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Fixed Effect Estimation of Patents and FDI: India and Its Economic Partners

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Economic globalization has facilitated business enterprises making use of trade agreements, FDI inflows and intellectual property related assets beyond national boundaries.The introduction of IPR related chapters in trade agreements especially the patent system is fostering innovation, and economic development in the country. India has signed CEPA (Comprehensive Economic Partnership Agreement) and CECA (Comprehensive Economic Cooperation Agreements) which has been instrumental in building integration of intellectual property rights compared to other bilateral trade agreements

This paper analyses the impact of FDI inflows on the number of patent applications filed in India by those countries which are part of CECA, CEPA and other trade treaties. A Year Fixed Effect methodology for a group of 11 countries is used to study the qualitative and quantitative estimation. The time period between 2005 and 2022 has been used in the estimation.The empirical findings support the hypothesis that countries under CECA and CEPA have significant positive results on investment inflows and filings of patent in India. Furthermore, India should design its trade policies like CECA/CEPA to help induce high quality FDI drive India towards creation of knowledge-based economy.

Keywords: IPR, Patents, FDI, CECA, CEPA, Knowledge Economy

FDI is a phenomenon recognized as an instrument for economic development, growth, innovation and it also supports process of globalization, global trade, and economic integration.Economists like Robert Solow, Paul Romer, Joseph Schumpeter, Joan Robinson and others in their work have clearly embarked upon the role of innovations/R&D in achieving optimum growth level in any country.[1] The FDI inflows encourages the parent country to proceed with the choice of either ownership mode which refers to establishment of a wholly-owned affiliate or a joint venture (partially-owned affiliate), or the choice on investment mode which is refers to a new venture (greenfield investment).[2] In globalized world, these choices of either firm specific and nation specific criteria affect the decisions for the investment and innovation.

A large amount of literature is available which highlights the role of country specific criteria in order to attract FDI inflows. However, a relatively small portion of literature available to highlight the role of intellectual property rights (IPRs) in such cases.[3] Developing countries have significantly reinforced their intellectual property (IP) laws in recent times in response to growing pressure from advanced countries, particularly after the establishment of World Trade Organization's (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) in 1995.[4] The adoption of the trade-related intellectual property rights accord, or TRIPs, is the most important development. WTO countries are required by TRIPS to establish and implement stringent, non-discriminatory minimum standards of intellectual property protection. IPR systems have since gone through a process of global strengthening and standardization. The question of whether stronger IPRs are appropriate for the economic progress of countries, regardless of their stage of economic development, is raised by the inclusion of IPR in international trade discussions (agreements) at the World Trade Organization level.[5] Asignificant transformation is occurring inside the global system of intellectual property rights (IPRs). Several emerging nations have made major efforts to safeguard their intellectual property rights. IPR issues are currently covered under a number of regional trade agreements.[6] Furthermore, a number of nations have tightened their intellectual property rights (IPR) laws as a result of signing trade agreements that contain IPR-related chapters and IP provisions known as TRIPS-Plus, or TRIPS+.[7] In principal, trade agreements are a trade policy, yet they are increasingly influencing the development of IPR systems and bolstering IP protection globally.[8]

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India has entered in several bilateral trade agreements and regional trade agreements over the time. These agreements, includes many aspects of trade from tariff on goods and services to economic cooperation in the fields of investment, intellectual property rights, services, and exchange. India has trade agreements with South Asian countries, ASEAN, Mexico, Thailand, Australia, UAE, and several other countries. India has signed the Comprehensive Economic Partnership Agreement (CEPA) and the Comprehensive Economic Cooperation Agreement (CECA) with a small number of countries. In 2005, Singapore became the first country to sign an agreement with India for Comprehensive Economic Cooperation. Article 11.2 of the India-Singapore CECA reflects the IPR statement: "*The forms of cooperation may include- joint consideration of the organization of seminars, symposia, training programs, and workshops in India and in Singapore; and development of programs, platforms, tools, and other infrastructure to promote the effective use and application of IPRs*."[9]

India signed CEPAs with South Korea in 2010 and Japan in 2011, respectively. Under the South Korea-India CEPA, Articles 5.9 and 12.5 of the agreement make the following IPR declarations: "promoting a strong and efficient regime of intellectual property rights in accordance with their laws and regulations & Cooperation in field of IPRs, enforcement of intellectual property rights consistent with the TRIPS Agreement."[10] Under the India-Japan CEPA IPR Statements is mentioned in following sections: Article 104 talks about the promotion of Public Awareness concerning protection of Intellectual Property, Article 105 highlights importance of Patents, Article 106 is related with trademarks and Article 107 deals with Geographical Indications (GIs) respectively.[11] India and Malaysia signed CECA in 2011. Under the Article 10.2 Section D, the agreement explicitly talks about adherence to intellectual property rights law and regulations.[12] In the recent years, India has signed a CEPA with the United Arab Emirates (UAE) in 2022 further extending its network. Under this Agreement, Chapter 11 Sub-section 11.1 to 11.34 deals with cooperation and enforcement in the field of intellectual property right.[13]

India has a strong, fair, dynamic intellectual property rights (IPR) Policy that complies with Trade Related Aspects of Intellectual Property Rights (TRIPS). India has a strong legal, regulatory, and judicial system in place to protect intellectual property rights (IPRs). It complies with its international responsibilities and makes use of the international regime's flexibility to fulfil its developmental needs. The Indian government has passed several laws and statutes to improve the effectiveness of their enforcement, including the Designs Act of 2000, the Patent Act of 1970, the Trade Marks Act of 1999, and the Copyright Act of 1957.[14]

Empirical studies and theoretical literature have produced mixed results regarding the relationship between intellectual property rights (IPR) and the inflow of FDI into host countries.[15] Intellectual Property Rights (IPRs) are very crucial for fostering technological advancement and widespread dissemination of technology. Advance countries have adjusted their IP rules and regulations according to the requirements. Studies suggest that the type of IPR ecosystem (patents, trademarks, Industrial designs, GIs) influences foreign direct investment decision.[16] The robust intellectual property rights regime influences the trade, knowledge transfer, and innovation for developing nations.The government of India adopted the National IPR policy in 2016 to stimulate creativity and innovation across industries and offer clear guidance on intellectual property rights.[17]

The above discussion shows that FDI, IPR (patents) and Trade Agreements promotes innovation and has certain degree of impacton economic growth. The research work attempts to study the relationship between FDI inflows from CECA (Singapore and Malaysia) and CEPA (Japan and South Korea) countriesand other 7 countries (United States of America, United Kingdom, China, France, Germany, Mauritius and United Arab Emirates) on the filings of patent applications in Indian office. The need for such type of trade agreements for India is important as it will boost innovation, R&D and further create a knowledge driven economy.

Literature Review

The foreign direct investment act as engine of host country’s economic development by enhancing income level, national output, transfer of technology, promotion of innovation and increases production network.[18] The potential benefits of foreign direct investment (FDI) besides these include improved technology, increased competition, increased domestic investment, economies of scale, access to foreign

markets, improved labour productivity and closing the gap in foreign exchange between host and foreigner countries.[19] Policymakers held that among all other factors, economic freedom, intellectual property rights protection, and high-quality institutions positively influences economic growth by attracting foreign direct investment.[20] Weak intellectual property rights deter foreign investors from making investments in technology-intensive industries and encourage them to lay less value on production. [21] Hence, theideal factor of development is the evolution of new innovations and inventive ideas, research and development, and their application in the manufacturing of goods and services as well as in the creation of knowledge. Therefore, it is crucial to promote and protect these inventions and creations in the form of intellectual property rights. This emphasizes the importance for the establishment of a strong and efficient intellectual property rights (IPR) framework that preserves the interests of society as a whole while promoting and incentivizing innovation and creativity.With stronger and broader IPR regimes, firms can avoid imitation of their original product which will encourage them to further innovate the products in the technology space. Conversely, weaker IPR regimes allow for closer substitutes to challenge the original innovation potentially discouraging international firms regarding the Foreign Direct Investment.[22]

Kanwar and Evenson highlight that the study between technological change and IPR protection using R&D investment as a proportion of Gross National Expenditure (GNE) to capture increases in knowledge. They used the Ginarte–Park index as an explanatory variable in a random effects model. The study revealed that stronger IPR protection increased the technological change in the country.[23] Robert Solow was the first to realize, that "knowledge," is a significant factor in economic growth. The basic neo-classical growth model, which Solow and Swan established together, has become the standard and foundation for contemporary theoretical and empirical research on economic growth.[24] The idea of endogenous growth model and traditional neoclassical's economic theories have highlighted technological development as one of the main causes of economic expansion. It is perceived that any kind of investment in R&D is vital for the creation of knowledge. The microeconomic data shows that there is evidence while studying the link between R&D and economic performance at industry level.

The theories have emphasised that any kind of technological advancement changes the production trajectory in the production possibility curve. Such kind of technologies benefits the economy through increase in income level and output level.The technological advancement is categorized into innovations, inventions, different types of creativity, patents, and product differentiations.The study by Solow in its growth theories has focused on finding the reasons behind innovation.[25] Therefore, in contemporary endogenous growth theory models, technical progress is seen as a causal factor that influences the development of new products (patents). These developments enable constant and dynamic growth, which in turn results in improvements that raise the competitiveness of production processes. Among other factors of corporate success, investing in patent filings can have an impact on value addition, competitiveness, business expansion, and employment creation. Schumpeter established the first link between competition, growth and innovation, arguing that large monopolistic enterprises are more motivated to innovate than small firms.[26] Maskus, in his studies explains that the different kind of innovation gives firms more market power to generate profits and reinvest in innovations and patenting. For example, the productivity gains of companies in United States derived its own investment fromits own R&D. Similarly, countries like Germany, Mexico, and few other high income countries are benefitting in economic growth by promoting filings of patent applications, strengthening of IPR system and allowing investment in R&D set up.[27] This illustrates the rationale for the various policy initiatives that nations are implementing to boost patent filings.

In the past few decades there have seen a rise in global proximity, particularly in the form of Trade Agreements and Foreign Direct Investment (FDI). This was shaped since the 1990s through a process of reduction of investment barriers and trade promotion, strengthened through signing of regional, bilateral and multilateral trade and investment agreements.[28] In 1994, the World Trade Organization (WTO) was established with the goal of regulating global trade and providing a framework for trade policy. This was accompanied by a number of agreements that required institutional reforms, including those pertaining to intellectual property rights (IPRs). The Trade Related Aspects of Intellectual Property Rights Agreement (TRIPS) was outcome of this establishment.

Following the signing of the TRIPS Agreement, nations have to adopt or modify their intellectual property (IP) related laws to meet a set of basic standards. Since then, there has been a global effort to strengthen and harmonize intellectual property rights (IPRs) systems. However, different countries may require different kinds of IPRs systems due to differences in development and capabilities.[29]

Indian economy in the last two decades has emerged as prominent economy. It has emerged as 3rd largest economy in the world in PPP (purchasing power parity) and the 5th largest in terms of the exchange rate.[30] India stood 5th in world ranking of total FDI inflows (2020-2021) as per the reports of World Bank 2021. With its growing industrial and scientific advancements, India manages a delicate balance between the IPR and private rights. The establishment of an intellectual property rights (IPR) ecosystem promotes research and innovation in industries, social sciences, technological spheres. With the government focusing on "*Make in India*" and "*Atmanirbhar Bharat*", the IPR regime's strengthening has become even more important. Furthermore, the Covid-19 epidemic has provided ample evidence of the creative potential of intellectual property rights (IPR), notably in the fields of medical and health as well as technology and digital industries that are vital for rebounding from the eventual economic downturn.

There is an alternative viewpoint that suggests that the majority of developing nations function as net importers of Intellectual Property (IP). It is argued that by adopting western practices and theories regarding IP may introduce restrictions and hinder the diffusion of knowledge and technology, unless a comprehensive approach is established for interpreting and enforcing Intellectual Property Rights.[31] India has a strong, equitable, dynamic IPR Policy that complies with Trade Related Aspects of Intellectual Property Rights (TRIPS). India meets its international obligations through its administrative, legislative and judicial framework, to protect IPRs and makes use of it to solve its developmental objectives. India has robust IP laws and a strong IP jurisprudence. The national priorities and underlying policy direction are reflected in the legislative framework; these have changed throughout time to take into account international commitments and development demands. A comprehensive National IPR Policy was adopted in May 2016, to stimulate creativity and innovation across sectors, and provide a framework regarding IPR issues.

As mission statement, policy stimulates a dynamic, vibrant and balanced intellectual property rights system in India to: "*foster creativity and innovation and thereby, promote entrepreneurship and enhance socioeconomic and cultural development, and focus on enhancing access to healthcare, food security and environmental protection, among other sectors of vital social, economic and technological importance*".[32] The National IPR Policy will safeguard the public interest while fostering a comprehensive and favourable environment to fully utilize intellectual property for India's socio-cultural and economic development. This kind of legislation will support the IP culture by assisting and empowering all inventors and creators to reach their full potential in producing, safeguarding, and using IPRs, all of which will promote economic growth, job opportunities, and wealth creation. The policy discusses about the laws in India that regulate various types of intellectual property rights (IPRs) include the Patents Act of 1970, the Trade Marks Act of 1999, the Designs Act of 2000, the Geographical Indications of Goods (Registration and Protection) Act of 1999, the Copyright Act of 1957, the Protection of Plant Varieties and Farmers' Rights Act of 2001, the Semiconductor Integrated Circuits Layout-Design Act of 2000, and the Biological Diversity Act of 2002.India and states have planned out various IPR strategies to attract domestic and foreign companies. India and its trading partners have elaborately discussed about improving IPR regime in India. India is one among those developing countries who had signed trade agreements like Comprehensive Economic Partnership Agreement, Comprehensive Economic Cooperative Agreement, Free Trade Agreements and others in which strengthening IPR is an important agenda. Scholars argue that firms are more likely to invest in countries with strong protection, since the smaller risk of imitation leads to a relatively larger net demand for protected products. This argument indicates towards a positive IPRs-FDI link.[33]

There is also a perspective that higher levels of IPR protection may cause MNCs to invest less in developing countries resulting in lower productivity of firms in those countries. Simultaneously if some developing countries have strong IPR regime, then also there is a possibility that companies might not invest

more due to low generation of profits. The net effect of different levels of IPR protection on FDI is generates ambiguous results.[34] Therelationship impact of FDI inflows on IPR varies depending upon the on economic condition of the country. The variation of outcome (i.e. impact of FDI on IPR) is seen in different capacity in developed countries, developing countries and least developed countries.The India in its trade agreements like CECA and CEPA has explicitly mentioned about the clauses related to IPR mostly patents, trademarks, industrial designs and others aspects. Countries like South Korea and Japan under CEPA Trade Agreement, Singapore and Malaysia under CECA Trade Agreement, have invested in manufacturing and service sectors of Indian economy. Countries like United States of America, Germany, China, France, and Mauritius have also invested in sectors like pharmaceutical, chemical, machinery, electrical equipment industries and electronics.

In 2021–2022, FDI inflows total 58,773 USD million and Rs 4,37,188 crores were made into India from all nations, according to the Department for Promotion of Industry and Internal Trade (DPIIT). Total foreign direct investment (FDI) inflows from all nations between April 2000 and March 2022 were 588,528 USD million and Rs 36,212 crores. The top 10 nations with the most investment for 2021–2022 are Germany, the United Arab Emirates, Cyprus, Mauritius, Singapore, the United States, Japan, the United Kingdom, and the Cayman Islands. With 26% of all FDI inflows, Mauritius received the largest investment; Singapore came in second with 23%; the United States of America came in third with 9%; the Netherlands came in fourth with 7%; and Japan came in fifth with 6% of all FDI investment. United Kingdom (5%), Cayman Islands (2%), Germany (2%), United Arab Emirates (2%), Cyprus (2%), and other countries (18%) made up the remaining top five.[35]As per the annual report of DIPP (2021), FDI inflows in India have increased by $1.60 billion over the previous fiscal year the Covid-19 pandemic. The foreign direct investment inflows for the fiscal year 2021-22 were at $83.57 billion. Since the fiscal year 2003–04, when the overall FDI inflows were barely $4.3 billion, the nation's FDI inflows have more than doubled in the year 2021-2022. The top ten industries that attracted the largest inflows of foreign direct investment (FDI) were the following: trading, automobiles, construction, construction development, chemicals, drugs and pharmaceuticals, metallurgical, computer software and hardware, telecommunication, and the service sector. About 16% of FDI inflows went into the services sector, with computer software and hardware coming in second with 14%.The trading sector received 6% of the total, the automobile sector received 6%, and the telecommunications sector came third with 7% of the total. Remaining other five sectors were construction development, construction (Infrastructure Activities), drugs, chemicals, pharmaceuticals, and metallurgical industries respectively.

These kinds of investment have propelled creativity and innovation Research & Development. Two things make this new innovation useful: first, it produces a new product with inherent values. Second, this innovation has multiplier effects for both the industry and the inventor when it is patented.[36] For the Indian economy to grow, the country's patent filings must be strengthened. A patent gives the owner of the patent the only authority to bar others for a set amount of time from creating, utilizing, importing, and selling the patented invention.According to a 2010 Organization for Economic Cooperation and Development (OECD) study titled "Policy Complements to the Strengthening of IPRs in Developing Countries," foreign direct investment (FDI) rises by 3.8% for every 1% increase in trademark protection, 2.8% for every 1% increase in patent protection, and 6.8% for every 1% increase in copyright protection.[37] Establishing an ideal environment for innovation and raising R&D spending as a proportion of GDP are prerequisites for transforming the Indian economy into a knowledge hub and R&D powerhouse. This research study is of first kind where the role of countries like Singapore, Japan, South Korea, Malaysia, United States, United Kingdom, China, Germany and others are being analysed while studying the relationship between FDI and filings of patent applications in India.

Data and Methodology

This research aims to investigate the effects of foreign direct investment (FDI) from eleven countries under Group-1 and Group-2 on filing of patent applications in India which has been presented through statistical abstract. Group 1 countries include the trading partners under CECA and CEPA trade agreements. Countries like Japan, South Korea, Singapore and Malaysia. Group 2 includes those countries which are not part of any partnership or

cooperation agreements. Countries like United States, United Kingdom, France, Germany, Mauritius, United Arab Emirates and China. The reason for selecting these countries is that they make top contribution in FDI inflows in India. China has been included in the analysis considering the trade imbalance and geo-political conflict in Asian continent. Further, data on foreign direct investment (FDI) inflows, the total number of patent applications filed, variables like GDP per capita, annual inflation growth rate, and Labor participation rate, have been extracted for quantitative analysis from a variety of sources, including the UNCTAD reports, World Investment Reports, database of World Intellectual Property Rights Organization, Reserve Bank of India annual reports, Ministry of Commerce and Industry reports, and other government reports. The time period of data related to filings of Industrial design applications in India is from 1994 to 2022. The dependent variable used in the econometric analysis is the total number of applications of patents filed by each country in Indian office. There are several independent variables that can affect the filings of patent applications. The major important variables which have the potential to decide the filing of patent applications are amount of Foreign Direct Investment represented as fdi_new; Gross Domestic product per capita of the country represented as gdp_1 reflects the economic performance and development of the country. Labour force participation rate shows the percentage of working age of the population. It is represented as lfpr_1 in the empirical study. Annual inflation growth rate is an important parameter to capture the purchasing power of the country. It is denoted as inflation_1. The problem of multicollinearity has been taken into consideration. The problem of auto correlation has also been addressed. Year Fixed Effect is a methodology is used to sweep away all those variations between individual countries and control all those variables, whether it is observed or not, as long as the variables remain constant within the larger category. In the analysis, CECA and CEPA have been signed in different years. In order to capture the effect of individual country this year fixed method is used. The data related to FDI inflows in India is between 1990 and 2022.

Statistical Description and Empirical Results

The significant legal tool for protecting intellectual property rights is a patent. The two most important aspects of patents from an economic standpoint are that (1) they involve new knowledge as it is expressed in an innovative product or method, and (2) they grant the inventor (limited) exclusive rights.To determine how IPR protection affects economic growth, scholars have examined the relationship between IPR regulations and economic factors. Braga and Fink discussed the relationship between FDI inflows and patent protection, finding that FDI inflow was significantly related with intellectual property rights (IPR).[38]

India experienced major structural transformation after 1991 economic reforms under which many sectors were opened up for foreign investment. Figure 1 discusses the foreign direct investment (FDI) inflows into India from 1992-93 to 2021-22.

These reforms aimed to liberalize India's economy and attract foreign investments. In 1992-93, India saw a modest FDI inflow of $315 million, followed by a slight increase to $586 million in the subsequent year. However, in 1994-95, FDI inflows more than doubled, reaching $1,314 million, signalling a significant surge in foreign investment. This upward trend continued for the next three years until 1997-98. The East Asian financial crisis of 1997 had a dampening effect on FDI inflows into India. Although

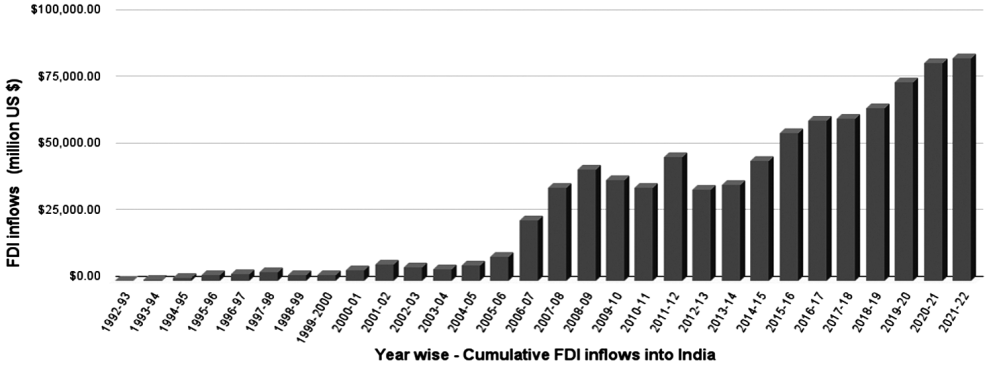

Fig. 1 — Cumulative FDI inflows in India
Source: Authors' calculation based on data collected from Reserve Bank of India (RBI)

India managed to mitigate the impacts of the crisis, there was a slight decline in FDI inflows during this period. Consequently, FDI decreased from $3,557 million in 1997-98 to $2,155 million in FY 1999-2000. The increase in FDI inflows for the fiscal years 2000-01 and 2001-02, with amounts reaching $4,029 million and $6,130 million USD respectively, marked a positive trend. However, in FY 2002-03, there was a decrease in inflows to $5,035 million USD, followed by a further decline to $4,322 million USD the following year. Several factors contributed to this decrease in FDI inflows into India. From FY 2004-05 to FY 2008-09, there was a notable increase in foreign direct investments (FDI) into India, with inflows rising from $6,051 million USD to $1,873 million USD by FY 2008-09. This period witnessed robust economic growth and increasing investor confidence in India's burgeoning market. However, in 2008 the global financial meltdown had a strong impact on the foreign investments which led to a downturn in FDI inflows for the next two years. As a result of the crisis, FDI fell to $34,847 million USD in FY 2010-11. Despite this setback, investment inflows rebounded to $46,556 million USD the following year. However, by FY 2012-13, FDI inflows declined once again to $34,298 million USD.

The fluctuations in FDI during this period were largely influenced by the global economic conditions, with the financial crisis especially the Euro crisis in 2012-13 exerting a temporary dampening effect on investor sentiment and capital flows. From fiscal year (FY) 2013-14 to FY 2021-22, foreign direct investments (FDI) into India experienced consistent growth, with inflows increasing from $36,046 million USD to $83,570 million USD. Several factors contributed to this stable growth in FDI inflows into India during this period. Government initiatives such as *Make in India*, *Startup India*, and *Product Linked Incentive (PLI) schemes* targeted at specific sectors such as electronics manufacturing, FMCG, pharmaceuticals, semiconductors, and telecom and networking products, created a favorable investment climate and encouraged FDI inflows. In 2014, out of 190 countries India stood at 142nd position when it comes to ease of doing business index, however, by 2019 its ranking had significantly improved to 63rd.[39] Overall, these concerted efforts by the government, coupled with favorable policies and a stable political environment, contributed to the sustained growth in FDI inflows into India, post 2014.

India has entered into multiple comprehensive agreements with various countries.Singapore was the first ever country to sign a Comprehensive Economic Cooperation Agreement (CECA) with India in 2005. Malaysia also signed CECA with India in 2011. Subsequently, during 2010-11, India inked CEPA agreements with two East Asian nations, namely South Korea (2010) and Japan (2011).The figure 2 shows the FDI inflows from the 4 countries (Singapore, Malaysia, Japan and Korea).There has been substantial increase in FDI inflows over the period. As per the agreement, India signed CECA with Singapore in 2005, and Malaysia in 2011. India signed CEPA with South Korea in 2009, and Japan in 2011 respectively. Since than there has been subsequent rise in FDI inflows. The FDI was attracted in the sectors like automobile, pharmaceuticals, electronics and communication, computer applications, software services and others. With the inflows the number of patent applications filed in India by these countries in different sectors has

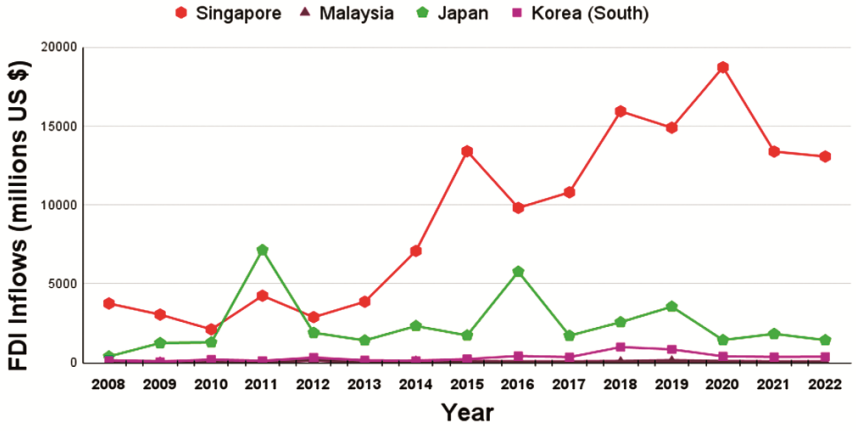

Fig. 2 — FDI Inflows from CECA and CEPA partners into India
Source: Author's calculation based on data from RBI, Ministry of Commerce, Govt of India

also increased. The following figures gives an outline of the patent applications filed by four countries in last 10 to 20 years respectively. Figure 2 represents Set-1 meaning those four countries which are part of CECA and CEPA.

Figure 3 illustrates the total number of PCT National Phase entries by four Asian countries: Japan, Republic of Korea, Singapore, and Malaysia in India during the period 2005 to 2022.

Japan clearly stands out with the highest number of patents filed through PCT National Phase entries. Though in 2005, the difference with other countries was minimal, this gap has widened over the years. In 2005, Japan filed 1060 patents, while Korea, Singapore, and Malaysia filed 458, 47, and 10 patents, respectively. In 2012, Japan filed the highest number of patents through PCT National Phase entries, with 4849 patents. In the same year, the patents filed by the other three countries were 637, 57, and 39, respectively. From 2013 to 2016, there was a slight decline in the number of patents filed through PCT National Phase entries by Japan in India. In 2013, the patents numbered 4756, decreasing to 3375 patents in 2016. From 2017 to 2019, there was a slight increase in the number of patents through PCT National Phase entries. In 2017, 3551 patents were filed, and in 2019, this number increased to 3815 patents. In 2022, the number of patents filed through PCT National Phase entries was 3708.

The Republic of Korea follows Japan as the second-highest patents filed under PCT National Phase entries. Until 2014, the number of patents filed was stable. However, from 2015, the number nearly doubled when it filed 1305 patents compared to 594 in 2014. After this year, the number of patents increased gradually with a few hiccups, and it filed its highest number of patents under PCT National Phase entries in 2022 when it filed 1832 patents in India. Singapore and Malaysia have lower patents filed under PCT National Phase entries compared to Japan and Korea. In 2005, Singapore filed 47 patents, which increased to 85 in the following year. However, there is no trend in the patents filed by Singapore under PCT National Phase entries. In 2022, Singapore filed its highest number of patents when it submitted 154 patents under PCT National Phase entries in India. Malaysia did not cross double-digit numbers throughout this period. The highest number of patents filed by Malaysia under PCT National Phase entries was in 2011 when it submitted 61 patents. In 2022, no patents were filed by Malaysia in India under PCT National Phase entries.

The other 7 countries which form the Set-2 include United States of America, United Kingdom, United Arab Emirates, China, France, Germany and Mauritius. These countries have invested in Indian economy in various sectors. The pattern of FDI inflows from these countries is highlighted from the below Fig. 4. These 7 countries are still out of CECA and CEPA treaties.These countrieshave separate trade treaty which involves trade facilitation, reductions in trade tariff and diversification of trade baskets. India has received foreign direct investment from these countries in the manufacturing and service sectors.Since 2008, the Mauritius has remained the top investing country in India. The figure shows the decline in FDI inflows between 2008 and 2010. There was dip in the FDI inflows between 2012 and 2013,

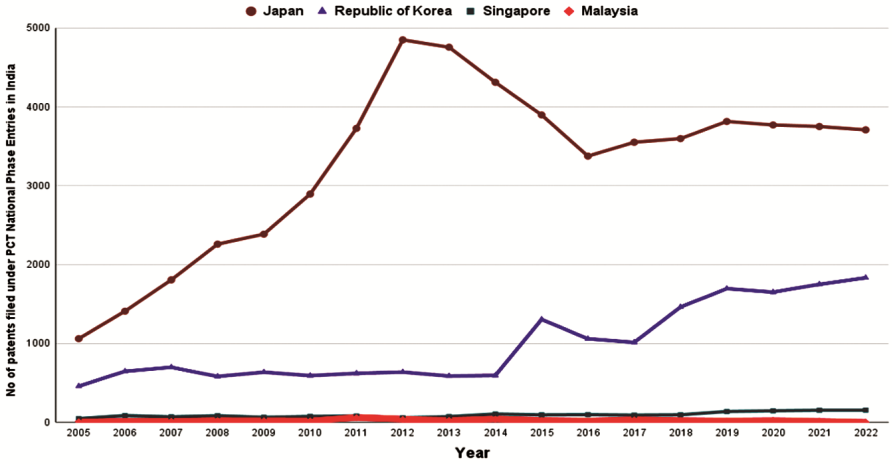

Fig. 3 — Number of patents filed under PCT National entries in India by CECA & CEPA partners

Source: Authors' calculation based on the data available from WIPO (World Intellectual Property Rights Organisation), annual reports from DPIIT (Department of Promotion of Industry and Internal Trade) under Ministry of Commerce and Industry, Govt. of India

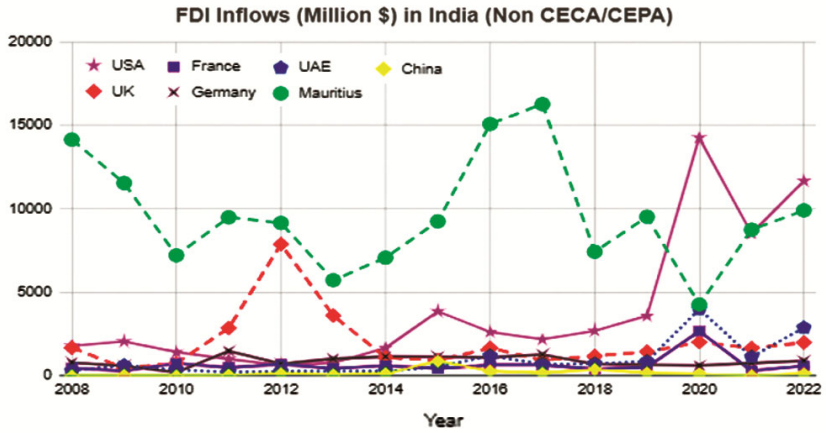

Fig. 4 — FDI inflows in India from Non CECA and Non CEPA partners
Source: Author's calculation based on data from RBI, Ministry of Commerce, Govt. of India

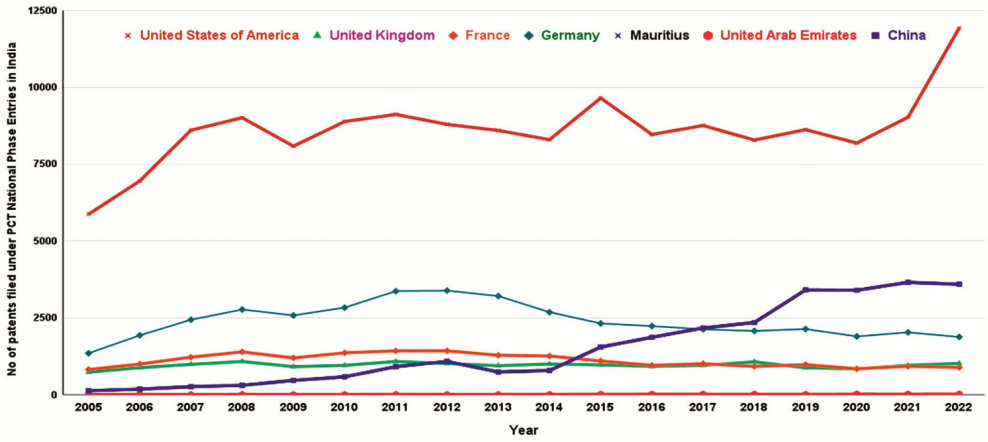

Fig. 5 — PCT national entries in India by Non CECA and Non CEPA countries
Source: Authors' calculation based on the data available from WIPO (World Intellectual Property Rights Organisation), annual reports from DPIIT (Department of Promotion of Industry and Internal Trade) under Ministry of Commerce and Industry, Govt. of India

after which the inflows increased till 2017. However there was sharp decline in 2018 and remained at lower side in 2020 due to Covid outbreak. After 2020 there was trend reversal and the inflows increased significantly. The FDI inflows from United Kingdom were at peak between 2010 and 2014; the inflows have declined after 2014 and did not rise significantly thereafter. There was slight increase in the FDI inflows from 2019 onwards till 2022. The FDI inflows from United States increased sharply after 2013 onwards. After 2018 there was sharp rise in FDI inflows till 2020, declined slightly after that. After 2021 there is an upward trend in investment inflows. The FDI inflows from France remained static with slight rise in 2019 onwards but declined after 2021; similarly Germany has remained close to France in terms of investment flows and remained the margin of 2000 million US dollar every year. The data on investment inflows from UAE shows that it remained comparatively higher than that of Germany and France respectively. The FDI inflows from UAE have increased after 2021. The FDI inflows from China have been very less. The data tells that the contribution is around 0.33 percent of total FDI inflows every year. The reason for selecting these countries is the ranking of them in FDI contribution in India. As per the DPITT statistics, based on total FDI inflows between 2000 and 2023, Mauritius ranks 1st, United States of America ranks 3rd, United Kingdom ranks 6th UAE ranks 11th, Germany is 9th, France at 11th and China is at rank 21st respectively.[40] The reason behind selecting China is due to geo-political situation and rising trade imbalance of India with China in last 1 decade.

Figure 5 illustrates the total number of patents filed under PCT National Phase entries annually to seven

major countries: The United States, The United Kingdom, France, Germany, Mauritius, The United Arab Emirates, and China during the period 2005 to 2022.

The United States of America holds the top position with the highest number of patents filed under PCT National Phase entries among these countries. In 2005, America filed 5874 patents under PCT National Phase entries, which gradually increased to 9013 patents filed under PCT National Phase entries by 2008. From 2009 to 2022, there were upward trend in patents filed by America innovators under PCT National Phase entries. In 2022, the patents filed in India by American were around 11900. This positive trend is due to various MoUs and agreements signed between USA and India. In 2005, India and US signed Science and Technology Cooperative Agreement.[41] The agreement was first of its kind in India, which mentioned about the collaboration between Indian and American scientists in government agencies, the private sector, and academia in areas like basic sciences, space, energy, nanotechnology, health, and information technology that will advance scientific understanding and benefit all of our peoples. It also establishes for the first time intellectual property right protocols and other provisions necessary to conduct active collaborative research.

The second country to follow the United States was Germany, which filed 1351 patents under PCT National Phase entries in 2005. Over the next three years, the number of patents filed increased to 1933, 2441, and 2774, respectively. From 2009 to 2012, we can observe, no of patents filed under PCT National phase entries increased from 2582 in the year 2009 to 3389 patents filed under PCT National phase entries in 2012. From 2013 to 2018, we can observe that the number of patents gradually decreased from 3212 in 2013 to 2077 patents filed under PCT National phase entries in 2018. Over the next four years, we can see ups and downs in the number of patents filed by Germany under PCT National Phase entries with 2139, 1899, 2030 and 1882 patents respectively.

China stands as the third-largest country, among to file patents under PCT National Phase entries in India during this period compared to other countries. In 2005, only 132 patents were filed by China, but the number of patents filed gradually increased until 2012, reaching 1086 patents filed under PCT National Phase entries. However, in 2013, the number of patents fell back to 742 filed under PCT National Phase entries. Nonetheless, we can observe a consistent increase in patents filed from 2013 to 2019, with China filing 3412 patents under PCT National Phase entries by 2019. From 2020 to 2022, there is some fluctuation, with 3401, 3658, and 3595 patents filed, respectively. China is followed by France. From 2005 to 2008, the number of patents filed under PCT National Phase entries increased from 822 to 1396. Highest patents filed under PCT National Phase entries by China in India was in 2021 when it filed 3658 patents which slightly decreased to 3595 patents in the following year (2022).

The United Kingdom is the next country with the most number of patents filed under PCT National Phase entries among the aforementioned countries. From 2005 to 2008, we observe a gradual increase in the number of patents filed under PCT National Phase entries from 735 to 1084 patents in 2008. During the years 2009 to 2022, there is a static trend in patents filed by the United Kingdom. Lowest number of patents under PCT National Phase entries by the United Kingdom was filed in 2020 with 841 patents. The highest patents were filed in 2008 and 2011 respectively with 1084 patents filed under PCT National Phase entries.

The United Arab Emirates and Mauritius are the two countries with the least number of patents filed under PCT National Phase entries compared to the aforementioned countries. From 2005 to 2014, the United Arab Emirates filed single-digit patents under PCT National Phase entries. However, from 2015 to 2022, they reached double digits. The highest number of patents filed under PCT National Phase entries by the United Arab Emirates was 23 in the year 2022, while the lowest was a single patent filed in 2005.[42] Mauritius, throughout the years from 2005 to 2022, only filed single-digit patents under PCT National Phase entries. Five times, in 2006, 2007, 2009, 2010, and 2012, no patents were filed under PCT National Phase entries by Mauritius. The highest number of patents, five patents, was filed twice during this period, once in 2008 and the other in 2022.

Results and Discussion

There are two results derived from Year Fixed Effect estimation methodology. Year fixed effect method is used to control individual country and get away from any kind of deviation between individual countries. The empirical results are divided in two parts

Set-1 and Set-2 respectively. The below Table 1 shows the quantitative results for countries under Set-1.

The quantitative result shows that the cumulative effect FDI inflows from Japan, Singapore, Malaysia and South Korea under Set-1 (CEPA/CECA) have positive and significant impact on the patent applications fillings under the PCT National phase entries in India across different sectors. The sectors like automobiles, pharmaceuticals, electronics equipment IT services and software services. These four countries have selected India as hot destination for foreign investment. The correlation between patent filings and GDP per capita is positively correlated and it highly significant as well. This shows that growing GDP per capita is an important factor in attracting filing of patent applications in India.

The other variables like labour participation rate and annual inflation rate is negatively correlated and are non-significant in nature. The reason for negative correlation with labour participation rate is because of low labour standard and low awareness in labour market. Annual inflation rate negative correlation shows that higher inflation erode the profitability of patented products. Low inflation rate is always conducive choice for foreign countries while investing. The graphical presentation of patent filing under PCT national phase entries shows that Singapore and Malaysia have less number of patent filings compared to Japan and South Korea. The low filings are due to less FDI inflows compared to other 2 countries.

In Table 1 the countries under CECA and CEPA have validated the clauses pertaining to IPR mentioned under the trade agreement. The agreements have mentioned special clauses on IPR protection and promotion. The positive and significant coefficient results is supportive of the assessment that CECA and CEPA treaties has been the driving force for filling of patent applications in India and creating knowledge hub driven Indian economy. The overall regression is a Good-Fit equation given the values of R-squared and Adjusted R-squared.

The result under Table 2, Set-2 shows that FDI inflows by the countries under this group (United States, Mauritius, United Kingdom, France, Germany, China and United Arab Emirates) havepositive correlation with the total patent filings but it is non-significant in nature. Similarly, labour participation is negatively correlated. The GDP per capitaand patent filings is also negatively correlated. The inflation rate had positive coefficient but it is non-significant in nature. This result indicates that countries outside CECA and CEPA treaties have not shown interest in filing patent applications in India. The primary reason for this outcome might be due to non-availability of IPR infrastructurefor these countries. However there is an exception in case of United States of America. USA has signed bilateral cooperation MoUs with India in 2006. The Memorandum of Understanding (MoU) emphasizes the need to collaborate in the areas of intellectual property rights through capacity building, human resource development, and public awareness initiatives, as well as to work together to support innovation, creativity, and technological advancement by offering a dynamic regime.The combined effect of these seven countries had non-significant impact of FDI inflows on patent applications filling in India.The main focus of this study is to examine the effect of FDI inflows within

Table 1 —Results for Set-1 - CECA and CEPA economic partners

```
Linear regression,                              F(   4,     14)   =     173.95
                                                Prob > F          =     0.0000
                                                R-squared         =     0.9871
                                                Adj R-squared     =     0.9678
                                                Root MSE          =     0.3700

------------------------------------------------------------------------------
    patent_1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdi_1 |   .2075721   .0547798     3.79   0.002      .090081    .3250631
      lfpr_1 |  -5.978833   4.110506    -1.45   0.168    -14.79499    2.837325
       gdp_1 |   .8039294   .1057749     7.60   0.000     .5770648    1.030794
infilation_1 |  -.0108116   .1144407    -0.09   0.926    -.2562624    .2346392
       _cons |   18.99627    18.1141     1.05   0.312     -19.8546    57.84714
-------------+----------------------------------------------------------------
        year |         F(17, 14) =      2.941   0.024           (18 categories)
```

Source: Author's result derived from econometric model based on year Fixed effect Estimation Methodology

Table 2 — Results for Set-2 –Non-CECA and Non-CEPA economic partners

```
Linear regression                                   F(  4,     90)   =      90.27
                                                    Prob > F         =     0.0000
                                                    R-squared        =     0.8135
                                                    Adj R-squared    =     0.7617
                                                    Root MSE         =     1.1072

------------------------------------------------------------------------------
    patent_1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdi_1 |   .0430777   .0892696     0.48   0.631     -.134272    .2204274
      lfpr_1 |  -3.492741   1.426083    -2.45   0.016    -6.325903   -.6595777
       gdp_1 |  -2.533981   .1818242   -13.94   0.000    -2.895207   -2.172756
infilation_1 |    .034425   .1949142     0.18   0.860    -.3528061    .421656
       _cons |   47.47953   6.028003     7.88   0.000     35.50385    59.45522
-------------+----------------------------------------------------------------
        year |         F(21, 90) =      2.493   0.002           (22 categories)
```

Source: Author's result derived from econometric model based on Year Fixed Effect Estimation Methodology

CECA and CEPA partners with Non CECA/Non-CEPA partners on filling of patent applications in India. This establishes that such type of partnership agreements exerts positive and significant effect on FDI inflows. This implies that the IPR play an important role in attracting FDI and advanced technology production processes.

This result also gives a glimpse that most of the countries have been investing in India to strengthen the manufacturing sector thus making India economy as dump-yard or offshore production house whereas the agreements like CECA and CEPA has been designed to make India a knowledge hub which may drive the economy not through manufacturing for others but making India ready for knowledge driven economy and also supports the schemes like Make in India. The increase in filing of patent applications shows the technological advancement and rising innovative ecosystem in India.

Conclusion

FDI inflows have significant influence on innovation and economic development. Economic reforms, trade agreements and government policies have strengthened the IPR regime in India. Building of patent filing system is important for the Indian economy. The progressive trade agreements like CEPA andCECA have shown positive influence in encouraging quality patent competitiveness in India. The research study is first in India which highlights the effectiveness of comprehensive trade agreements and its comparison with patent filings in by several countries in the Indian office. The results offer astrong positive linkage between foreign direct investment inflows in India and filings of patent application byCEPA and CECA economic partners. The result validates the theoretical proposition of Schumpeter's innovation theory and Paul Romer Endogenous growth theory that technological innovation and creativity (patents) drives towards higher growth and economic prosperity. The theoretical proposition of Maskus gets validated in case of India, that due to the inadequate IPR facilitation, some of the top investing countries show lesser interest towards filing of patent applications and FDI. This outcome may act as future guideline for policy makers while framingsuch type of economic partnership/comprehensive agreements. India can improve its transform its production base into a knowledge economy through investment in building an ecosystem where innovation and creativity are encouraged in private and public sectors, industry, R&D centers and academia, leading to generation of protectable patents that can be commercialized. The limitation of the study is the presence of multiple endogenous and exogenous parameters which were not analysed in the empirical study. The availability of data on patent filings those by the investing countries in industries, MSMEs, start-ups, R&D institutions, universities and colleges, and entrepreneurs, can provide more insights on the linkage between FDI and trade agreements. There is huge scope for further research on examining the sectoral industry wise data of patent applications and its correlation withsector wise FDI inflows. This is important for India to make transition from manufacturing competitive economy towards the knowledge competitive economy.

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