 2021) study which indicates that innovation significantly impacts firm's exports performance, thus, firms need to strategically indulge in innovation and benefit from creative outputs to improve export performance. Innovation offers a means for Chinese firms to catch up and it is also the key driver of exports success. The results also conform to (López-Bazo & Motellón, 2018) study which refers that innovation contributes to increasing firms productivity in the future and getting more attractive products, thus, making it easy for firms to face export additional costs, achieve higher productivity and increase competitiveness, as while innovation benefits allow firms to cover export costs in some regions, policies intended to stimulate innovation are likely to be effective in promoting exports through increasing number of exporting firms in Spain. The results also conform to (Durmaz, & Yıldız., 2020) study which indicates that a strong positive relation exists between number of patents in Japan and exporting high-tech products, therefore, innovation is considered a significant factor in promoting high-tech products to BRICS countries, and that innovation activities should receive great attention to create a high added value in those countries. The results also conform to (Bottega & Romero, 2021) study which asserts that technological competitiveness has a greater impact on high-tech exports comparing to low-tech exports. It also asserts importance of transformation towards producing high-tech products to achieve a higher export growth. The study (Huseynova & Huseynov, 2023) also confirms the existence of a direct relationship between a country's innovative development and its position in international trade.

8. Conclusions

This research addressed the impact of global innovation indicators on export development in China, and eight hypotheses were tested. The results of the statistical analysis can be divided into two groups. The first includes the existence of a statistically significant direct correlation between the enterprise index and China's total exports. China has adopted a clear innovation strategy based on stimulating knowledge-intensive economic activities, which has contributed to the development of the innovation system. National institutions have played a vital role in promoting innovation activities and increasing exports. There is also a statistically significant direct correlation between the human capital and

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research index and China's total exports, as the huge increase in the volume of spending on research and development, which increased by about 226% during the period (2011-2022), confirms the Chinese government's keenness to rely on research, development and innovation to develop exports and drive the economic development process. There is also a statistically significant direct correlation between the creative output index and China's total exports, as the Chinese government has worked to promote local innovation models such as introducing technology through digestion and absorption, integrating innovation, and encouraging original innovation. There is also a strong statistically significant direct correlation between China's global innovation index and China's total exports. It has established The Chinese government has established high-tech zones, technology parks, innovation clusters, and funds to support innovative projects. China has become the world's first in the number of patent applications submitted to national patent agencies. The steady increase in exports coincided with China's 22-rank advance in the Global Innovation Index during the research period. The second shows that there is no statistically significant relationship between the infrastructure index and China's total exports. Despite the Chinese government's interest in improving infrastructure, it still ranks modestly in the infrastructure index and the environmental sustainability index, indicating that it is not consistent with the development of Chinese exports. There is also no statistically significant correlation between the market development index and China's total exports. China still ranks modestly in both the credit index and the investment index, indicating that it is not consistent with the development of Chinese exports. There is also no statistically significant correlation between the business sophistication index and China's total exports. Although China ranks first in the world in the knowledge workers index, it ranks modestly in the innovation linkages index, indicating that it does not match the development of Chinese exports. There is also no statistically significant correlation between the knowledge and technology output index and China's total exports. China still ranks relatively modestly in the knowledge diffusion index, which does not match the development of Chinese exports. In the future, the role of government in developing innovation indicators in China can be studied.

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