An Index of De facto Intellectual Property Rights Protection and its Impact on Economic Growth in India

Kartiki Verma*
Delhi School of Economics, University of Delhi

Abstract

This paper constructs a novel index of the de facto strength of intellectual property protection using Indian data from 1970 to 2020. This index reflects the actual strength of intellectual property rights provided in India during the sample period, and improves upon earlier measures which merely provide a measure of de jure protection. Our overall measure is derived from three sub-indices relating to patent rights, copyrights, and trademarks, using alternative aggregation schemes such as equal weights, principal components analysis, and factor analysis. Tests confirm that the rank ordering of data points is robust to these alternative aggregation methods. An autoregressive distributed lag specification is used to study the relationship between economic growth in India and the new de facto measure of intellectual property protection, for the period 1970 to 2020. The aggregate effects of IPR strengthening on economic growth do not capture the changes due to different economic regimes relevant to IPR protection. To capture these effects, we incorporate the regime-specific heterogeneities such as the level of innovation and the level of imitation threat (high vs. low) and analyze how de facto and de jure protection vary across these heterogeneities. In case of high innovation state, we find that a one unit increase in the de facto IPR strengthening initially decreases the economic growth by around 59% in the short run and then increases economic growth by about 51% in the long run, indicating a U-shaped relationship between IPR and growth reflecting the initial adjustment costs associated with strengthening IPR and the subsequent benefits as innovation ecosystems mature. On the other hand, in state of high imitation threat, a one unit strengthening of the de facto IPR protection increases economic growth by 9% in the short run and then decreases the economic growth in the long run by around 19%, indicating an inverse U-shaped relationship between IPR and growth suggests that stringent IPR enforcement in high-imitation economies may stifle growth once imitation-based industries face diminishing returns. A similar relationship is detected between de jure IPR protection and growth across both the regimes. We also find that these results are stronger for the de facto IPR protection as compared to the de jure IPR protection in both short and long runs across both the regimes indicating the contribution of the implementation aspect of IPRs. Furthermore, impulse response functions also confirm these relationships. However, as we further extend the time periods to check the sustainability of these results to more lag length, it is found that in developing country like India, the long run increase in economic growth encouraged by IPR strengthening would not be sustained even in the case of high innovation, if country's innovation absorptive capacity is inadequate due to improper institutional infrastructure and low levels of education. Moreover, if the economy is in high imitation state, then the long run decrease in the economic growth can remain persisted implying the importance of regime-specific effects of IPR strengthening for the policy making.

JEL Code: O34, C43, K11, O43
Keywords: Intellectual property rights, enforcement, de facto index, economic growth

* Department of Economics, University of Delhi, Delhi-110007; Email: <kartikiverma@econdse.org>.

1. Introduction

Intellectual property rights (IPRs) safeguard the innovation and creativity of individuals and businesses in diverse areas such as manufacturing technology, designs, literary and artistic works, and more (Braga and Carlos, 1996; WIPO, 1997). Protecting intellectual property (IP) rights is essential because significant benefits driven by R&D investments can be lost if competitors infringe on products or copy techniques. This applies to developing a business model, improving business scalability, or expanding the business. Without protection, knowledge functions as a 'public good' that is non-excludable and non-rivalrous in nature (Stiglitz, 1999; Maskus and Reichman, 2005). The former means once knowledge is generated, it can't be completely restricted from being sold or used by others. The latter means one person's use of intellectual property doesn't diminish its availability for others (Romer, 1990). This suggests that the additional cost for another person to use this knowledge is zero. However, if the price is set at zero, it would result in no production, causing underinvestment in research and development. This potential market failure indicates the necessity for legal protection of IP by the government to encourage investment in knowledge creation and thereby benefit society (Stiglitz, 1999).

In recent decades, the world has moved towards stronger protection of intellectual property, very importantly patents (Lerner, 2002). Figure 1[2] shows the trend of total patent applications[3] filed in the top six patent offices including China, USA, Korea, European patent office, Japan, and India from 1990 to 2021. The graph illustrates a significant rise in patent applications at major patent offices. Notably, China's patent applications surge dramatically by around 815% which is around 9 times from 2005 to 2021. It is a striking growth rate, peaking around 2020-2021 with 15,85,663 patent applications out of which 14,26,644 are filled by its residents, signaling China's strong focus on protecting innovations. After China, patent filing in the United States is the second highest with 5,91,473 patents filed in 2021. It shows a growth rate of around 244% from 1990 to 2015 after which it stabilizes. This league is followed by the Republic of Korea and European Patent Office (EPO) with gradual increase in patent filings from 1990 to 2021 with 2,37,998 and 1,88,778 patents filed in 2021, respectively. While Japan

[2] Figures and tables are given in the end.

[3] Total Patent Applications includes direct national application counts and applications through PCT (Paris Cooperation Treaty, a global treaty on patent law that came into force in 1970) counts. Under PCT applications, one patent application allows to obtain patent rights in more than 150 signatory nations of the Paris Cooperation Treaty. For more information, see, https://www.wipo.int/pct/en/faqs/faqs.html#:~:text=The%20PCT%20is%20an%20international,national%20or%20regional%20patent%20applications.

initially rises by around 19% from 1990 to 2000 before stabilizing. India displays gradual increase from 1990 to 2021 with 61,573 patent filed in 2021. This trend reflects the global recognition of IPR's critical role in safeguarding inventions and driving economic growth.

Figure 2 shows the trend of net receipts for the use of IP in terms of franchise and licence fees, and payments/receipts from the use of brand names (not including outright sales of IP) in selected countries including US, Germany, UK, France, Brazil, China, Korea, India, Japan, Australia, and Russia from 1990 to 2022. The United States generates the highest receipts in the world, peaking in 2021 with net receipts of $82.287 billion USD from the use of IP rights. An increase of $62.473 billion USD net receipts can be seen from 1990 to 2015 after which it almost stabilizes, suggesting its strong IP market. Germany shows an increment of $40.211 billion USD from 2005 to 2021 before which its payments exceeded its receipts. It is followed by the UK which shows an increase of $7.61 billion USD in IP receipts post-2000 till 2015 after which it shows stable and positive net receipts, suggesting consistent IP market activities. Japan, Brazil, India, Korea, Australia, and Russia show lower and more stable net receipts indicating smaller IP markets and their negative net receipts shows that these countries are net buyers of IP. On the contrary, China displays notable decline in the receipts of $35.139 billion USD post-1995 to 2021 which do not go parallel with its strikingly increasing trend of patent applications. This also suggests that quality of patents in terms of their saleability matters. Overall, the graph underscores the growing and varying importance of IP rights globally since globalization.

From the beginning of 1980s, trade in knowledge-intensive goods and services increased substantially. This caused pressure from developed countries for the strengthening of intellectual property rights protection, (Helpman, 1992; Maskus 1998; Braga et. al, 2000), leading to the TRIPS agreement of 1994. TRIPS is the most comprehensive multilateral trade agreement initiated for intellectual property protection (UNCTAD, 1996). The main objective of implementing the TRIPS agreement was to establish common minimum standards that would ensure equal treatment of IPR in all member countries (Bronckers, 1994). Enforcing a uniform IP protection across countries was a challenging task (Maskus, 1998). Developed countries got one year to implement the TRIPS standards i.e., by 1st January 1996. Developing nations and those who were converting to a market economy including India, Brazil, South Africa, Indonesia, etc., were given ten years (i.e., by 1st January 2005). Least-developed countries (LDCs) were allowed eleven years (i.e., by 1st January 2006) which was extended to 1st July 2013, in November 2005. At the WTO Ministerial Conference, Doha, 2001, the least-developed nations were granted an additional ten years to implement TRIPS patent and "undisclosed information" rules relating to pharmaceuticals (Maskus, 1998 and USPTO, n.d.[4]).

Empirical studies show how this tightening of the IPR regime across nations significantly influences various economic factors, such as domestic innovation (Kanwar and Evenson, 2003; Chen and Puttitanun, 2005; Kanwar and Sperlich, 2019), foreign direct investment (Javorcik, 1994; Maskus, 2000; Lai, 1998; Glass and Saggi, 2002; Kanwar and Sperlich, 2023), trade (Maskus and Penubarti, 1995; Rafiquzzaman, 2002; Ivus, 2010; Sheikh and Kanwar, 2022; Sheikh and Kanwar, 2024), licensing (Markusen, 1995; Yang and Maskus, 2001; Kanwar, 2012), and economic growth (Gould and Gruben, 1996; Gold et. al, 2019). These studies typically use quantitative measures to assess IP protection strength that emphasizes the need of a composite index which can capture key aspects of IP protection, including 'enforcement' to provide data-driven insights, and support evidence-based policymaking.

There exist a few indices which measure the strength of IP protection across countries including Rapp and Rozek (1990), Sherwood (1997), Ostergard (2000), Ginarte and Park (1997), and Papageorgiadis (2014), etc. These indices consist several issues related to measuring the strength of IP protection at various levels, which our study aims to address. First and foremost, previous studies lack to capture the aspect of implementation of IP laws in its true sense i.e., observing the actual courtroom behaviour for the provision of remedies in case of IP infringement. Rapp and Rozek (1990) index does not incorporate any 'enforcement component' which may overestimate the IP protection in some countries. Ostergard (2000) and Sherwood (1997)[5] support the idea of incorporating both the existence and implementation aspects of IPR laws. However, Ostergard (2000) used the reports from the US state department on economic and trade practices[6] to measure the enforcement of IPR laws which seems quite subjective[7]. Its enforcement component does not capture any prior judicial reviews, trial histories, or customs which does not consider how the actual laws have been applied and interpreted in real-world scenarios. Moreover, the scores for existence of laws and enforcement are multiplied to derive the IPR protection scores for each nation and each type of law which is problematic because if one component is 0 then, the entire score will be 0. The methodology

[4] See, https://www.uspto.gov/ip-policy/patent-policy/trade-related-aspects-ip-rights

[5] Ostergard (2000) states the weaknesses of Sherwood (1997) and came up with an upgraded index.

[6] See the protection of intellectual property rights, under the general framework, *The report on the US State Department on economic and trade practices*, 1989, available at https://www.govinfo.gov/content/pkg/CPRT-107JPRT77259/pdf/CPRT-107JPRT77259.pdf

[7] The report comments on whether a country is on the priority watch list of the US Special 301 Report, has bad foreign relations, or is found discriminating against foreign nationals on issues related to IP, etc.

of measuring IP strength is also not very clear and these indexes now have become obsolete[8]. Ginarte and Park (1997) were amongst the first to provide an objectively computed index of IPR. It incorporates the aspect of enforcement in their patent rights index but their measure is only *de jure* and not *de facto* which captures the presence or absence of legal remedies and lacks to capture the implementation aspect of patent laws in the case of patent infringement. Papageorgiadis (2014) also emphasises the need for capturing implementation in its index. However, its index is also subjective and does not capture the actual implementation directly[9]. Ignoring the implementation aspect or using *de jure* measures of IPR protection instead of *de facto* measures can generate measurement error[10] which can produce 'biased' and 'inconsistent' estimates. This difference matters because a country having a complete patent law regime on the books and 0 enforcement is equivalent to having no patent laws at all (Becker, 1968; Mookherjee and Png, 1992). Our index corrects this issue by calculating the scores according to the provisions in case of IP infringement by going through actual lawsuits, details of which will be discussed later.

Second, most of the studies such as Rapp and Rozek (1990) and Ginarte and Park (2000) focus only on patent rights to measure the strength of the entire IP regime as patents are the most important IPR instruments among all. However, they overlook other instruments such as copyrights and trademarks which are also important. Our index utilizes three forms of IPR laws[11] (patents, copyrights, and trademarks) to verify the reliability and stability of the IPR protection scores over time.

Third, to combine different components of the final index, aggregation strategies used by most of the previous studies is based on simple equal weighting only. On the other hand, this study uses three different weighting strategies including equal weights, principal component analysis and factor analysis to derive varied weights for a robust final index.

Finally, none of the existing indices provide variations of IP protection across industries. Our index is the first that shows industry wise variations for India to cater industry-specific needs for IP protection which will be discussed later. The prime focus of this study is to quantitatively measure the *de facto* IPR protection for India.

---

[8] Ostergard (2000) prepared a code sheet measuring the strength and execution of IPR laws. The contents of the code sheet are not very clear. Moreover, the author conducted the study only for three years i.e., 1988,1991,1994 which makes it obsolete and not helpful in capturing the post-TRIPS scenarios.

[9] Papageorgiadis (2014) uses the Corruption Perceptions Index (CPI) and Special 301 Report to capture the implementation aspect. Where, CPI is based on interviews and surveys, risks bias, while the Special 301 Report, despite assessing IP enforcement, is US-centric and lacks transparency.

[10] The measurement error (e_1) can be positive, negative, or zero.

[11] Ostergard (2000) also utilizes these three forms of IPR laws.

2. Intellectual Property Rights in India: A Brief Discussion

India along with 117 other countries[12] signed the GATT Agreement at Marrakesh in Morocco on 15 April 1994 for the establishment of the World Trade Organization (WTO). With this, India became obligated to implement TRIPS agreement as a member signatory. A Patent Bill, 1995 was introduced with the establishment of the 'mail-box provisions', under which pharmaceutical and agrochemical product patent applications must be accepted that were filed during the TRIPS transition period to review later for the grant. Moreover, Exclusive Marketing Rights (EMR)[13] must be granted to those patent applications under the mail-box which receives marketing approval before a decision on the patent grant for up to five years or until a decision on a product patent is granted or rejected, whichever occurs first (WTO, 1997). A Patent Bill, 1995 was introduced in March 1995 in the Lok Sabha (i.e., the lower house of Parliament) but defeated in the Rajya Sabha (i.e., the upper house of parliament). This leads to the Patent Ordinance, which also had a limited life under the constitution and lapsed later on. Due to this failure of not implementing the basic requirement of EMR and mail-box provision, USA filed a case against India (US vs India, DS50, n.d.)[14] in the WTO dispute settlement body in 1997 for not following TRIPS regulations properly. This resulted into the Patent Amendment Act of 1999 which provides EMR to the product patent applicants. This is followed by the Patent Amendment Act of 2002 which introduced some notable changes such as increase in the term of patentability to 20 years. India also committed to two major international IP agreements, Paris Convention for the Protection of Industrial Property (1998), and Patent Cooperation Treaty (PCT)[15] (1998) which allows for patent protection in many countries by filing one international patent application. With the enactment of the Patent Amendment Act 2005, India became fully compliant with TRIPS.

India encountered the majority of the effects of the tightening of IPR laws (mainly patent laws) on its manufacturing sector, particularly within the food, drug, and pharmaceutical industries due to the high dependency of these sectors on patent protection. The Indian

[12] Later in 1999, WTO had 135 countries as its members. Currently, WTO has 164 member countries. See, *World Trade Organization (WTO) Countries 2023*. (n.d.). Retrieved 25 October 2023, from https://worldpopulationreview.com/country-rankings/wto-countries

[13] Exclusive Marketing Rights (EMRs) are privileges granted to the applicants of product patents that allow the applicants to sell or distribute the substance mentioned in their patent applications.

[14] See, DS50 (n.d.) at https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds50_e.htm

[15] See Patent Amendment Act 2002, page 3, paragraph 6, available at the IP India website https://ipindia.gov.in/writereaddata/Portal/IPOAct/1_39_1_patent-amendment-act-2002.pdf

pharmaceutical sector was worth around $4.3 billion[16] in 2003-04. After the allowance of product patents[17], selling and manufacturing generic copies of drugs became illegal that reduced the revenue options for the Indian pharmaceutical industry and arose a negative sentiment in the Indian drug market (Grace, 2004). However, Indian firms changed their strategy by increasing the investment in R&D, focusing more on product innovation, and shifting their focus to exporting to more profitable and regulated markets like the US and Western Europe (Grace, 2004). Figure 3 illustrates the R&D intensity[18] and average R&D expenditure of the Indian pharmaceutical industry from 2004 to 2023. It can be seen that overall, the average R&D expenditure of pharma gradually and significantly raised from INR77.86 million in 2004 to around INR 600 million in 2023 which is almost 8 times. It also shows that the R&D intensity of pharma has almost doubled from 6.5% in 2005 to 12.6% in 2017, after which it stabilizes. Figure 4 shows the trends of total patent applications and grants in India from 1995 to 2021 (WIPO, 2023)[19]. It shows a gradual and remarkable rise in applications from 8,538 in 2000 (right after the provision of EMR for product patents) to 61,573 in 2021, which is almost 7 times more. Whereas, total patent grants started to increase somewhere around 2004 onwards and moved parallel to the total patent applications, with two peaks in 2008 and 2020 with 16,061 and 30,721 patent grants, respectively. This suggests that the external push of having strong IPR laws helped India to take the ladder of innovation which in turn helped firms to generate more profits and growth.

3. Related Literature: Intellectual Property Rights Indices

Majorly there are three types of literature in the indexing of IP rights strength. Each type shows an improvement over the previous type and this shift makes the importance of measuring the implementation aspect more unambiguous in the calculating measures of the strength of intellectual property protection. First type of literature includes indices such as Rapp and Rozek (1990) which are deficient on the count of even in a *de jure* sense. While, there are second types such as Ginarte and Park (1997) which do try to account for enforcement measures but are deficient in a *de facto* sense.

[16] The statistics is available on the Intercontinental Medical Statistics (IMS data) website, at https://www.iqvia.com/insights/the-iqvia-institute/available-iqvia-data/ims-health-market-research-and-reports-repository

[17] The first pharmaceutical product patent issued under India's new patents regime was granted in March 2006 to Hoffman-La Roche for its Hepatitis C therapy under the brand name Pegasys. See, Barnard, D. L. (2001).

[18] R&D intensity is calculated as the ratio of total R&D expenditure to the last year's total sales ratio.

[19] Estimates of patent filings in India is obtained from the WIPO database (July 2023) at https://www.wipo.int/ipstats/en/

There is a third type of literature that attempted to address the issue of incorporating the execution of IPR laws by employing some of the indirect methods. These studies include Becker (1968), Mookherjee and Png (1992), Kanwar (2012), Hu and Png (2013), etc. Hu and Png (2013) modified by taking the product of the Ginarte and Park index and Fraser's index[20]. They have taken this formula based on the argument of papers by Becker (1968), and Mookherjee and Png (1992). Kanwar (2012) on the other hand, used the area 2 subindex, developed by Gwartney, Lawson, and Norton (2008)[21] to modify the Ginarte and Park's index for their study. The author added area 2 subindex to GP index which is a better approach than Hu and Png (2013) because of its additive nature. Multiplication makes the entire score 0 even if only one of the components is 0. There exist some other important indices that measure the innovation capacities of countries such as the Global Competitiveness Index (also known as the World Economic Forum Index) and the Global Innovation Index which are also worth mentioning.

However, these studies still fall short of a direct approach that can capture the true essence of implementation. This involves the study of the 'court behavior' in case of intellectual property disputes evaluating whether the laws are actually being enforced in trials by examining the courts, the process of litigation, and other relevant factors. This is a huge research gap in the literature that needs to be catered and our study tries to capture it. This study is the first which attempts to develop a *de facto* index capturing the dimension of implementation of the standard TRIPS recommended IP rights in the specific context of India. The next section discusses the construction of the new IPR Implementation (IPRI) index in detail.

4. A New Implementation Index

This study presents a novel *de facto* IPR Implementation (IPRI) Index reflecting variations in the execution of intellectual property right laws in India from 1970 to 2020[22] on a quinquennial frequency. The final IPRI index is a weighted average[23] of the three distinct sub-indices namely

[20] The Frasers Institute's Economic Freedom of the world Index measures the degree of Economic freedom of countries.
[21] Gwartney, Lawson, and Norton (2008) measure various facets of a nation's enforcement environment such as, the execution of legal contracts, the autonomy of the judiciary, court impartiality, etc.,
[22] The reason for choosing this timeline is because 1970 is the year when the major act in intellectual property rights i.e., the Patent Act of 1970 was enacted. This timeline also includes the year of TRIPS inclusion. Moreover, the data on the legal search engines for IP infringement cases is available from 1970 onwards. Details related to legal search engines are mentioned in Chapter 2.
[23] Weighting strategy is discussed later in Chapter 2.

the Patent Implementation Index, Copyright Implementation Index, and Trademark Implementation Index representing the three most important instruments of intellectual property rights i.e., Patents, Copyrights, and Trademarks respectively.

To create the IPRI Index, a comprehensive database is compiled from IPR infringement lawsuits heard in Indian courts, including District and High Courts. The collected lawsuits are first categorized into patents, copyrights, and trademarks, and analyzed every five years from 1970 to 2020. This database encompasses various details for each collected lawsuit based on the legal provisions such as the grant and pace of preliminary injunction, burden of proof reversal, other reliefs granted, duration of the suit, origin of plaintiffs and defendants, jurisdiction and related industry of the infringed product or service, settlement issues, and final verdicts which is scored accordingly. The following are the details of the underlying components considered to construct the index along with their scoring strategies:

1) <u>Provision of preliminary injunction</u>: An injunction is a preventive remedy granted by the court to stop any wrongful action by the infringing party, preventing further injury to the plaintiff. This remedy is effective not only in intellectual property infringement cases but also in other scenarios, such as restraining a defendant from using a plaintiff's license without permission (A.P. State Electricity Board vs Mateti S.V.S. Ramachandra Rao, 2015) or from making misleading advertisements that slander a plaintiff's product (Havells India Ltd. vs Eveready Industries India Ltd., 2015). Article 50 of the TRIPS agreement empowers the Indian judicial system to grant preliminary injunctions in IPR infringement cases (Verma, 2004). This enforcement mechanism is significant from both traditional and efficiency viewpoints (Ginarte and Park, 1997; Brooks and Schwartz, 2005). Traditionally, it acts as a barrier to infringement, maintaining the status quo between parties during the lawsuit. From an efficiency perspective, it promotes efficient behavior from the defendant by serving as both a stick (punishment for infringement) and a carrot (reimbursement of compliance costs if the defendant prevails. The score for this component is 1 if a preliminary injunction is granted in an IP infringement lawsuit or 0 otherwise.
2) <u>The pace of delivering a preliminary injunction in infringement cases</u>: This component indicates the time (in months/years) taken in the grant of preliminary injunction during an infringement lawsuit. The scores for this component equal to 1 if the preliminary injunction relief is obtained within a month, 2/3 if the relief is obtained between 1 and 6 months, 1/3 if it takes between 6 months and a year, and 0 if it takes more than a

year[24]. This cut-off is chosen because it is observed that it approximately takes a period of 1 week to 1 year to grant a preliminary injunction and there are only a few cases in which the duration went beyond a year.

3) Conversion of a preliminary injunction: This component tracks rulings where a preliminary injunction is converted into the final adjudication of a lawsuit. As an interim relief, a preliminary injunction can be converted into a permanent injunction (with or without compensation), substituted with monetary compensation, or vacated at the end of the trial. The factor equals 0 if vacated, 1/3 if only compensation is ordered, 2/3 if converted into a permanent injunction without compensation, and 1 if converted into a permanent injunction with compensation.
4) Burden of proof reversal: This component indicates if the burden of proof is shifted to the defendant, simplifying the court procedure for the plaintiff and promoting litigation in process patent-related issues only. This component is considered only in the patent implementation index. It takes a value of 1 if the burden of proof is on the defendant to prove non-infringement, and 0 otherwise.
5) Anton pillar orders: Anton pillar order (or Anton Piller order) is a remedy which allows plaintiff to search the premises of the defendant and seize the evidence of infringement without prior notice to the defendant. These orders are relevant for preserving evidence of intellectual property infringement (Ng, 1997). The order was named after an English case *Anton Piller KG v Manufacturing Processes Limited (1975)*. The scores for this component are equal to 1 if court orders search and seizure for the discovery of evidence of infringement or 0 otherwise.
6) Cost entitlement: The relief of 'cost entitlement' is granted by the court to reimburse the cost of the suit (court fee, attorney's fee, and any local commissioner's fee) to the plaintiff, at the end of the suit. If the cost is entitled back, then the score equals to 1 or 0 otherwise; and
7) Duration of entire lawsuit: This category indicates the *total* length of the patent infringement trial in the Indian courts, right from the date of filing till the final disposal. A greater length, ceteris paribus, is taken to mean a delay in justice, which implies inefficient enforcement of patent infringement cases, whereas a shorter duration is equated with better enforcement. We realize that this supposition is somewhat

[24] The variable is negatively skewed, and the data is concentrated between 0.5 and 1, with very little to the left of 0, which means that the time taken to grant the preliminary injunction is beyond 1 year in very few cases.

simplistic, because a longer duration for some cases may have to do with those lawsuits being more complicated rather than having been inefficiently enforced. However, it is not possible to differentiate between more and less difficult cases at present, and therefore we ignore this issue on pragmatic grounds. We estimate the duration score as:

$$Duration\ Score = 1 - \frac{Number\ of\ years\ spent\ in\ resolving\ the\ dispute}{20} \quad (1)$$

Thus, its value ranges from 0 to 1, where smaller values indicate weaker enforcement of patent rights and larger value indicate the converse. Hence, an increase (decrease) in the number of years spent in resolving the patent infringement dispute decreases (increases) the score value, implying less (more) efficient enforcement. The denominator (20 years) represents the standard term of patent protection under the TRIPS agreement. If the dispute settlement is delayed beyond 20 years, that amounts to justice denied and 'weak' enforcement (i.e., any negative score is considered equivalent to 0 for simplicity in interpretation).

For convenience, we have grouped all the like factors together under the following four broad categories:

(i) Preliminary injunction, which is the unweighted sum of the realised scores for first three components i.e., provision of a preliminary injunction, pace of granting a preliminary injunction, and conversion of a preliminary injunction;

(ii) Burden of proof reversal, which consists the fourth factor i.e., burden of proof reversal;

(iii) Other entitlements, which is the unweighted sum of the realised scores of fifth and sixth components i.e., Anton Pillar and cost entitlement and;

(iv) Duration of the lawsuit, which is the seventh factor reflecting the length of a patent infringement lawsuit.

The first three categories are based on the remedies available for the protection of patent rights, copyrights and trademarks against any infringement according to the Indian Patent Act 1970 (2005), Copyright act (1956) and Trademark Act (1999) except second (i.e., burden of proof reversal) which is only applicable in patent infringement cases. The fourth category is indicative of the pace of the implementation of IP laws in the Indian Courtrooms.

We also wanted to add the 'cost of litigation' as a fifth category for our proposed index, because it is indicative of the monetary hurdles faced by IP owners during various stages of the trial. Thus, the higher the cost of litigation, the more difficult it is for IP owners to opt for litigation as a way of getting justice from the courts. This constitutes a hurdle in the implementation of the IP laws, and makes the enforcement mechanism relatively less relevant.

Thus, a high cost of litigation effectively implies weaker protection than is available on paper. A high cost of litigation pushes parties to opt for alternative dispute resolution remedies such as out-of-court settlement or mediation (WIPO, 2010)[25], which may yield sub-optimal redressal from the plaintiff's viewpoint. However, unfortunately due to lack of cost related information we could not consider it.

To compute the three sub-indices patent rights implementation index (PRI Index), copyright implementation index (CRI index) and trademark implementation index (TRI index) we follow the steps below. For patent rights, copyrights and trademark implementation indexes different scoring has been done with their respective infringement cases. We show steps for the construction of patent implementation index below and in the similar way other two indices are also created:

Step 1: We begin with the scores of the four underlying components, namely, preliminary injunction (PIS_i), burden of proof reversal ($BPRS_i$), duration of lawsuit (DL_i), and other entitlements (OI_i), for every infringement case i in our sample, where these cases are spread over the sample period 1970 to 2020. How these individual scores are computed has been explained above.

Step 2: Summing these scores, we obtain a single value for each patent infringement case, i.e. $X_i = PIS_i + BPRS_i + DL_i + OE_i$. Since the preliminary injunction score lies between 0 and 3, the burden of proof reversal score lies between 0 and 1, the duration of lawsuit score lies between 0 and 1, and the other entitlements score lies between 0 and 2, their sum X_i lies between 0 and 7 for each patent infringement case i. However, the sum for each of the copyright and trademark infringement cases lies between 0 to 6 because $BPRS_i$ is not applicable to copyright and trademark cases. Hence, their sum is equals to $PIS_i + DL_i + OE_i$.

Step 3: For each patent infringement case i, this sum (X_i) is normalised using the formula $X_i^N = \frac{X_i - Min(X_i)}{Max(X_i) - Min(X_i)}$, so that the normalised sum X_i^N (where superscript N indicates the normalised variable) lies between 0 and 1.

Step 4: Since the infringement cases i are spread over the sample period 1970 to 2020, evidently so is the normalised sum X_i^N. The arithmetic mean of X_i^N over all i in a given year t, yields the patent rights implementation index for year t, i.e., $PRII_t = \underset{i}{Mean}(X_i^N)$ for year t, where t = 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005, 2010, 2015, 2020.

[25] See WIPO Magazine (2010), available at untitled (wipo.int).

Using these data, we can then evaluate the strength of patent rights protection. For instance, if $0 \leq PRII_t \leq 0.33$, we may consider this to represent a relatively weak patent rights implementation regime, if $0.33 \leq PRII_t \leq 0.67$, we may consider this to indicate a moderate patent rights implementation regime, and if $0.67 \leq PRII_t \leq 1$, we may consider this to signal a relatively strong patent rights implementation regime.

In the similar way, copyright and trademark implementation indices are also created and represented. The next section discusses the data sources and sample characteristics based on the three sub-indices.

4. Data and Sample Characteristics

For information extraction purposes, we primarily used the 'Indian Kanoon' website, with some material retrieved from the 'Supreme Court Cases' (SCC)[26] website. These are reliable and widely used Indian law search engines, that contain the judgments for cases filed in the Indian courts. Although the judgments consisted of all the major information that we required, some of the important information such as the date of filing the case, the date of final disposal of the case, and some other details were missing. To collect these details, we had to trace back all the law cases to 'E-Courts'[27] which is an Indian government website that contains information on all State High Courts and District Courts, along with the final judgments.

Our dataset comprises a total of 414 intellectual property infringement cases pertaining to patents, copyrights, and trademarks. Out of these 414 cases, 51 or 12.3% cases relate to patent, 97 or 23.4% cases relate to copyright and 266 or 64.3% cases relate to trademark infringement. Although, patent infringement cases are not large in numbers, these are the only available infringement cases that were fully disposed of before our cut-off date of September 2023. Moreover, many cases do not reach the court due to the preference of out-of-court settlement by the parties, because of the high litigation cost, all of which result in the small sample size of patent cases. Out of these available patent infringement cases, maximum number of cases pertain to the pharmaceutical industry, about 33%, followed by 16% cases from the chemical industry, and the remaining 51% cases belonging to several other industries. Table 1 shows the frequency distribution of patent, copyright, and trademark infringement cases categorized by industry. In this table, we have used the 3-digit level of classification of industries from the National Industrial Classification (NIC)[28], 2008 to form groups of small

[26] I used SCC for reading legal articles, Acts, and other for other terminology.
[27] See E-Courts website, available at https://services.ecourts.gov.in/ecourtindia_v6/
[28] See, details of NIC, 2008 at https://www.ncs.gov.in/Documents/NIC_Sector.pdf

industries such as toothpaste, ties, etc., mentioned in the extracted infringement cases. It shows that around 49% of copyright infringement cases, which is quite a high percentage, relate to creative and entertainment industry including artistic works, followed by around 19% cases from the publishing industry i.e., books, periodic journals and newspapers and 15% cases relate to television and broadcasting industry such as electronic media, TV shows, etc. It illustrates that 50% of trademark infringement cases pertain to pharmaceutical, food, chemical, consumer electronics, apparels, and beverages having maximum cases relate to the infringement of brand names of pharmaceutical industries. Rest of the 39 industries such as tobacco, footwear, jewellery, bags, etc., shown in the table relate to the remaining 50% of the infringement cases in trademark. This shows that overall, pharmaceutical, chemical and food industries are more prone of patent as well as trademark infringement in India and owners of IP pertaining to these industries are more vulnerable to implementation of IP laws in courts and seek strong protection of IPR.

It is interesting to note that in our sample, the maximum number of IPR infringement cases file in Delhi High Court which comprises about 76%, 58%, and 51% of patent, trademark and copyright infringement cases, respectively[29]. Based on the trend of preliminary injunction grants from 1970 to 2020 as shown in panel (b) of Table 2, it is likely to say that there is nearly 77% likelihood of getting a preliminary injunction in case of IP infringement in India which is quite good. On an average, this likelihood is maintained over time from 1975 to 2020. Panel (c) shows that on average, the pace of getting a preliminary injunction has increased over time such that the length of a preliminary injunction trial has been reduced from approximately 1 year to 1 month from 1975 to 2020.

We found that on average, foreign plaintiff firms are 12% more likely to get preliminary injunction than Indian plaintiff firms. The proportion of a foreign firm to get preliminary injunction is around 85% on average which shows that there is no discrimination against foreign firms in Indian courts when granting reliefs. The average duration for obtaining a preliminary injunction is within a month which is almost similar for both domestic and foreign firms, indicating no discrimination based on origin. It is important to know that any

[29] Delhi jurisdiction is crucial in IP infringement cases for two main reasons. First, the Delhi High Court is recognized as a premier commercial court in India, significantly contributing to patent and trademark jurisprudence (Lokur et al., 2022). Second, the establishment of the Intellectual Property Division (IPD) by the Delhi High Court focuses on efficiently resolving IP disputes, including patents, trademarks, and copyrights, with specialized expertise. To access this expertise, many companies relocate their registered offices to Delhi, falling under the court's jurisdiction (Halliburton, 2017).

discrimination in delaying or denying reliefs can harm India's reputation in resolving IP disputes globally.

It is found that on average about 23% of plaintiffs receive both a permanent injunction and compensation at the end of the final trial, around 38% got only permanent injunction while around 37% plaintiffs' preliminary injunction is vacated (almost same as the number of permanent injunctions). Reasons for such huge revocation include failure to prove infringement, lack of jurisdiction, and faux cases because of which plaintiffs often settle out of court to avoid delays and other issues.

It is found that on average, an IP infringement trial in India takes around 5 years 2 months to dispose of completely[30]. However, these results are overestimated for two main reasons. First, mediation: It is found that around 19% of IP infringement cases were compromised through the Centre of Mediation and Conciliation, avoiding high costs and delays. Notably, 41% of patent infringement cases used mediation, indicating its effectiveness as an Alternative Dispute Resolution (ADR) method. Second, non-appearance of defendants: In about 20% of cases, defendants stopped appearing, leading to early case disposal. Additionally, around 2% of cases were withdrawn by plaintiffs before the final verdict. Delays and corruption in the enforcement mechanism push plaintiffs towards ADR, which suggests distrust in the litigation process. However, promoting ADR mechanism such as mediation and arbitration can enhance judicial efficiency[31].

Additionally, we found that in 74% of IP infringement cases, courts granted Anton Pillar orders (i.e., search/seize/destroy order) when claimed by the plaintiff. Moreover, in 55% of cases courts entitle back the costs of proceedings, including lawyer and commissioner fees, which is nominal and do not represent the actual costs incurred by the plaintiff at all.

5. Patent Rights, Copyrights and Trademark Implementation Indices

Figure 5 graphs the Patent Rights Implementation Index over our sample period 1970 to 2020. Although the index depicts some fluctuation over time, we find that it lies in the 'moderate zone' ranging between 0.33 and 0.67 for the bulk of the sample period with mean value of 0.37, except for the years 1985 and 2010. The overall trend of the index, as emphasized by the dotted line in Figure 5, seems to be linear and increasing. This implies that over our sample period,

[30] Overall, on average, the score for the length of the full IP infringement trials in India is 0.74. By putting this in equation (1), i.e., $0.74 = 1\text{-}k/20$, we get 5.2, which is equivalent to 5 years and 2 months or 5 years approximately.

[31] Cost of arbitration needs to be moderated to make it more affordable.

the enforcement of patent rights in India has strengthened not just in a *de jure* sense, but in the *de facto* sense as well.

We estimated the linear growth rate of patent rights implementation per period over time as shown in Figure 6. It shows that there is no consistent growth pattern over time from 1970 to 1995 but after 1995, a consistent rate of improvement can be seen (although, negative till 2010) with positive growth rates in 2015 and 2020. This is because, before 1995, minimum standards did not exist in India due to which the estimated growth rates seem fluctuating. From 1995 to 2005, patent rights were in constant amendments to include new laws which causes to increase the growth of implementation of these laws later on 2005 onwards. In particular, after 2010 the execution of laws improved, and the PRI index increased approximately by 98% and 20% from 2010 to 2015 and from 2015 to 2020, respectively (Figure 5). The analysis of our case data reveals that this was because of grant of more relief in this period and result is not affected by sample size because a sufficient number of patent infringement cases are collected from 2010 onwards (See, Table 2). On an average, the data deviates around 0.16 units from the mean value. The minimum value is around 0.22 and maximum is 0.57, representing the maximum variation in the patent rights protection regime.

Figure 7 graphs the copyright implementation index. Overall, the index is increasing as estimated by the linear fitted dotted line shown in Figure 7, and majority of the data points lie in the moderate zone interval from 0.33 to 0.67 (except,1970 and 1985), indicating that the implementation of copyright laws in India is neither too weak nor too strong. The increasing fitted line indicates that the copyright laws are also strengthened overtime in the *de facto* sense. Several fluctuations can be observed in the data till the year 2010, which could be because of the introduction of amendments in the copyright laws till 2012. However, the index increased consistently from 2010 to 2020 with an overall growth rate of 12% indicating an improvement of implementation in the last decade. On an average, the index values around 0.42 with a standard deviation of around 0.12. The minimum and maximum values are around 0.2 and 0.57, respectively showing a shift in the implementation of laws from weak to moderate zone.

The graph shown in Figure 8 represents the trademark implementation index based on our sample from period 1975 to 2020. The overall trend of the index is also linear and increasing, estimated by the dotted line as shown in Figure 8, indicating the strengthening of trademark laws protection in the *de facto* sense. All the values of the index lie in the moderate zone interval from 0.33 to 0.67 and interestingly, values for year 2005 and 2015 seem very close to the upper end of this cut-off, approaching strong level of enforcement. It can be seen from the figure, that before 1995, the index values show decline in the implementation of trademark laws. However, the rate of this decline is non-increasing and the index caught pace after the year 1995 (may be because of the introduction of the TRIPS agreement). After 2005, the index seems fluctuating but not too much which might have occurred due to an important amendment in the trademark laws of 2010. The average value of the index is around 0.41 with a standard deviation of 0.17, approximately. The minimum index value is around 0.34 and the maximum value is around 0.65, representing the maximum variation in the trademark protection regime in entire period from 1975 to 2020.

6. The IPR Implementation Index

The IPR Implementation Index (IPRII) is a weighted sum of the Patent Rights Implementation Index (PRII), the Copyrights Implementation Index (CRII), and the Trademark Implementation index (TRII), i.e.,

$$IPRII_t = w_P PRII_t + w_C CRII_t + w_T TRII_t \quad (2)$$

where, w_P, $w_C, and\ w_T$ are the weights corresponding to the patent implementation index, copyright implementation index, and trademark implementation index, respectively. Since the range of each of the sub-indices lies between 0 and 1, the range of the IPR implementation index also lies between 0 and 1.

Weights corresponding to each of the three sub-indices are determined based on the three widely used schemes: (i) Equal weights, (ii) Principal Component Analysis and (iii) Factor Analysis. Let us discuss the weighting criteria under each scheme in detail.

6.1 Equal Weight

Equal weighting strategy is widely used and one of the simplest approaches to calculate the aggregate indices. Many indices such as Human Development Index (UNDP, 1990) are constructed using equal weights. Ginarte and Park (1997) also applied equal weights to each of their underlying categories to create patent right index (also known as GP Index). Applying equal weights is equivalent of taking simple average of all the underlying categories of the proposed index. Under this scheme, $w_P = w_C = w_T = 0.33$ and the IPR Implementation Index (IPRII) is:

$$IPRII_t = {(PRII_t + CII_t + TII_t)}/{3} \quad (3)$$

This approach is simple, effortless and assigns equal importance to each of the three patent, copyrights and trademark implementation sub-indices.

6.2 Weights Determination using Principal Component Analysis (PCA)

PCA is generally used to reduce the dimensions of a dataset and it indicates which variable is more important among a list of variables (Pearson, 1901). We have three variables of interest that are patent rights, copyrights and trademark implementation indices. First, we check whether the data are normally distributed or not. Using Skewness/Kurtosis and Shapiro-Wilk tests, we found that all the three variables are normally distributed (panel (a) of Table 3). Next, we standardize all the variables of interest to remove any sensitivity in PCA results due to different units of variables (Bolch and Huang, 1974; Krishnan, 2010). Since, our indices are unitless and already normalized between 0 to 1, it is not as such required to standardizing the sub-indices in our case. However, for robustness, we have estimated principal components with or without standardization and both ways give the same results. We inspected correlation among all the three indices as shown in panel (b) of Table 3 which indicates that there exists sufficient correlation to perform PCA. Next, we performed Kaiser Meyer Olkin (KMO) test as a measure of adequacy of data for PCA analysis as shown in panel (c) of Table 3. The cut-off value is strictly greater than 0.6 indicating that the data is adequate for the principal component analysis (Krishnan, 2010; Li. et. al., 2020). Additionally, Barlett's test is also performed to check the sphericity of data. Result shows that the p-value is 0.006 (< 0.05) which is rejected at 5% significance level implying that there exists enough intercorrelation among variables to perform any factor analysis.

Panel (d) of Table 3 shows the results of PCA. We have used the correlation matrix over the covariance matrix for the PCA calculation. It is because using correlation matrix with original variables is equivalent of using covariance matrix with the standardized variables (Krishnan, 2010). Moreover, our sub-indices are normally distributed and normalised. Hence, standardizing the variables and using covariance matrix is not useful. Result shows that the maximum variation of approximately 77% is explained by the first principal component (PC1) followed by 17% by the second (PC2), and 6% by the third (PC3). A widely used eigenvalue rule which is also known as Kaiser's criteria states that only components having eigenvalues greater than or equals to 1 should be considered for the index creation (Guttman, 1954; Kaiser, 1960). In our case, PC1 has eigenvalue 2.303, followed by 0.517 for PC2 and 0.179 for PC3, so that PC1 is enough to summarize the three indices.

Using the PC1 scores, we compute: $PC_{1t}^{N} = \frac{PC_{1t} - Min(PC_{1t})}{Max(PC_{1t}) - Min(PC_{1t})}$, (where superscript N indicates the normalised variable). The resultant predicted PC1 scores vary over time and represents one of the versions of IPR implementation index using PCA.

Additionally, we have extracted the shares of PC1 loadings for each of three indices from panel (d) of Table 3 and applied the resultant shares of loadings as weights in equation (2) to get another version. The shares of loadings are calculated in the following way:

$$w_i = \frac{u_i}{\sum_{i=1}^{3} u_i} \tag{4}$$

Here, u_i is the loading of the variable i corresponding to PC1 and w_i is the resultant weight of the variable i. Using this, we found $w_1 = w_P = 31.5\%$, $w_2 = w_C = 36\%$ and $w_3 = w_T = 32.5\%$ as the weights corresponding to patents, copyrights and trademark indices. These two versions of PCA-driven IPR Implementation indexes will help to robust the final findings.

6.3 Determination of Weights using Factor Analysis

Factor analysis is almost similar to PCA in terms of dimensionality reduction by dropping the redundant variables. However, there exist some differences between these approaches. Factor analysis takes latent variables into account and assumes that the existence of common factors shows the variation in the data, while PCA assumes that the linear combination of all the underlying variables captures the maximum variations. Factor analysis assumes that common factors are uncorrelated with each other (Spearman, 1904). We have already shown that all the three variables are normally distributed, and that the sample is adequate for factor analysis and the variables are sufficiently intercorrelated to find the common factors deriving variation in the data.

Table 4 shows the results for the factor analysis. Panel (a) shows that the maximum variation of approximately 97% is explained by factor 1, followed by factor 2 with 3% variation. These variations explained by factor 1 and factor 2 have been calculated by dividing their eigenvalues by the sum of the positive eigenvalues. A widely used eigenvalue rule known as Kaiser's criterion, states that only components having eigenvalues more than 1 should be considered for the index creation (Guttman, 1954; Kaiser, 1960). In our case, factor 1 has eigenvalue of 1.918, followed by factor 2 and factor 3 with eigenvalues of 0.054 and -0.172, respectively. Thus, factor 1 is enough to represent the IPR implementation index. Uniqueness shown in Panel (b) is the non-shared variance or the variance which is unique to the associated variable only. According to the factor analysis, higher uniqueness of the variable implies lower relevance of the variable (Mueller, 1978). Panel (c) shows the orthogonal rotation of the pattern matrix which shows the clearer picture of correlations between the variables and factors.

Having estimated factor 1 scores, we normalise them to lie between 0 and 1 by using the formula: $F_{1t}^{N} = \frac{F_{1t} - Min(F_{1t})}{Max(F_{1t}) - Min(F_{1t})}$, (where superscript N indicates the normalised variable).

The resultant predicted factor1 scores vary over time and represents one of the versions of IPR implementation index using factor analysis. We have also extracted the shares of factor 1 loadings for each of the sub-indices from Panel (b) of Table 5 and applied the resultant shares of loadings as weights in equation (2) to compute an alternative estimate of the IPR implementation index. The shares of loadings are calculated as:

$$w_i = \frac{v_i}{\sum_{i=1}^{3} v_i} \tag{5}$$

where, v_i is the loading of variable i corresponding to factor1 and w_i is the resultant weight of variable i. Using this, we found $w_1 = w_P = 30\%$, $w_2 = w_c = 38\%$ and $w_3 = w_T = 32\%$ as the weights corresponding to the patents, copyrights and trademark sub-indices. We shall use these two alternative estimates of the IPR Implementation index to test the robustness of our results.

Panel (a) of Table 5 summarizes and shows the trends of all the 5 versions of the IPR implementation index from 1970 to 2020. The 5 versions that are considered in this study are: (i) Equal-weight index, which is derived by taking simple average of all the three sub-indices (patent rights, copyright and trademark implementation indices); (ii) Norm_PC1_Predicted_Index, which is derived by normalizing the predicted PC1 scores; (iii) PC1_Share_Load_Index, which is derived by summing the product of each sub-indices with their corresponding shares of loadings given by PC1; (iv) Norm_F1_Predicted_Index, which is derived by normalizing the predicted factor1 scores; and (v) F1_Share_Load_Index, which is derived by summing the product of each sub-indices with their corresponding shares of loadings given by factor1. All the versions of IPR implementation index represent the *de facto* measures of the strength of IPR in India not just the *de jure* measures. This practice is novel in its own. The trend shown by all the five versions of IPR Implementation Index (IPRII) is similar and the overall trend of IPRII is linear and increasing as shown by the dotted line in Figure 9. It can be observed from Table 5 and Figure 9 that equally weighted index and indices based on PC1 shares and factor1 shares are almost similar and in fact overlapping each other with mean values of 0.39, 0.4 and 0.4 (approximately) respectively. Moreover, their standard deviations also equate at 0.13. On the other hand, index represented through the normalized PC1 and factor1 scores are scaled up version of the previous three with the mean values of around 0.70 and 0.66. The standard deviation of normalized PC1 and factor1 scores are around 0.28 and 0.29 respectively, which are quite similar. Figure 9 shows that all the five versions of IPRI index are mostly fluctuating overtime from 1970 to 2010 with peaks in 1975, 1990 and 2005, 2015 and 2020. Peaks in years 1975, 1990 and 2005 are resultant of the variations in the implementation of IPR laws due to several important amendments or policy shifts in the patent, copyrights and trademark laws in India from 1970 to 2010. After 2010, the graphs seem increasing and stabilized thereafter. An increase of around 36% in the strength of IPR laws in terms of implementation can be seen from 2010 to 2020, through equally weighted index and indices based on PC1 shares and factor1 shares. The index based on the normalized factor1 scores also shows a similar increase of around 37% from 2010 to 2020. On the other hand, the normalized PC1 scores shows even more increase of around 43% in the same interval.

Based on the values of the equally-weighted version of IPR Implementation Index ($IPRI_t$), we can categorize the implementation of intellectual property rights laws in India in zones (i.e., low, moderate and high) in the following way,

$$\begin{cases} 0 \leq IPRI_t \leq 0.33, & Weak\ IPRs\ in\ year\ t \\ 0.33 < IPRI_t \leq 0.67, & Moderate\ IPRs\ in\ year\ t \\ 0.67 < IPRI_t \leq 1, & Strong\ IPRs\ in\ year\ t \end{cases}$$

Based on this, it can be concluded that overall, the implementation of intellectual property rights in India is shifted from weak to moderate level from 1970 to 2020 which not only reflects the transition and adoption of strong IPR laws on the legal code but also shows their execution in reality.

The visual representation shown in Figure 9 represents that there is no difference in the rank ordering among the indexes due to a change in the weights on the underlying components. Panel (b) of Table 5 shows the index sensitivity to different weights, which determines whether the different weighting schemes produce substantial changes in the rank ordering of the data points. The Spearman rank correlation test is used here for the sensitivity check. Spearman's rho or Spearman's correlation coefficient tests whether the rank of the values in one sample is differentiated from that of the other sample. The range of Spearman's correlation coefficient lies between -1 to 1, where -1 means the ranks in samples are inverted and 1 means the ranks in samples are the same[32]. The first column of panel (b) of Table 5 shows that there is a high correlation between the rank ordering of the equally weighted index and all the other weighted versions. The correlation coefficients of other versions also show high correlation among themselves as shown in other columns. In other words, this reflects that the rank order is not changing with the change in the weights associated with each of the sub-indices. So, it remains to the researcher to choose the variation of his choice or use all of them to perform robustness checks.

[32] Ginarte and Park (1997) have also used spearman rank correlation to check the weight sensitivity of their index components.

6.4 Exploring the Shifts from De Jure to De Facto

To explore the shifts from *de jure* methods to *de facto* method of intellectual property rights indices, we are comparing the Ginarte and Park (1997) which is based on de jure measures and the new IPRI index. For the default version of the latter, we use the equally weighted estimate of the index, and then repeat the process using the other estimates of the index for the robustness checks. The purpose of comparing the new de facto index with the GP index is to identify differences between actual IPR implementation and the legal provisions outlined by the GP index. Any noted differences will highlight the value of capturing the actual enforcement of IP laws over time. The comparison will be done only for India because our new index is available for India only, even though the GP index is available for numerous countries. There is a positive correlation of 61.2% between IPRI index and GP index states that there is a positive relationship between these two indices. The other versions of IPRI index also portray similar results with correlation of around 65% on average. However, the result just reflects a simple relationship and not causality. A paired two sample t-test for means shows that these two indexes are different at 1% significant level and not identical in terms of their ranges and values. The result is true for all the variants of IPRI index which confirms that the two indices are conceptually and statistically different as expected and validates the fact that the calculated IPRI index based on the actual execution of IP laws shows a different picture of the Indian IP regime than that of shown by the GP index which is based on the adoption of laws on the books.

A graphical distinction is also made as shown in Figure 10 below which compares IPRI index with GP index over a period of 1970 to 2020. For comparison, we have taken the equally weighted IPRI index and GP index. Since, IPRI index ranges from 0 to 1, we have normalized the GP index also to the range of 0 to 1. The comparison clearly shows that the GP index has underreported the scores for India for the period before 1999 and overreported the scores for the period after 2000. This suggests that using the IPRI index post-2000 shows weaker IP law enforcement in India than the GP index indicates, even after adopting TRIPS. Thus, the IPRI index offers a more balanced and unbiased view.

7. The Impact of the New De Facto IPR Measure on Economic Growth

7.1 Objective

The objective of this section is to analyze the impact of the changes in the de facto IPR protection on the economic growth in India over time, focusing on how short run and long run dynamics of the relationship changes. Theory behind the relationship of IPR protection and economic growth suggests that strengthening of IPR generates confidence in innovators to innovate, promotes R&D (Romer, 1990; Grossman & Helpman, 1991) and technology transfers to the host country (Maskus, 2000; Lee & Mansfield, 1996) which further promotes economic growth. However, the straightforward aggregate effect of IPR protection on economic growth subsumes the effect caused by several heterogeneities and makes it hard to observe their effects. There can be several regime-specific heterogeneities such as the state of innovation or the level of imitation threat (i.e., high vs low) which can influence the aggregate effect of IPR on economic growth. It is expected that in high innovation regime, an increase in IPR protection leads to more positive economic growth as compared to the low innovation state (Park & Ginarte, 1997; Kanwar & Evenson, 2003). Similarly, in the case of high threat of imitation, strengthening of IPR protection may lead to negative economic growth causing reduction in prevalent infringing activities (Falvey, Foster, & Greenaway, 2006). Capturing the effect of these heterogeneities matters more in the developing economies like India because of their complex structure where high levels of innovation and imitation could co-exist simultaneously (Branstetter, Fisman, & Foley, 2006). Moreover, it is obvious that whatever state dominates, the effect of IPR on economic growth in that particular state will also dominate, which makes it important to evaluate the differentiated effects in these two states and to know whether the captured effect sustains over time or not. In this study, we have explored the impact of two such heterogeneities, one based on the state of high vs low innovation and other based on high vs low imitation threat. We expect that the effect of the strengthening of IPR protection on the economic growth can be differentiated across different level of innovation and different levels of imitation threat in the country. We further expect that the de facto IPR protection also matters and can have a different impact as the de jure protection in such heterogeneities.

7.2 Model Specifications and Estimation Results

This study uses an Autoregressive Distributed Lag (ARDL) Model specification to estimate the impact of the new de facto IPR protection on the economic growth in India. ARDL models exhibit inherent robustness to misspecification in the integration orders of relevant variables when dealing with cointegration. It provides a robust solution without requiring additional unit root testing, making it more efficient than traditional cointegration methods (Pesaran et. al., 2001; Nkoro and Uko, 2016). With ARDL, we can directly estimate models without concerning whether the variables are integrated of order 0 (I (0)), 1 (I (1)) or mix of both I (0) and I (1). However, any variable must not hold the integration order of 2 and above, or the method does not work. Moreover, ARDL model also works efficiently will small samples (Nkoro and Uko, 2016; Sharma and Arora, 2023).

7.2.1 Aggregate Effect Model

To capture the aggregate or overall effect of the de facto IPR protection on economic growth, we have used the following relationship of variables:

$$Growth = f(IPR, R\&D, FDI, Trade, Savings, Secondary\ school\ enrollment, Economic\ freedom)$$

Where, the key dependent variable is growth rate measured by log of real per capita GDP constant at year 2015 in USD which represents economic growth on an annual basis from 1970 to 2020. Whereas, the key independent variable is IPR protection which is represented by IPRI index as an indicator of the *de facto* protection or actual implementation of intellectual property rights in India calculated over the period of 1970 to 2020. We have taken the equally weighted version of IPRI index and used other variations further to make our results robust. A one period lag of IPR variable is taken because growth rate is expected to have a slightly delayed response to the changes in IPR enforcement (Gold et. al., 2019).

All the other variables such as R&D, trade, FDI, savings, secondary school enrolment and economic freedom are taken as control variables to avoid any misspecification in the analysis. R&D represents domestic innovation and measured by R&D intensity which is R&D expenditure as a percentage to GDP. Trade represents export and import flows to economy and measured by taking the sum of export and import flows as a share of GDP. Savings represents the potential domestic investment capacity and measured by gross domestic savings as a percentage of GDP. FDI represents foreign capital inflows and measured by net inflows of FDI as a percentage of GDP. Secondary school enrolment represents potential human capital and measured by gross secondary school enrolment ratio to the population that corresponds to the same level of education. Lastly, economic freedom represents freedom or openness in terms of trade; business; legal systems including rule of laws, judicial efficiency, etc.; property rights and regulations and it is measured by economic freedom of world index. Variables such as per capita real GDP, R&D, trade FDI, savings and secondary school enrolment are sourced from World Development Indicator database published by World Bank[33] annually. Whereas, Economic freedom index is taken from the Economic freedom of the World index published by Fraser's institute[34]. Table 6 shows summary statistics, unit root test and correlation of all the

[33] https://databank.worldbank.org/source/world-development-indicators
[34] https://www.fraserinstitute.org/studies/economic-freedom

variables taken in the analysis. For unit root testing, Augmented Dickey Fuller (ADF) and Zivot Andrews[35] tests have been applied. It is found that all the variables except IPRI index are I (1) and IPRI index is I (0). Hence, there is a mix of I (0) and I (1) variables which can be well handled by ARDL model.

To conduct this analysis, we have linearly interpolated IPRI Index and GP Index on an annual basis. Moreover, other variables consisting missing observations also interpolated linearly. So, in total we have 51 observations vary on annual frequency. We selected the Akaike Information Criterion (AIC) lag selection criterion over Bayesian Information Criterion (BIC) because BIC imposes a stricter penalty on additional lags, which can risk underfitting the model. AIC provides a more balanced approach, allowing us to include appropriate lags for efficient analysis, especially given our limited data. To address these constraints, we restricted the maximum lag length to 3, ensuring the best possible model fit while maintaining robustness. The following is the general ARDL specification of the aggregate effect model estimated as exercise-I:

$$\Delta lnGDP\_pcreal_t = \vartheta_0 + \sum_{i=1}^{j} \emptyset_i \Delta\, lnGDP\_pcreal_{t-i} + \sum_{i=1}^{k} \alpha_i \Delta IPR_{t-i} + \sum_{i=1}^{l} \beta_i \Delta R\&D_{t-i} + \sum_{i=1}^{m} \gamma_i \Delta Trade_{t-i} + \sum_{i=1}^{n} \sigma_i \Delta GDS_{t-i} + \sum_{i=1}^{o} \rho_i \Delta FDI_{t-i} + \sum_{i=1}^{p} \mu_i \Delta SSE_{t-i} + \sum_{i=1}^{q} \tau_i \Delta EF_{t-i} + \delta_1 IPR_{t-1} + \delta_2 R\&D_{t-1} + \delta_3 Trade_{t-1} + \delta_4 GDS_{t-1} + \delta_5 FDI_{t-1} + \delta_6 SSE_{t-1} + \delta_7 EF_{t-1} + \omega EC_{t-1} + \epsilon_t \quad (6)$$

Here, ϑ_0 is the constant term. $\emptyset_i$, α_i, β_i, γ_i, σ_i, ρ_i, μ_i and τ_i are short run coefficients. j, k, l, m, n, o, p and q are optimal lag order selected by the model itself for each variable according to AIC. δ_i's are coefficients representing long-run relationships. EC_{t-1} is the term representing error correction or feedback effect predicted from the residuals of long-run equation and ω is the parameter of speed adjustment which is expected to be negative and less than one showing a condition of convergence towards long run equilibrium.

A bounds test or ARDL cointegration test[36] is performed to check for the existence of long-run relationship. It is found that there exists a long run cointegration among these variables. The results qualify the cutoffs designed for both large sample and small sample given by Pesaran and Shin (2001) and Narayan (2005) respectively. Narayan (2005) reformulated a set of F-statistic's critical values for small samples, ranging from observations 30 to 80 as 2.496 to 3.346, 2.962 to 3.910, and 4.068 to 5.250 at 90%, 95%, and 99%, respectively.

[35] Zivot Andrews test allows for one structural break which is useful for policy variables such as IPR indices.

[36] In this test, the joint significance of long-run coefficients are tested using F-statistics or Wald-test.

7.2.1.1 Estimation Results

Panel (i) of Table 7 shows the results for exercise-I, we have found that the de facto IPR protection i.e., the strengthening of IPR implementation positively and significantly affect economic growth in the short run as well as in the long run at 5% significance level. A one-unit improvement in the effective implementation of IPR laws significantly boosts the average growth rate by approximately 33% in the long run, ceteris paribus. This finding underscores the transformative role of IPR implementation in fostering sustained economic growth by encouraging innovation, investment, and technological advancement. The coefficient of the error correction term (EC_{t-1}= -0.637) indicates around 64% adjustment back to the long-run equilibrium in each period. The negative sign confirms cointegration, and deviations from equilibrium are corrected fairly quickly. In short run, de facto IPR protection (ΔIPR) also shows a positive and significant impact on GDP growth of around 22%, suggesting a smaller but immediate contribution of IPR protection to growth compared to the long run. The signs of other control variables also came as expected. Last year's growth of real per capita GDP positively and significantly affects the current year's growth at 1% level of significance reflecting a contemporaneous effect. Variables such as trade, FDI, and R&D do not show any contemporaneous relationship with growth of real per capita GDP which is as expected. It takes time for the growth to respond to the changes in these variables. FDI and trade positively and significantly affect growth in long run. On the other hand, school enrolment rate has a negative effect on the growth in the short run but positive in the long run due to the time lag between investment in education and its economic returns. Economic freedom positively and significantly affect growth in both short run and long run. On the other hand, savings has a negative effect on growth in the long run.

Panel (ii) of Table 7 shows results for de jure IPR protection using GP index in place of IPRI index. It is found that strengthening of IPR laws positively and significantly affect the economic growth rate in the long run at 1% significance level but do not have any significant contemporaneous effect in the short run. A one-unit increase in IPR protection in terms of stricter IPR laws leads to around 11.7% increase in the growth rate on an average, in the long run. The negative and significant coefficient of the error correction term (EC_{t-1}= -0.63) confirms convergence and indicates a 63% adjustment back to the long-run equilibrium in each period. The results in the two regressions differ because we have used two different indices but still it can be observed that the magnitude of the de facto coefficient (panel (i)) is larger as compared to the de jure (panel (ii)) indicating greater effect of improved implementation.

Although the de jure coefficient is more significant than the de facto one making the bit misleading to compare the aggregate effects.

Overall, we can say that on average, strengthening of both de facto and de jure IPR protection seems to have a positive and significant influence on the economic growth in India in the long run. Moreover, in the short run, only the de facto IPR protection shows positive and significant influence on the economic growth indicating immediate confidence in investors due to better implementation of laws. However, these results might be influenced by the regime level heterogeneities such as the state of innovation or the level of imitation threat in the Indian economy. Strengthening IPR protection without knowing these regime specific effects may lead to deterioration of economic growth. That's why it is important to know these effects and then do remedies in the tailored way to get positive results.

7.2.2 High Innovation State Model

To capture the regime specific results, we first created a threshold for the high vs. low innovation level in the economy. To represent domestic innovation, R&D intensity level is taken, and for threshold, we have taken the median value of the R&D intensity from 1970 to 2020 which is around 60%. So, for R&D intensity greater than or equals to the median R&D intensity (0.60), the economy is considered in the state of high innovation or if the intensity is less than median then the economy is in low innovation state. To capture this threshold variable in the ARDL framework, we have created a dummy variable that takes value 1 in case of high innovation state and 0 otherwise. To capture the effect of IPR strengthening on the economic growth in India in case of high innovation state, we have created an interaction term between the dummy variable and the IPR variable by multiplying them. Two different interaction terms, one with de facto index representing the effect of the de facto IPR strengthening in high innovation state and the other with de jure index representing the effect of the de jure IPR strengthening in high innovation state are created and used in two different analysis to compare the changes across de facto and de jure protection across these heterogeneities.

The following is the general ARDL model specification used to estimate the high innovation state model as exercise-II:

$$\Delta lnGDP\_pcreal_t = \vartheta_0 + \sum_{i=1}^{j} \emptyset_i \Delta\, lnGDP\_pcreal_{t-i} + \sum_{i=1}^{k} \alpha_i \Delta IPR_{t-i} + \sum_{i=1}^{l} \theta_i (\, R\&D_H\ X\ IPR)_{t-i} + \sum_{i=1}^{m} \gamma_i \Delta Trade_{t-i} + \sum_{i=1}^{n} \sigma_i \Delta GDS_{t-i} + \sum_{i=1}^{o} \rho_i \Delta FDI_{t-i} + \sum_{i=1}^{p} \mu_i \Delta SSE_{t-i} + \sum_{i=1}^{q} \tau_i \Delta EF_{t-i} + \delta_1 IPR_{t-1} + \delta_2 (R\&D_H\ X\ IPR)_{t-1} + \delta_3 Trade_{t-1} + \delta_4 GDS_{t-1} + \delta_5 FDI_{t-1} + \delta_6 SSE_{t-1} + \delta_7 EF_{t-1} + \omega EC_{t-1} + \epsilon_t \quad (7)$$

Here, θ_i and δ_2 are the coefficients of interest representing the short and long run impacts of IPR strengthening on the economic growth in India in case of high innovation level.

A bounds test confirm the presence of long run cointegration among the variables. The results qualify the cutoffs designed for both large sample and small sample given by Pesaran and Shin (2001) and Narayan (2005) respectively.

7.2.2.1 Estimation results

Panel (i) of Table 8 shows results for the interaction of de facto with high innovation state. It can be observed that the inclusion of interaction term vanishes the standalone impact of IPR strengthening in both long and short run indicating the importance of combined effect of IPR strengthening in high innovation regime. It is found that for observations where economy is in high innovation state, strengthening of IPR implementation causes an immediate decline in economic growth in the short run while having a positive and significant effect on economic growth in the long run. A one-unit tightening in the implementation of IPR laws significantly declines the average growth rate by approximately 59% in the short run[37] and positively and significantly impact average growth rate by around 51% in the long run, in high innovation regime, ceteris paribus. Reason behind this can be that in the short term, stricter IPR enforcement often introduces adjustment costs, such as increased compliance expenses that requires resources for enforcement, judicial systems, and compliance, which may impose additional costs on businesses and government budgets. It also generates disruptions to firms reliant on imitation or reverse engineering. This may limit knowledge diffusion and raise licensing costs, slowing economic activity. Over time, these short-term constraints overcome as R&D investments begin producing marketable innovations. The economy benefits from higher productivity, foreign investment, and technological advancements. The signs of other control variables also came as expected.

Panel (ii) of Table 8 shows results for the interaction of de jure with the high innovation state. It can be seen that in the similar stances as previous regression, the inclusion of the interaction term vanishes the standalone impact of the de jure protection in both short run and long run indicating the importance of the combined effect of IPR protection and high innovation. A similar U-shaped/V-shaped relationship between the strengthening of IPR laws and economic growth is observed overtime indicating a non-linear relationship. A one-unit tightening in the IPR laws significantly declines the average growth rate by approximately 15%

[37] It represents the total effect for all the lags showing significant coefficients. In panel (i) of Table 8, lags 2 and 3 show significant and negative coefficients of -0.279 and -0.310 in the short run, respectively, meaning a total decline of 58.9% in the short run.

in the short run[38] and positively and significantly impact average growth rate also by around 15% in the long run, in high innovation regime, ceteris paribus.

Overall, in high innovation state, the results seem similar for both de facto and de jure IPR protection in both the short run and long run. First a decline in the short run and then an increase in the long run economic growth has been detected. This confirms the U-shaped relationship between the IPR protection and economic growth overtime, in case the economy is in high innovation state. To further confirm this relationship and to check that whether it sustains for longer period of time or not, we need to look for impulse response functions which will be discussed later. Furthermore, it can also be observed that the effect of de facto IPR protection is stronger in terms of both magnitude and significance than the effect of de jure IPR protection on the economic growth in both short and long runs indicating the importance of relationship between implementation of IPR laws and economic growth.

7.2.3 High Imitation Threat Model

To capture the effect of imitation threat level, we first created a threshold for the high vs. low imitation threat level in the economy. To represent imitation level of Indian economy overtime, the count of IP infringement cases from our sample is taken from 1970 to 2020. The sample size of IP infringement cases in this study only includes cases which already got disposed of before September 2023 (our cut-off date for data collection). It is a direct but small representation of the reality of IP infringement in India[39], and unfortunately, we do not get hold of the year-wise information of all the IP infringement cases and issues occur outside litigation, that's why using our sample is the only feasible option. For threshold, we have taken the median value of the count of IP infringement cases from 1970 to 2020 which is around 15 trials. So, for number of IP infringement trials greater than or equals to its median count, the economy is considered in the state of high imitation or if it is less than median then the economy is in low imitation state. To capture this threshold variable in the ARDL framework, we have created a dummy variable that takes value 1 in case of high imitation threat level and 0 otherwise. To capture the effect of IPR strengthening on the economic growth in India in case of high level of imitation threat, we have created an interaction term between the dummy variable and the IPR variable by multiplying them. Two different interaction terms, one with de facto index representing the effect of the de facto IPR strengthening in high imitation state and the other

[38] It represents the total effect for all the lags showing significant coefficients. In panel (ii) of Table 8, lags 1 and 2 show significant and negative coefficients of -0.0804 and -0.0692 in the short run, respectively, meaning a total decline of 14.96% in the short run.

[39] There can be several ways other of catering the issue of infringement apart from litigation such as mediation, arbitration or out of the court settlement which are infact more prevelant in the Indian scenarios.

with de jure index representing the effect of the de jure IPR strengthening in high imitation state are created and used in two different analysis to compare the changes across de facto and de jure protection across these heterogeneities.

The following is the general ARDL model specification used to estimate the high imitation state model as exercise-III:

$$\Delta lnGDP\_pcreal_t = \vartheta_0 + \sum_{i=1}^{j} \emptyset_i \Delta\, lnGDP\_pcreal_{t-i} + \sum_{i=1}^{k} \alpha_i \Delta IPR_{t-i} + \sum_{i=1}^{l} \theta_i (Imit_H\ X\ IPR)_{t-i} + \sum_{i=1}^{m} \gamma_i \Delta Trade_{t-i} + \sum_{i=1}^{n} \sigma_i \Delta GDS_{t-i} + \sum_{i=1}^{o} \rho_i \Delta FDI_{t-i} + \sum_{i=1}^{p} \mu_i \Delta SSE_{t-i} + \sum_{i=1}^{q} \tau_i \Delta EF_{t-i} + \delta_1 IPR_{t-1} + \delta_2 (Imit_H\ X\ IPR)_{t-1} + \delta_3 Trade_{t-1} + \delta_4 GDS_{t-1} + \delta_5 FDI_{t-1} + \delta_6 SSE_{t-1} + \delta_7 EF_{t-1} + \omega EC_{t-1} + \epsilon_t \quad (8)$$

Here, θ_i and δ_2 are the coefficients of interest representing the short and long run impacts of IPR strengthening on the economic growth in India in case of high imitation threat.

A bounds test confirm the presence of long run cointegration among the variables. The results qualify the cutoffs designed for both large sample and small sample given by Pesaran and Shin (2001) and Narayan (2005) respectively.

7.2.3.1 Estimation Results

Panel (i) of Table 9 shows results for the interaction of de facto with high imitation threat state. It can be observed that the inclusion of interaction term vanishes the standalone impact of de facto IPR strengthening in both long and short runs indicating the importance of the combined effect of IPR strengthening in high imitation regime. It is found that for observations where economy is detected to be in high imitation threat, strengthening of IPR implementation causes an immediate boost in economic growth in the short run while having a negative and significant effect on economic growth in the long run. A one-unit increase in the strengthening of IPR implementation significantly boosts the average growth rate by approximately 9% in the short run[40] and significantly reduces the average growth rate by around 19% in the long run, in case of high imitation state, ceteris paribus. Here, a non-linear inverse-U/inverse-V shaped relationship is detected. This is because, in short run, when economy is already in the high imitation state, strengthening of IPR implementation signals better governance and commitment to protecting innovation which further promotes confidence in investors and reduces risk to invest in innovation and in new technologies. Moreover, formalization improves tax revenues and regulatory efficiency, providing a short-term economic boost. While in the

[40] It represents the total effect for all the lags showing significant coefficients. In panel (i) of Table 8, lags 2 and 3 show significant and negative coefficients of -0.279 and -0.310 in the short run, respectively, meaning a total decline of 58.9% in the short run.

long run, since economy relies heavily on the diffusion of foreign technologies, often through informal or semi-formal channels, stricter IPR enforcement can restrict access to affordable technologies, reducing the ability of domestic firms to adapt and innovate, which is critical for long-term growth. Moreover, in high imitation state, implementing strong IPR laws can impose significant enforcement costs on the legal and administrative systems, diverting resources from other growth-enhancing areas. The inefficiency of legal systems in managing these costs over the long term can negatively impact overall economic performance. Developing countries like India may not yet have enough institutional or innovation capacity to fully leverage strict IPR implementation for sustained growth. The signs of other control variables also came as expected.

Panel (ii) of Table 9 shows results for the interaction of de jure with the high imitation state. It can be seen that a similar inverse U/V shaped non-linear relationship is found between the strengthening of de jure IPR protection and economic growth. In high imitation regime, a one-unit tightening in the de jure IPR protection positively and significantly increase the average growth rate by around 2% in the short run[41] and significantly declines the average growth rate by around 5% in the long run, ceteris paribus.

Overall, the results seem similar for both de facto and de jure IPR protection in both the short run and long run. First, an increase in the short run and then a decrease in the long run economic growth has been detected. This confirms the inverse U/V shaped relationship between the IPR protection and economic growth overtime, in case the economy is in the state of high imitation threat. To further confirm this relationship and to check that whether this result sustains for longer period of time or not, we need to look for impulse response functions which will be discussed later. Furthermore, here also, it can be observed that the effect of the de facto IPR protection is stronger in terms of both magnitude and significance than the effect of de jure IPR protection on the economic growth in both short and long runs which indicates stronger relationship between implementation and economic growth.

7.3 Impulse Response Functions

To capture the effect of one unit shock in the IPR enforcement on the economic growth overtime, Impulse Response Functions (IRFs) are used in this study. For this, we have re-estimated the models stated in exercises-I, II and III using the Vector Error Correction Model

[41] It represents the total effect for all the lags showing significant coefficients. In panel (ii) of Table 8, lags 1 and 2 show significant and negative coefficients of -0.0804 and -0.0692 in the short run, respectively, meaning a total decline of 14.96% in the short run.

(VECM) by taking the same optimal lag structure as estimated in the previous ARDL models based on the Akaike information criterion to maintain consistency. We have already confirmed the long run cointegration among all the variables in exercises-I, II and III by using the ARDL bounds test. Graphs shown in Figure 11 show IRFs representing the response of economic growth overtime based on the impulse generated by the de facto and de jure IPR strengthening in the high innovation state. Panel (i) of Figure 11 show the response of economic growth in 3-year time period (two-step function) for one unit shock in the de facto IPR protection. It shows that economic growth initially declines and then boost in the following lag which indicates a sign of V-shaped relationship as estimated by the previous ARDL estimation. A similar relationship can be observed in panel (ii) of Figure 11 where economic growth initially declines and then increase for one unit shock in the de jure IPR protection. This result makes the ARDL results robust. However, the peak in the economic growth does not seem to be sustained if we further increase the lag length. Panel (iii) shows the results for the impulse and response function between the de facto IPR strengthening on economic growth in India for a 10-year time period. It can be seen that V-shaped peaks and troughs in the growth rate slowly fades away and strengthening of IPR could not sustain high growth even in the state of high innovation. This may happen because of inadequate innovation absorptive capacity due to lack of proper institutional infrastructure and inadequate levels of education which is not enough to reap the sufficient benefits from the existing R&D and innovation. A similar structure can be seen for the impulse and response function between the de jure IPR strengthening and economic growth in panel (iv).

Figure 12 shows the impulse response functions for de facto and de jure IPR strengthening on the economic growth in India, in case of high imitation threat. Panel (i) of Figure 12 shows that a one-unit shock in the de facto IPR strengthening cause a positive initial response in the economic growth which further leads to deteriorate. This result indicates an inverse U-shaped relationship between IPR and economic growth in the state of high imitation. Panel (ii) of Figure 12 shows the similar picture using the de jure IPR protection. On expanding the time horizon to 10-year period, the decline in the economic growth still seems persistent for both de facto and de jure IPR protection.

Overall, these results imply that if the economy is in the high imitation state, strengthening of IPR enforcement will definitely lead to deteriorate economic growth in the long run. However, if the economy is in high innovation state, strengthening of IPR protection can boost economic growth in the long run but may not sustain high growth rate further due to several other reasons such as low innovation absorptive capacity, inadequate infrastructure, low levels of education, etc. To sustain a positive relationship, it is required to improve on these issues and encourage domestic innovation without weakening the IPR enforcement in the economy.

7.4 Postestimation Tests

We have performed all the important diagnostic test to ensure that the reliability of results. For testing autocorrelation or serial correlation in our case, Durbin Watson's alternative test and Portmanteau test for white noise are used. These tests are suitable for checking the presence of autocorrelation especially in the case of small sample. For all the models stated in exercises-I, II and III, there is no issue of autocorrelation is found. The issue of heteroscedasticity is checked using White's test and Breusch-Pagan/Cook-Weisberg test for heteroscedasticity (both F and Chi-square stats). These tests indicate that there is no issue of heteroscedasticity found in any of the model. Small sample Shapiro-Wilk W test for normality and q-norm plot are used to check the normality of the residuals. It is found that error terms are normal. A model stability CUSUM6 test is performed to examines whether the residuals of a regression are stable over time. It checks for structural breaks in the regression model. Figure 13 shows the results for all the models. The two diagonal lines represent critical bounds at a specific confidence level (usually 5%). The CUSUMSQ statistic appears to stay within the bounds for most of the sample period, indicating stability. However, at the very end of the sample (around 2020), the statistic slightly crosses the upper critical bound for few models and came back inside the bound, signaling a slight structural break in the model during the final period. It is highly plausible that the structural break observed in the later part of the sample (around 2020) could be attributed to the economic decline caused by the COVID-19 pandemic. Since, it represents only a slight deviation only in few models which is towards the very end of the sample size, we can safely comment that our results are still reliable and not affected by this break.

8. Conclusion and Policy Implications

This study presents a novel de facto index (IPRI) to measure the strength of intellectual property rights (IPR) enforcement in India, based on actual IP infringement cases adjudicated in Indian courts between 1970 and 2020. By employing three robust aggregation techniques—equal weights, principal component analysis, and factor analysis—the study constructs an innovative measure that reflects the practical enforcement of IPR beyond mere legislative intent. The index reveals a transition in India's IPR protection, evolving from weak enforcement in the 1970s to a moderate level by 2020. This progression reflects both the adoption of stronger IPR legislation and improvements in enforcement mechanisms. Critically, the de facto index diverges significantly from the widely used Ginarte and Park (GP) index. The GP index underestimates India's IPR strength before 2000 and overestimates it post-2000, highlighting inaccuracies in traditional measures. These discrepancies underscore the importance of using enforcement-based indices to accurately capture the real-world strength of IPR protection, particularly in emerging economies like India.

The study further investigates the impact of IPR strengthening on economic growth using an autoregressive distributed lag (ARDL) model. The findings reveal that de facto IPR enforcement positively and significantly influences economic growth in both the short and long run when no heterogeneities are introduced. A similar positive long-run effect is observed for de jure IPR protection. However, incorporating regime-specific heterogeneities—such as high vs. low levels of innovation and imitation threats—provides nuanced insights. In a high-innovation regime, both de facto and de jure IPR enforcement initially dampen economic growth but later result in significant long-term growth, indicating a U/V-shaped relationship. This reflects the initial adjustment costs associated with strengthening IPR and the subsequent benefits as innovation ecosystems mature. Conversely, in a high-imitation regime, stronger IPR enforcement initially boosts economic growth but later hampers it, showing an inverse-U-shaped relationship. This suggests that stringent IPR enforcement in high-imitation economies may stifle growth once imitation-based industries face diminishing returns. The impulse response analysis further confirms these dynamics. Strengthening IPR enforcement in a high-imitation economy is likely to hinder long-term growth unless complemented by measures to enhance innovation capacity. In contrast, in a high-innovation economy, stronger IPR enforcement fosters growth in the long run but fails to sustain high growth rates indefinitely due to structural limitations such as inadequate infrastructure, low education levels, and limited absorptive capacity for innovation.

Despite its contributions, this study has some limitations. First, the new de facto index is created for India only, making it difficult to analyze country-level panel effects. Tracking IPR implementation for all countries is challenging due to the lack of transparency in judicial data and the substantial time required to analyze legal cases comprehensively. Second, the study does not perform structural break analysis for IPR implementation over time, which could provide deeper insights into policy shifts. Future research could focus on modeling structural changes more rigorously. Additionally, while checks for reverse causality and endogeneity were not performed, this study assumes that IPR strengthening is exogenous, as India's IPR laws were significantly influenced by the TRIPS agreement imposed by developed nations. However, addressing potential endogeneity in future research could strengthen the findings. Finally, the small sample size of this study limits its generalizability, highlighting the need for further exploration with larger datasets and additional econometric techniques.

The following are the policy implications to be considered by the IPR policy makers:

1. Context-Specific IPR Strategies: In high-imitation regimes, excessive enforcement of IPR may discourage growth by limiting the scope for imitation-led learning. Moderate enforcement, combined with incentives for incremental innovation, could be more effective.
2. Supporting Innovation Ecosystems: In high-innovation regimes, stronger IPR enforcement can drive long-term growth, but policymakers must address structural barriers such as inadequate infrastructure, limited R&D investment, and low innovation absorption capacity to sustain this growth.
3. Enhancing Domestic Innovation: Strengthening domestic innovation systems through improved education, skill development, and funding for R&D is critical to ensuring that IPR policies translate into sustainable economic growth.
4. Balancing Enforcement with Flexibility: While enforcing IPR is crucial, flexibility is necessary to prevent overprotection that may stifle growth, especially in imitation-driven economies.
5. Refining Global IPR Metrics: The discrepancies between the de facto index and the GP index highlight the need for better global measures of IPR enforcement that consider real-world implementation. Such metrics can provide more accurate insights for developing economies.

By addressing these challenges and leveraging the nuanced findings of this study, policymakers can optimize IPR enforcement to foster sustainable economic growth while accommodating the diverse dynamics of innovation and imitation in the Indian economy.

References

Aitken, B., Harrison, A., & Lipsey, R. E. (1996). Wages and foreign ownership A comparative study of Mexico, Venezuela, and the United States. *Journal of international Economics*, *40*(3-4), 345-371.

Barnard, D. L. (2001). Pegasys (Hoffmann-la roche). *Current Opinion in Investigational Drugs (London, England: 2000)*, *2*(11), 1530–1538.

Basole, A. (2015). Authenticity, innovation, and the geographical indication in an artisanal industry: the case of the Banarasi Sari. *The Journal of World Intellectual Property*, *18*(3-4), 127-149.

Becker, G. S. (1968). Crime and punishment: An economic approach. *Journal of Political Economy*, *76*(2), 169-217.

Bouquet, C. and Deutsch, Y.: 2008, 'The Impact of Corporate Social Performance on a Firm's Multinationality'. *Journal of Business Ethics*, 80, 755-769.

Braga, C. A. P., Fink, C., & Sepulveda, C. P. (2000). *Intellectual property rights and economic development* (Vol. 412). World Bank Publications.

Bronkers, M. C. E. J. (1994). The Impact of TRIPS. *Intellectual Property protection in Developing countries. Netherland*.

Brooks, R. R., & Schwartz, W. F. (2005). Legal uncertainty, economic efficiency, and the preliminary injunction doctrine. *Stan. L. Rev.*, *58*, 381.

Boelhouwer, J., & Stoop, I. (1999). Measuring well-being in the Netherlands: The SCP index from 1974 to 1997. *Social indicators research*, *48*, 51-75.

Bolch, B. W., & Huang, C. J. (1974). *Multivariate statistical methods for business and economics* (pp. 72-75). New Jersey: Prentice-Hall.

Chen, Y., & Puttitanun, T. (2005). Intellectual property rights and innovation in developing countries. *Journal of development economics*, *78*(2), 474-493.

Cohen, W. M., & Klepper, S. (1992). The anatomy of industry R&D intensity distributions. *The American Economic Review*, 773-799.

Cooley, J. W. (1985). Arbitration vs. mediation-explaining the differences. *Judicature*, *69*, 263.

Dam, K. W. (1994). The economic underpinnings of patent law. *The Journal of Legal Studies*, *23*(1), 247-271.

Deardorff, Alan V. (1992) Welfare effects of global patent protection,*Economica* 59: (February), 35–51.

Dinlersoz, E., Goldschlag, N., Yorukoglu, M., & Zolas, N. (2023). *On the Role of Trademarks: From Micro Evidence to Macro Outcomes* (No. 23-16).

Diwan, I., & Rodrik, D. (1991). Patents, appropriate technology, and North-South trade. *Journal of International economics*, *30*(1-2), 27-47.

Dutta, A., & Sharma, S. (2008). Intellectual property rights and innovation in developing countries: Evidence from India. *World Bank document. Available at: wwwwds. worldbank. org/.../475240WP0Intel1Box0334139B01PUBLIC*.

E-Courts. (n.d.). https://services.ecourts.gov.in/ecourtindia_v6/

Filmer, D., & Pritchett, L. H. (2001). Estimating wealth effects without expenditure data—or tears: an application to educational enrollments in states of India. *Demography,* 38, 115-132.

Fink, C., & Maskus, K. E. (2005). *Intellectual property and development: lessons from recent economic research*. Washington, DC: World Bank and Oxford University Press.

Ginarte, J. C., & Park, W. G. (1997). Determinants of patent rights: A cross-national study. *Research policy*, *26*(3), 283-301.

Glass, A. J., & Saggi, K. (2002). Intellectual property rights and foreign direct investment. *Journal of International economics*, *56*(2), 387-410.

Gold, E. R., Morin, J. F., & Shadeed, E. (2019). Does intellectual property lead to economic growth? Insights from a novel IP dataset. *Regulation & Governance*, *13*(1), 107-124.

Goltsman, M., Hörner, J., Pavlov, G., & Squintani, F. (2009). Mediation, arbitration and negotiation. *Journal of Economic Theory*, *144*(4), 1397-1420.

Gould, D. M., & Gruben, W. C. (1996). The role of intellectual property rights in economic growth. *Journal of development economics*, *48*(2), 323-350.

Grace, C. (2004). The effect of changing intellectual property on pharmaceutical industry prospects in India and China. *DFID Health Systems Resource Centre*, 1-68.

Grossman, G. M., & Helpman, E. (1991). Trade, knowledge spillovers, and growth. *European economic review*, *35*(2-3), 517-526.

Guttman, L. (1954). Some necessary conditions for common-factor analysis. *Psychometrika*, *19*(2), 149-161.

Gwartney, J., Lawson, R., Hall, J., & Norton, S. W. (2008). Economic Freedom of the World: 2008 Annual Report-chap. 2.

Helpman, E. (1992). Innovation, imitation, and intellectual property rights.

Hu, A. G., & Png, I. P. (2013). Patent rights and economic growth: Evidence from cross-country panels of manufacturing industries. *Oxford Economic Papers*, *65*(3), 675-698.

IMF. (2023). *Balance of Payments* [dataset]. IMF. https://data.imf.org/?sk=388DFA60-1D26-4ADE-B505-A05A558D9A42&sId=1479329132316

Indian Kanoon. (n.d.). https://indiankanoon.org/

Intellectual Property Statistics. (n.d.). Retrieved 25 October 2023, from https://www.wipo.int/ipstats/en/index.html

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and psychological measurement*, *20*(1), 141-151.

Kanwar, S. (2012). Intellectual property protection and technology licensing: The case of developing countries. *The Journal of Law and Economics*, *55*(3), 539-564.

Kanwar, S., & Evenson, R. (2003). Does intellectual property protection spur technological change?. *Oxford Economic Papers*, *55*(2), 235-264.

Kanwar, S., & Evenson, R. E. (2001). Does intellectual property spur technological change? *Yale University*.

Kanwar, S., & Sperlich, S. (2020). Innovation, productivity and intellectual property reform in an emerging market economy: evidence from India. *Empirical Economics*, *59*, 933-950.

Kanwar, S., & Sperlich, S. (2019). *Intellectual Property Protection and Foreign Direct Investment into Less Developed Economies in the post-TRIPs Period* (No. 301).

Klasen, S. (2000). Measuring poverty and deprivation in South Africa. *Review of income and wealth*, *46*(1), 33-58.

Krishnan, V. (2010). Constructing an area-based socioeconomic index: A principal components analysis approach. *Edmonton, Alberta: Early Child Development Mapping Project*.

Lai, E. L. C. (1998). International intellectual property rights protection and the rate of product innovation. *Journal of Development economics*, *55*(1), 133-153.

Lemley, M. A., & Volokh, E. (1998). Freedom of speech and injunctions in intellectual property cases. *Duke LJ*, *48*, 147.

Lerner, J. (2002). Patent protection and innovation over 150 years. Working Paper No. 8977, National Bureau of Economic Research, Harvard University.

Leubsdorf, J. (2007). Preliminary injunctions: In defense of the merits. *Fordham L. Rev.*, *76*, 33.

Mansfield, E., Schwartz, M., & Wagner, S. (1981). Imitation costs and patents: an empirical study. *The economic journal*, *91*(364), 907-918.

Maskus, K. E. (1998). The international regulation of intellectual property. *Weltwirtschaftliches Archiv*, *134*(2), 186-208.

Maskus, K. E. (2000). Intellectual property rights and economic development. *Case W. Res. J. Int'l L.*, *32*, 471.

Maskus, K. E. (2000). *Intellectual property rights in the global economy*. Peterson Institute.

Maskus, K. E., & Penubarti, M. (1995). How trade-related are intellectual property rights?. *Journal of International economics*, *39*(3-4), 227-248.

Maskus, K. E., & Reichman, J. H. (Eds.). (2005). *International public goods and transfer of technology under a globalized intellectual property regime*. Cambridge University Press.

Mookherjee, Dilip, and Ivan PL Png. "Monitoring vis-a-vis Investigation in Enforcement of Law." *The American Economic Review* (1992): 556-565.

Morrison, W. A. (1990). The Impact of the Creation of the Court of Appeals for the Federal Circuit on the Availability of Preliminary Injunctive Relief Against Patent Infringement. *Ind. L. Rev.*, *23*, 169.

Mueller, G. O. (1978). The United Nations draft code of conduct for law enforcement officials. *Police Stud.: Int'l Rev. Police Dev.*, *1*, 17.

Mueller, J. M. (2006). The tiger awakens: the tumultuous transformation of India's patent system and the rise of Indian pharmaceutical innovation. *U. Pitt. l. reV.*, *68*, 491.

Narayan, P. (2004). *Reformulating critical values for the bounds F-statistics approach to cointegration: an application to the tourism demand model for Fiji* (Vol. 2, No. 04). Australia: Monash University.

Narayan, P. K. (2005). The saving and investment nexus for China: evidence from cointegration tests. *Applied economics*, *37*(17), 1979-1990.

Narayan, P., & Smyth, R. (2005). Trade liberalization and economic growth in Fiji. An empirical assessment using the ARDL approach.

Newman, K. (2014). Don't Copy That Floppy: The IP Enforcement Dilemma in the United States. *New Eng. J. on Crim. & Civ. Confinement*, *40*, 191.

Nkoro, E., & Uko, A. K. (2016). Autoregressive Distributed Lag (ARDL) cointegration technique: application and interpretation. *Journal of Statistical and Econometric methods*, *5*(4), 63-91.

Noorbakhsh, F. (1998). The human development index: some technical issues and alternative indices. *Journal of International Development: The Journal of the Development Studies Association*, *10*(5), 589-605.

Ostergard, R. L. (2000). The measurement of intellectual property rights protection. *Journal of International Business Studies*, *31*, 349-360.

Padgett, R. C., & Galan, J. I. (2010). The effect of R&D intensity on corporate social responsibility. *Journal of Business Ethics*, *93*, 407-418.

Papageorgiadis, N., & Sofka, W. (2020). Patent enforcement across 51 countries–Patent enforcement index 1998–2017. *Journal of World Business*, *55*(4), 101092.

Papageorgiadis, N., Cross, A. R., & Alexiou, C. (2014). International patent systems strength 1998–2011. *Journal of World Business*, *49*(4), 586-597.

Park, W. G. (2008). International patent protection: 1960–2005. *Research policy*, *37*(4), 761-766.

Pearson, K. (1901). LIII. On lines and planes of closest fit to systems of points in space. *The London, Edinburgh, and Dublin philosophical magazine and journal of science*, *2*(11), 559-572.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289-326.
Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289-326.
Prowess IQ, CMIE. (2023). *IP Charges (Debit and Credit)* [dataset]. Center for Monitoring Economics. https://prowessiq.cmie.com/

Rapp, R. T., & Rozek, R. P. (1990). Benefits and costs of intellectual property protection in developing countries. *J. World Trade*, *24*, 75.

Romer, P. M. (1990). Endogenous technological change. *Journal of political Economy*, *98*(5, Part 2), S71-S102.

SCC Online® | The Surest Way to Legal Research. (n.d.). Retrieved 15 December 2021, from https://www.scconline.com/

Seyoum, B. (1996). The impact of intellectual property rights on foreign direct investment. *The Columbia Journal of World Business*, *31*(1), 50-59.

Sharma, S., & Arora, R. (2023). Macroeconomic determinants of India's participation in global value chains: An empirical evidence. *Journal of Asian Economic Integration*, *5*(1), 7-28.

Sheikh, R. A., & Kanwar, S. (2022). Does Host Country Intellectual Property Protection Matter for Technology-Intensive Import Flows? Working Paper No. 329, Center for Development Economics, Delhi School of Economics.

Sherwood, R. M. (1996). Intellectual property systems and investment stimulation: The rating of systems in eighteen developing countries. *Idea*, *37*, 261.

Siebeck, W. E. (1990). *Strengthening protection of intellectual property in developing countries: a survey of the literature*. World Bank.

Spearman, C. (1910). Correlation calculated from faulty data. *British journal of psychology*, *3*(3), 271.

Stiglitz, J. E. (1999). Knowledge as a global public good. *Global public goods: International cooperation in the 21st century*, *308*, 308-325.

Sweet, C. M., & Maggio, D. S. E. (2015). Do stronger intellectual property rights increase innovation? *World Development*, *66*, 665-677.

Taubman, A., Wager, H., & Watal, J. (Eds.). (2020). *A handbook on the WTO TRIPS agreement*. Cambridge University Press.

Taylor, M. S. (1993). TRIPS, trade, and technology transfer. *Canadian Journal of Economics*, 625-637.

Unctad. (1996). World Investment Report 1996: Investment, trade and international policy arrangements. *Foreign Trade Review*, *31*(3), 85-109.

Verma, S. K. (2004). ENFORCEMENT OF INTELLECTUAL PROPERTY RIGHTS: TRIPS PROCEDURE & INDIA. *Journal of the Indian Law Institute*, *46*(2), 183-206.

White, M. (2002). World Intellectual Property Organization. *Journal of Business & Finance Librarianship*, *8*(1), 71-78.

Wichterman, D. (1991). Intellectual Property Rights and Economic Development: An Issue Brief. *Washington DC: Agency for International Development Center for Development Information and Evaluation*.

WIPO IP Statistics Data Center. (n.d.-a). Retrieved 24 September 2023, from https://www3.wipo.int/ipstats/key-search/search-result?type=KEY&key=201

Wooldridge, J. M. (2009). *Introductory economics: A modern approach*. Mason, Cengage-Learning.

Yang, L., & Maskus, K. E. (2009). Intellectual property rights, technology transfer and exports in developing countries. *Journal of Development Economics*, *90*(2), 231-236.

Table1: Frequency Distribution of Patents, Copyrights and Trademarks Infringement Cases by Industry						
Industry	Patents		Copyrights		Trademarks	
	Freq.	(%)	Freq.	(%)	Freq.	(%)
Air and spacecraft and related machinery	1	1.96				
Basic chemicals, fertilizer and nitrogen compounds	8	15.69			5	1.88
Basic iron and steel					1	0.38
Basic precious and other non-ferrous metals					1	0.38
Beverages					14	5.26
Computer programming, consultancy and related acti.					8	3.01
Construction of buildings					2	0.75
Consumer electronics	1	1.96			17	6.39
Creative, arts and entertainment activities			48	49.48	6	2.26
Dairy products					1	0.38
Data processing, hosting and related activities; web portals			1	1.03		
Domestic appliances	1	1.96			3	1.13
Electric motors, generators, transformers and electricity	4	7.84			2	0.75
Electric power generation, transmission and distribution	1	1.96				
Electronic components					1	0.38
Food products	1	1.96				
Footwear					3	1.13
Games and toys	2	3.92				
General-purpose machinery	1	1.96			10	3.76
Growing of non-perennial crops	2	3.92			3	1.13
Jewellery, bijouterie and related articles					1	0.38
Management consultancy activities					1	0.38
Measuring, testing, navigating and control equipment;					2	0.75
Medical and dental instruments and supplies					1	0.38
Motion picture, video and television programme active.			1	1.03		
Motor vehicles	2	3.92			10	3.76
Other chemical products					23	8.65
Other electrical equipment	1	1.96				
Other fabricated metal products; metalworking service					3	1.13
Other food products					25	9.39
Other manufacturing					4	1.5
Other personal service activities					1	0.38
Other social work activities without accommodation					2	0.75
Other textiles					1	0.38
Pharmaceuticals, medicinal chemical and botanical	17	33.33			38	14.29
Plastics products	1	1.96				
Printing and service activities related to printing			2	2.06	4	1.5
Products of wood, cork, straw and plaiting materials					7	2.63
Publishing of books, periodicals and other publishing activities			18	18.56	8	3
Real estate activities with own or leased property					11	4.14
Refined petroleum products	1	1.96			9	3.38
Rubber products					2	0.75
Short term accommodation activities					4	1.5
Software publishing			11	11.34		
Specialized design activities			1	1.03		
Special-purpose machinery	2	3.92			3	1.13
Spinning, weaving and finishing of textiles					1	0.38
Structural metal products, tanks, reservoirs and steam					1	0.38
Tanning and dressing of leather; manufacture of luggage, bags	1	1.96			2	0.75
Telecommunication	4	7.84				
Television programming and broadcasting activities			15	15.46	2	0.75
Tobacco products					3	1.13
Transport equipment					1	0.38
Travel agency and tour operator activities					1	0.38
Vegetable and animal oils and fats					2	0.75
Wearing apparel, except fur apparel					16	6.02
Total	51	100	97	100	266	100

Table 2: Preliminary Injunction Statistics in IP infringement Trials by Year													
	(a) Number of IP trials				(b) Preliminary Injunction (PI) Grants					(c) Duration of PI Grants			
Year	Patents	Copyrights	Trademarks	Total	No. of trials where PI claimed	Prop. of granting PI when claimed (Average)	Std. Dev.	Min	Max	Average Duration of granting PI from the date of filing the suit	Std. Dev.	Min	Max
1970	0	2	0	2	1	0	.	0	0	.	.	.	.
1975	1	1	2	4	4	1	0	1	1	.17	.34	0	.67
1980	1	3	3	7	6	.83	.41	0	1	.58	.42	0	1
1985	2	3	6	11	9	.78	.44	0	1	.56	.46	0	1
1990	1	3	1	5	5	1	0	1	1	.67	.34	.33	1
1995	3	9	9	21	21	.76	.44	0	1	.69	.43	0	1
2000	3	3	5	11	11	.82	.41	0	1	.37	.48	0	1
2005	1	12	40	53	44	.84	.37	0	1	.8	.33	0	1
2010	9	25	82	116	97	.71	.46	0	1	.82	.35	0	1
2015	16	23	108	147	115	.79	.41	0	1	.87	.29	0	1
2020	14	13	10	37	32	.69	.47	0	1	.88	.26	0	1
Overall	51	97	266	414	345	.77	.42	0	1	.79	.35	0	1

Table 3: Tests for Principal Component Analysis (PCA)

Panel (a): Skewness/Kurtosis and Shapiro-Wilk W Tests for Normality									
Skewness/Kurtosis						Shapiro-Wilk W Test			
Vars	Obs	P(Skew)	P(Kurt)	adj_chi2(2)	Prob>chi2	W	V	z	Prob>z
PRI	11	0.307	0.482	1.780	0.410	0.957	0.700	-0.61	0.731
CRI	11	0.240	0.981	1.590	0.452	0.935	1.053	0.092	0.463
TRI	11	0.062	0.058	6.290	0.043	0.884	1.876	1.188	0.117

Panel (b): Matrix of Correlations			
Variables	(1)	(2)	(3)
(1) PRI Index	1.000		
(2) CRI Index	0.708	1.000	
(3) TRI Index	0.484	0.753	1.000

Panel (c): Kaiser-Meyer-Olkin (KMO) Test of Sample Adequacy and Barlett's Test for Sphericity			
KMO Test-Statistic	Barlett's Test		
	Chi-Sq	Degree of Freedom	P-value
0.617	12.612	3	0.006**

Note: *Here, ** indicates that the null hypothesis is rejected at 5% level of significance.*

Panel (d): Principal Components (Eigenvectors)			
	PC1	PC2	PC3
Eigenvalue	2.303	0.517	0.179
Proportion	0.768	0.172	0.060
	PC1	PC2	PC3
PRI Index	0.546	0.744	0.385
CRI Index	0.621	-0.052	-0.782
TRI Index	0.562	-0.666	0.491

Panel (e): Component Rotation Matrix-Orthogonal Varimax			
	PC1	PC2	PC3
PC1	0.546	0.562	0.621
PC2	0.744	-0.666	-0.052
PC3	0.385	0.491	-0.782

Table 4: Tests For Factor Analysis				
Panel (a): Factor Analysis/Correlation				
Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.918	1.864	1.065	1.065
Factor2	0.054	0.226	0.030	1.095
Factor3	-0.172	.	-0.095	1.000

LR test: independent vs. saturated: chi2(3) = 14.16 Prob>chi2 = 0.0027** (Significant at 5% level)

Panel (b): Factor Loadings (Pattern Matrix) and Unique Variances			
Variable	Factor1	Factor2	Uniqueness
PRI Index	0.716	0.169	0.458
CRI Index	0.905	0.002	0.180
TRI Index	0.765	-0.160	0.390

Panel (c): Rotated Factor Loadings (Pattern Matrix) and Unique Variances			
Variable	Factor1	Factor2	Uniqueness
PRI Index	0.469	0.567	0.458
CRI Index	0.721	0.548	0.180
TRI Index	0.706	0.334	0.390

Panel (d): Factor Rotation Matrix		
	Factor1	Factor2
Factor1	0.797	0.604
Factor2	-0.604	0.797

Table 5: Index of IPR Implementation: 1970 to 2020					
Panel (a): Different Weighting Strategies					
Year	Equal-Weight Index	Norm_PC1_Predicted _Index	PC1_Share_Load _Index	Norm_F1_Predicte d_Index	F1_Share_Load _Index
1970	0.0647222	0	0.0697058	0	0.0735892
1975	0.4288095	0.7808041	0.4308964	0.7751884	0.4322536
1980	0.399709	0.7026699	0.399908	0.6534133	0.399572
1985	0.2771958	0.4239078	0.2776994	0.3444132	0.2780556
1990	0.4574074	0.8304898	0.4566144	0.7824802	0.4550806
1995	0.3877337	0.6731681	0.3877036	0.6150228	0.387217
2000	0.3905926	0.6518362	0.3889789	0.5350471	0.3877111
2005	0.480924	0.8980723	0.4846225	0.9181266	0.4878106
2010	0.3866213	0.7006826	0.3908703	0.7284495	0.3942812
2015	0.5302356	0.9889606	0.5308304	0.9604961	0.5310417
2020	0.5283741	1	0.5294147	1	0.5295517
Panel (b): Summary Statistics					
Mean	0.393847745	0.695508309	0.395204036	0.6647852	0.396014936
Standard Deviations	0.130999721	0.283785135	0.130130785	0.292934303	0.129355134
Minimum	0.0647222	0	0.0697058	0	0.0735892
Maximum	0.5302356	1	0.5308304	1	0.5310417
Panel (c): Sensitivity of the IPR Implementation Index: Spearman's Rank Correlation Test					
Variables	(1)	(2)	(3)	(4)	(5)
(1) Equal Weight Index	1.000				
(2) Norm_PC1_Predicted_Index	0.955	1.000			
(3) PC1_Share_Load_Index	0.973	0.982	1.000		
(4) Norm_F1_Predicted_Index	0.927	0.991	0.973	1.000	
(5) F1_Share_Load_Index	0.973	0.982	1.000	0.973	1.000
Spearman rho = 0.973					

Table 6: Summary Statistics/Unit Root Test/Correlation								
	Panel (a): Summary Statistics					(b): Unit Root Test: Augmented Dickey Fuller Test		
Variable	Obs.	Mean	Std. Dev.	Min	Max	Test Statistics (Level)	P-value (Level)	Integration Order
$lnGDP\_pcreal_t$	51	6.536	.549	5.856	7.573	2.053	0.9987	I (1)
Equal weight index	51	.401	.092	.065	.53	-4.498	0.0002***	I (0)
Norm_PC1_Predicted_Index	51	.711	.2	0	1	-4.121	0.0009***	I (0)
Norm_F1_Predicted_Index	51	.678	.211	0	1	-3.271	0.0162**	I (0)
PC1_Share_Load_Index	51	.403	.092	.07	.531	-4.430	0.0003***	I (0)
F1_Share_Load_Index	51	.403	.091	.074	.531	-4.380	0.0003***	I (0)
GDS_t	51	22.748	7.873	9.761	34.377	-1.354	0.6042	I (1)
FDI_t	51	.776	.899	-.03	3.621	-1.165	0.6885	I (1)
$Trade_t$	51	26.355	15.164	7.662	55.794	-1.019	0.7463	I (1)
$R\&D_t$	51	.441	.321	.02	.859	-1.377	0.5934	I (1)
SSE_t	51	46.531	17.422	23.235	76.12	0.552	0.9864	I (1)
EF_t	51	5.612	.704	4.46	6.68	0.365	0.365	I (1)
GP PRI index	51	2.135	1.242	1.03	3.76	0.520	0.9855	I (2)
Aug IPR Index	51	2.536	1.3	1.095	4.29			I (2)

*Note: *** indicates significant at 1% level, ** indicates significant at 5% level.*

(c): Matrix of Correlation						
	(1)	(2)	(3)	(4)	(5)	(6)
(1) ln (GDP pc real)	1.000					
(2) equal weight Index	0.703	1.000				
(3) PC1 predicted Index	0.717	0.997	1.000			
(4) F1 predicted Index	0.743	0.970	0.985	1.000		
(5) PC1 Share Index	0.709	1.000	0.998	0.974	1.000	
(6) F1 Share Index	0.714	0.999	0.999	0.977	1.000	1.000

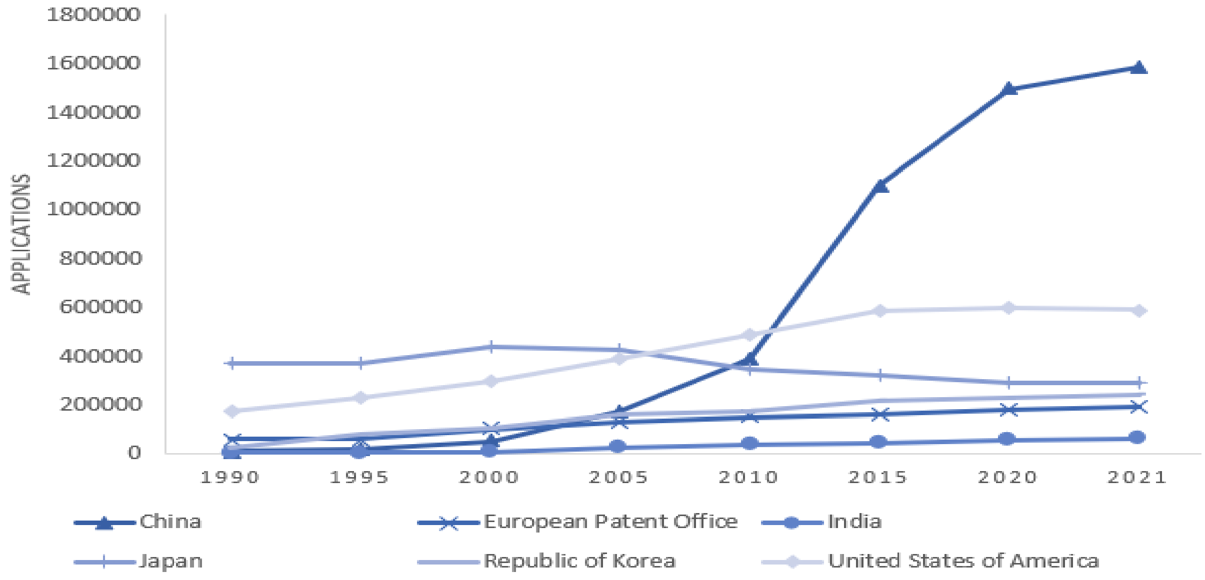
Table 7: Exercise-I: ARDL Estimation Results for Aggregate Effect Model						
	Panel (i): De facto (IPRI index)			Panel (ii): De jure (GP PRI index)		
	(1)	(2)	(3)	(1)	(2)	(3)
VARIABLES	Adj.	LR	SR	Adj.	LR	SR
D. IPRI			0.208**			
			(0.0960)			
D. GP PRI						-0.0270
						(0.0804)
D. R_D			-0.148			-0.339*
			(0.194)			(0.175)
D. Trade			-0.00122			-0.00108
			(0.00223)			(0.00156)
D. Gross domestic savings			0.00485			0.00325
			(0.00350)			(0.00344)
LD. Gross domestic savings			0.0124***			0.00269
			(0.00379)			(0.00413)
L2D. Gross domestic savings			0.0154***			0.0116***
			(0.00344)			(0.00401)
D. FDI			-0.00528			-0.0149
			(0.0104)			(0.0118)
LD. FDI			-0.0218			
			(0.0147)			
D.SSE			0.00416			0.00383
			(0.00279)			(0.00277)
LD.SSE			-0.0152***			-0.0158***
			(0.00330)			(0.00343)
L2D.SSE			-0.0102***			-0.0104***
			(0.00356)			(0.00331)
D.EF			0.0970***			0.125**
			(0.0279)			(0.0548)
L. IPRI		0.326**				
		(0.130)				
L. GP PRI					0.117***	
					(0.0323)	
L. R_D		0.132			0.224	
		(0.124)			(0.139)	
L. Trade		0.00556***			-0.00172	
		(0.00186)			(0.00248)	
L. Gross domestic savings		-0.0193**			-0.00937	
		(0.00717)			(0.00872)	
L. FDI		0.0517**			-0.0237	
		(0.0205)			(0.0196)	
L. SSE		0.0256***			0.0252***	
		(0.00163)			(0.00188)	
L. EF		0.152***			0.0658	
		(0.0379)			(0.0508)	
L. lnGDP pcreal	-0.637***			-0.630***		
	(0.107)			(0.0969)		
Constant			2.947***			3.162***
			(0.512)			(0.485)
Observations	48	48	48	48	48	48
R-squared	0.734	0.734	0.734	0.719	0.719	0.719

Standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

Table 8: Exercise-II: ARDL Estimation in case of interaction with high innovation state						
VARIABLES	Panel (i): De facto			Panel (ii): De jure		
	(1)	(2)	(3)	(1)	(2)	(3)
	Adj.	LR	SR	Adj.	LR	SR
LD. lnGDP_pcreal						-0.0769
						(0.155)
D. IPR			0.187			-0.0764
			(0.289)			(0.139)
LD. IPR			0.445			-0.128
			(0.262)			(0.115)
L2D. IPR			0.268			
			(0.224)			
D. R&D H X IPR			0.115			0.0164
			(0.0724)			(0.0237)
LD. R&D H X IPR			-0.279***			-0.0804**
			(0.0871)			(0.0372)
L2D. R&D H X IPR			-0.310***			-0.0692**
			(0.0839)			(0.0283)
D. Trade			-0.00805***			-0.00469*
			(0.00227)			(0.00248)
LD. Trade			0.00380			
			(0.00239)			
L2D. Trade			0.00440			
			(0.00285)			
D. GDS			0.00678**			0.00927**
			(0.00308)			(0.00409)
LD. GDS			0.0100**			0.00469
			(0.00430)			(0.00541)
L2D. GDS			0.0176***			0.0119**
			(0.00437)			(0.00433)
D. FDI			0.0573**			-0.0191
			(0.0205)			(0.0124)
LD. FDI			-0.0944***			
			(0.0225)			
L2D. FDI			-0.0347			
			(0.0213)			
D.SSE			0.0143***			0.00203
			(0.00476)			(0.00290)
LD.SSE			-0.0140***			-0.0137***
			(0.00355)			(0.00383)
L2D.SSE						-0.00881**
						(0.00393)
D.EF			0.127*			0.0802*
			(0.0732)			(0.0449)
LD.EF			0.0764			
			(0.0520)			
L2D.EF			0.248***			
			(0.0687)			
L. IPR		-0.0416			-0.0557	
		(0.182)			(0.0912)	
L. R&D H X IPR		0.510***			0.149*	
		(0.143)			(0.0767)	
L. Trade		-0.00411*			-0.00327	
		(0.00206)			(0.00429)	
L. GDS		-0.0116***			0.00395	
		(0.00401)			(0.00818)	
L. FDI		0.157***			-0.0377	
		(0.0287)			(0.0367)	
L. SSE		0.0270***			0.0212***	
		(0.00182)			(0.00322)	
L. EF		0.0167			0.131*	
		(0.0549)			(0.0656)	
L. lnGDP_pcreal	-0.830***			-0.615***		
	(0.148)			(0.106)		
Constant			4.438***			2.972***
			(0.802)			(0.502)
Observations	47	47	47	48	48	48
R-squared	0.861	0.861	0.861	0.748	0.748	0.748
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1*						

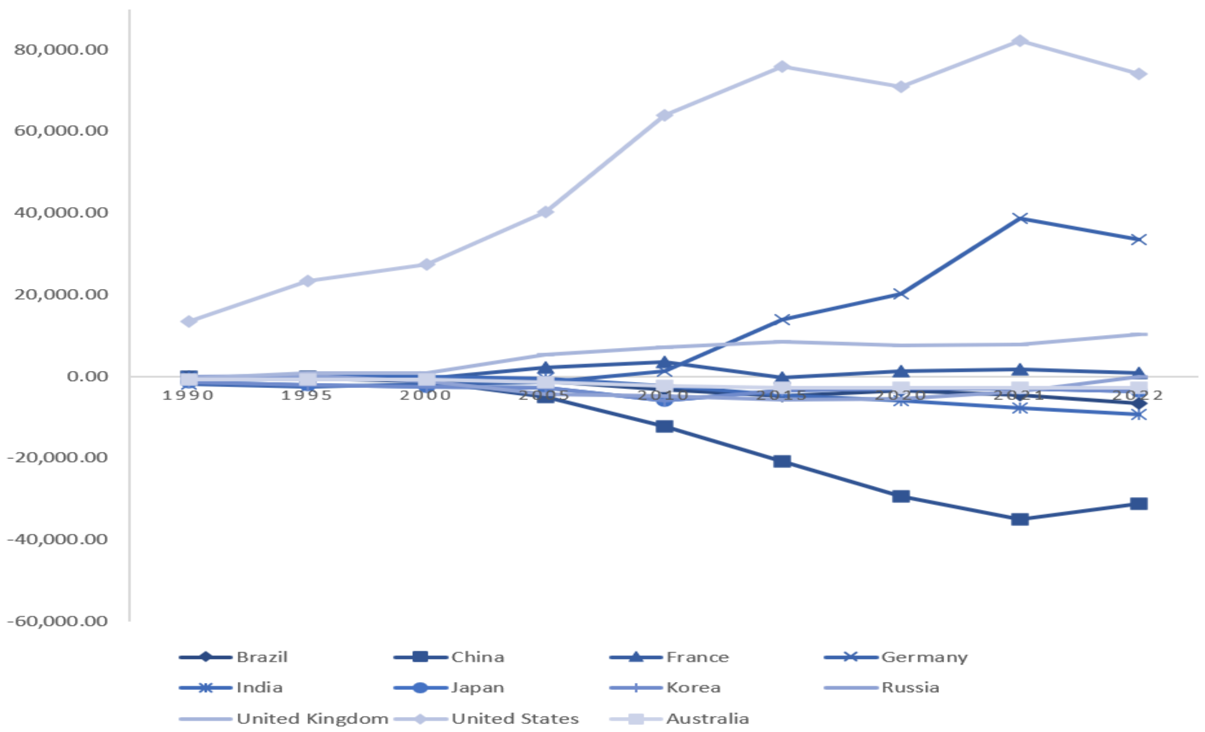
Table 9: Exercise-III: ARDL Estimation in case of interaction with high imitation threat state						
VARIABLES	Panel (i): De facto			Panel (ii): De jure		
	(1)	(2)	(3)	(1)	(2)	(3)
	Adj.	LR	SR	Adj.	LR	SR
LD. lnGDP_pcreal						-0.112
						(0.164)
D. IPR			0.00706			0.00625
			(0.278)			(0.0874)
LD. IPR			-0.00972			
			(0.257)			
L2D. IPR			0.352			
			(0.226)			
D. Imit H X IPR			-0.0547			-0.00569
			(0.0411)			(0.00973)
LD. Imit H X IPR			0.0847*			0.0196*
			(0.0466)			(0.0111)
D. Trade			-0.00147			-0.00484
			(0.00209)			(0.00294)
LD. Trade						-0.000478
						(0.00224)
L2D.TradeofGDP						-0.00240
						(0.00177)
D. GDS			0.00836***			0.00848**
			(0.00298)			(0.00388)
LD. GDS			0.0120***			0.00571
			(0.00398)			(0.00579)
L2D. GDS			0.0141***			0.0131**
			(0.00380)			(0.00473)
D. FDI			0.00224			-0.00769
			(0.0108)			(0.0136)
LD. FDI			-0.0227			-0.0270
			(0.0137)			(0.0178)
D.SSE			0.00163			-0.00142
			(0.00317)			(0.00371)
LD.SSE			-0.0194***			-0.0169***
			(0.00429)			(0.00407)
L2D.SSE			-0.0110***			-0.00794*
			(0.00355)			(0.00421)
D.EF			0.168***			0.0876**
			(0.0303)			(0.0376)
L. IPR		0.162			0.124**	
		(0.143)			(0.0537)	
L. Imit H X IPR		-0.189***			-0.0485*	
		(0.0658)			(0.0242)	
L. Trade		0.00597***			0.00210	
		(0.00135)			(0.00504)	
L. GDS		-0.0135***			3.21e-06	
		(0.00259)			(0.00810)	
L. FDI		0.0542***			0.0130	
		(0.0172)			(0.0353)	
L. SSE		0.0248***			0.0214***	
		(0.00107)			(0.00307)	
L. EF		0.223***			0.159**	
		(0.0213)			(0.0658)	
L. lnGDP_pcreal	-0.753***			-0.550***		
	(0.121)			(0.117)		
Constant			3.222***			2.479***
			(0.513)			(0.561)
Observations	47	47	47	48	48	48
R-squared	0.793	0.793	0.793	0.762	0.762	0.762
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1						

Figure 1: Trends in Patent Applications for the Top Six Patent Offices (1990 to 2021)



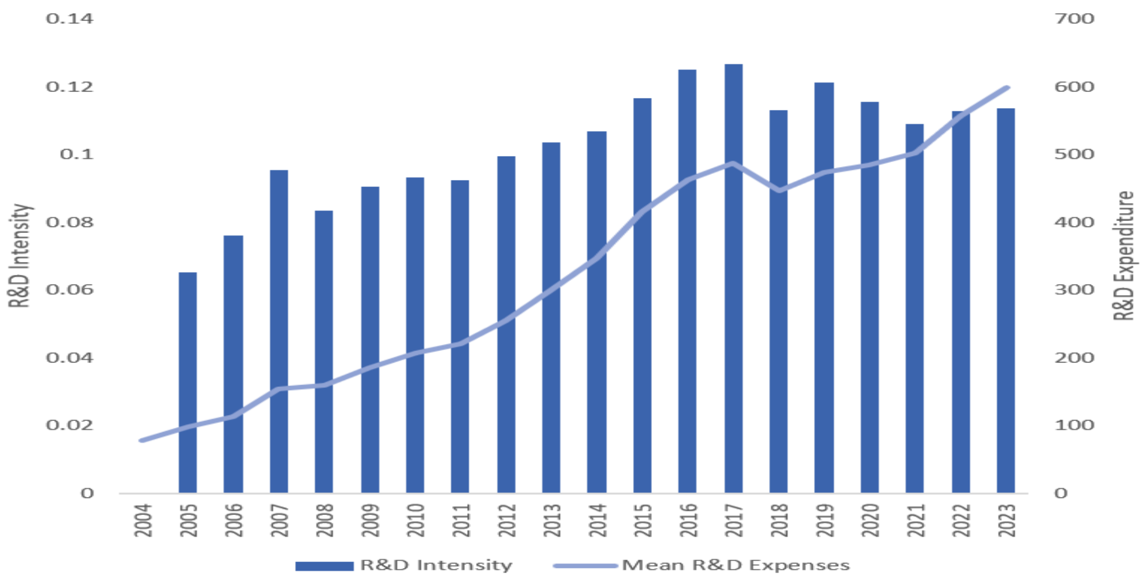
Note 1: Based on WIPO data (last updated in July 2023) at https://www.wipo.int/ipstats/en/

Figure 2: Net Receipts of Selected Countries from the Use of IP (License and Franchise Fees/Trademark revenue) (US$ million) (1990-2022)



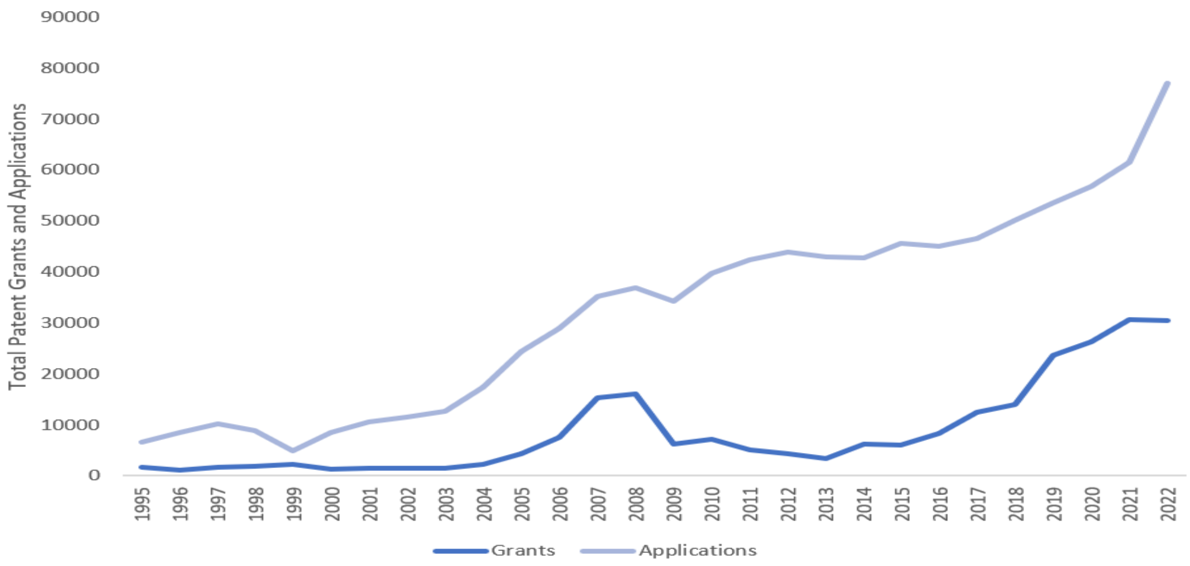
Note 1: Based on Balance of Payments data of the International Monetary Fund database (latest available till year 2022) https://data.imf.org/?sk=388DFA60-1D26-4ADE-B505-A05A558D9A42&sId=1479329132316

Figure 3: R&D Intensity and Expenditure of the Indian Drugs and Pharmaceutical Industry (in Million Rs.)



Note1: To calculate R&D intensity, we have taken the ratio of yearly averages of R&D expenditure of all the Indian pharmaceutical firms[42] available at the Center for Monitoring Economy (CMIE) Prowess database to their yearly average of the total sales[43] value lagged for one period[44].

Figure 4: Total Patent Applications and Grants (1995 to 2022)



Note1: Based on the estimates of the number of patent fillings and grants in India for years 1995 to 2021 obtained from the WIPO database (July 2023) at https://www.wipo.int/ipstats/en/

[42] There is a total of 948 pharmaceutical firms available at the CMIE website.
[43] This criteria of calculating the R&D intensity is used by many studies such as Cohen and Klepper (1992), Bouquet and Deutsche (2008), Padget and Galan (2010), and etc.
[44] The total sales variable is lagged one year because the budget for R&D is typically allocated several months before the funds are actually expended (Cohen and Klepper, 1992). That's why, the R&D expenditure of this year depends on the sales of the last year.

Figure 5: The Patent Rights Implementation Index

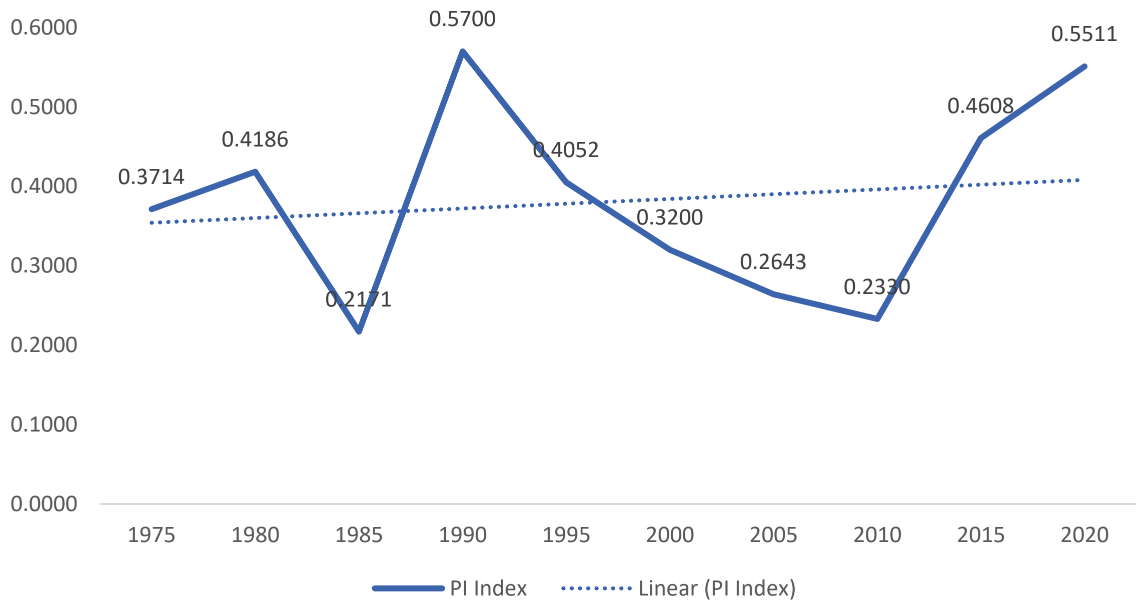


Figure 6: Patent Rights Implementation Index (Growth Rates)

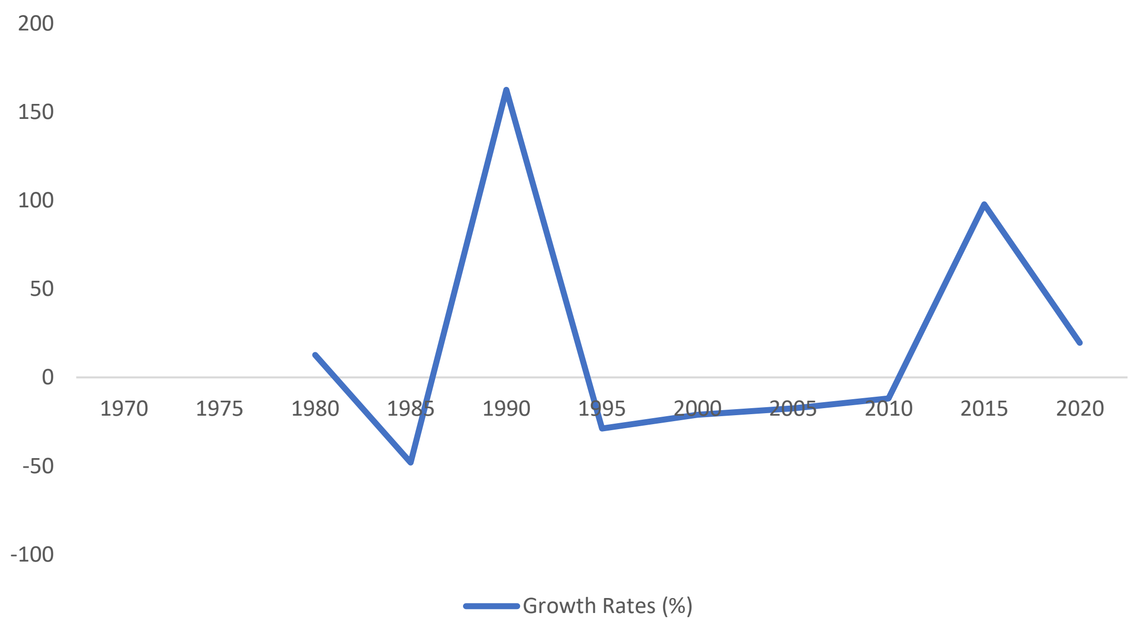


Figure 7: The Copyright Implementation Index

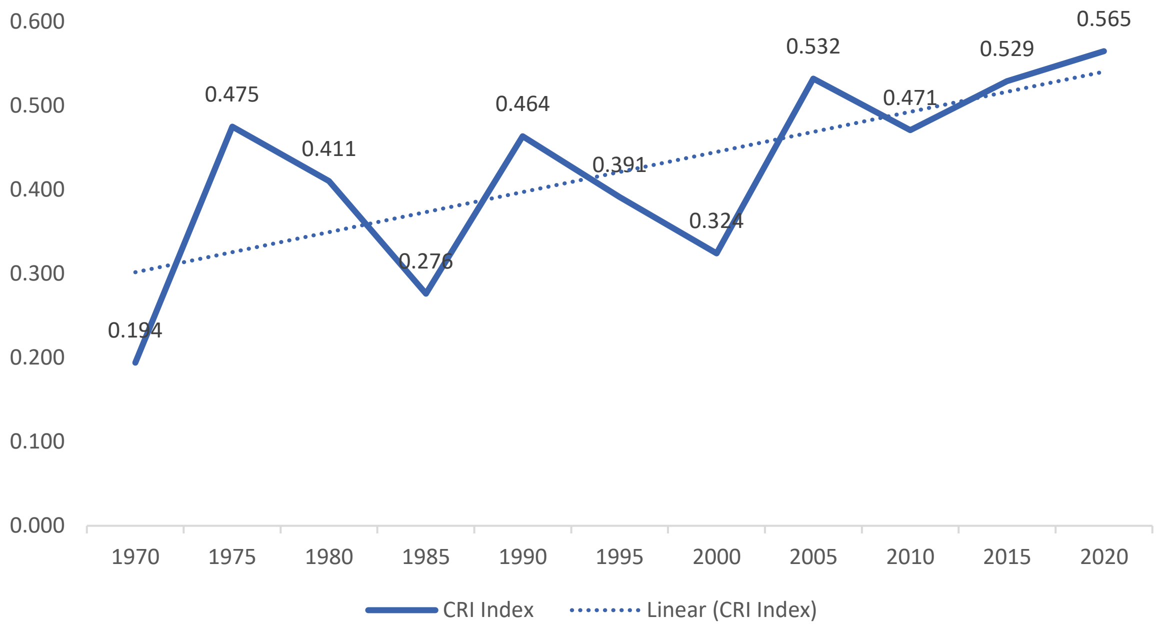


Figure 8: The Trademark Implementation Index

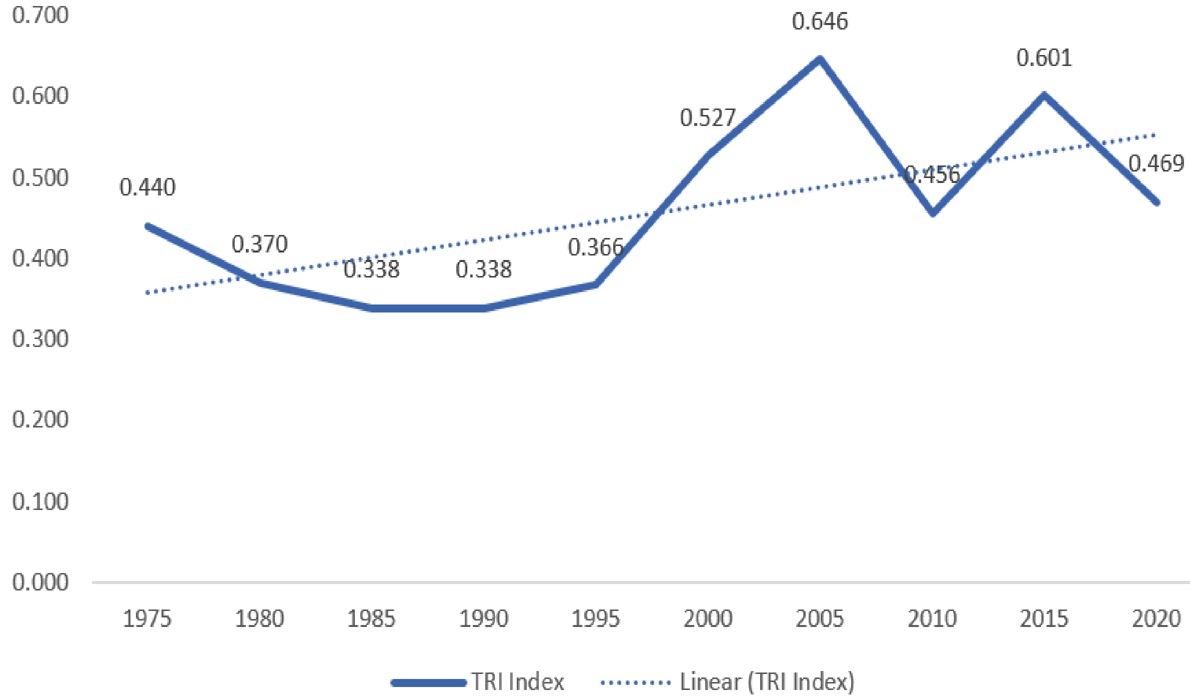


Figure 9: Different Versions of IPR Implementation Index: 1970 to 2020

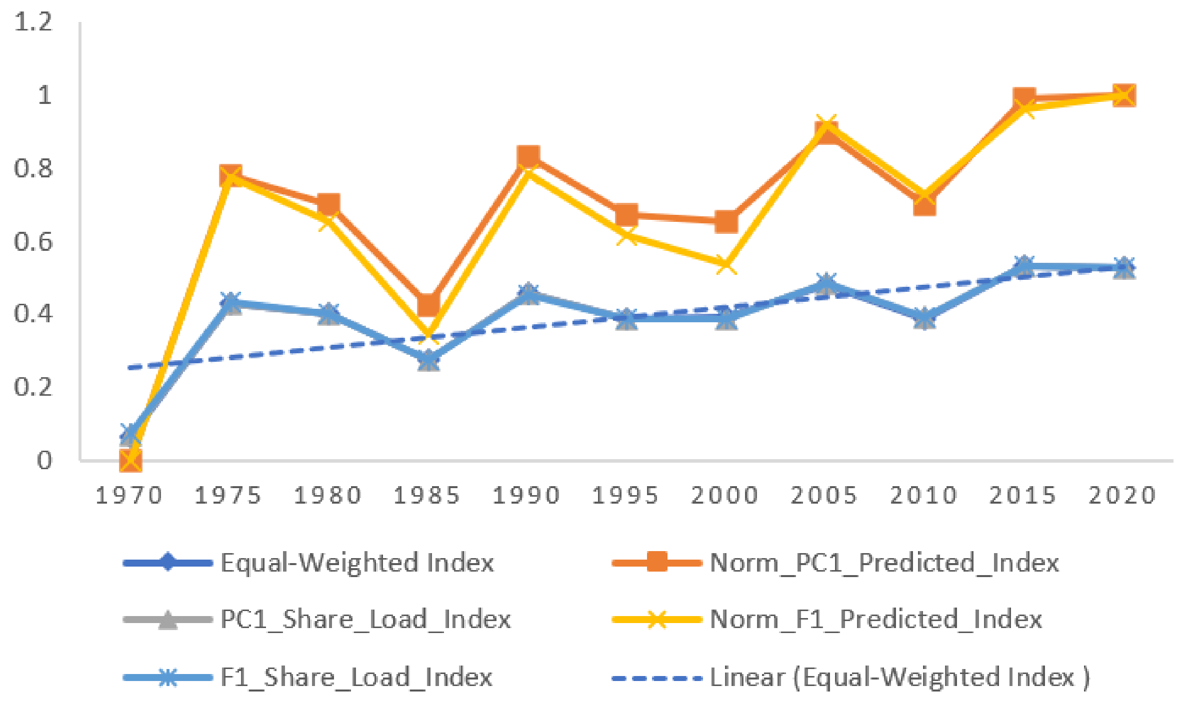


Figure 10: Comparison Between IPRI Index and Normalized GP Index

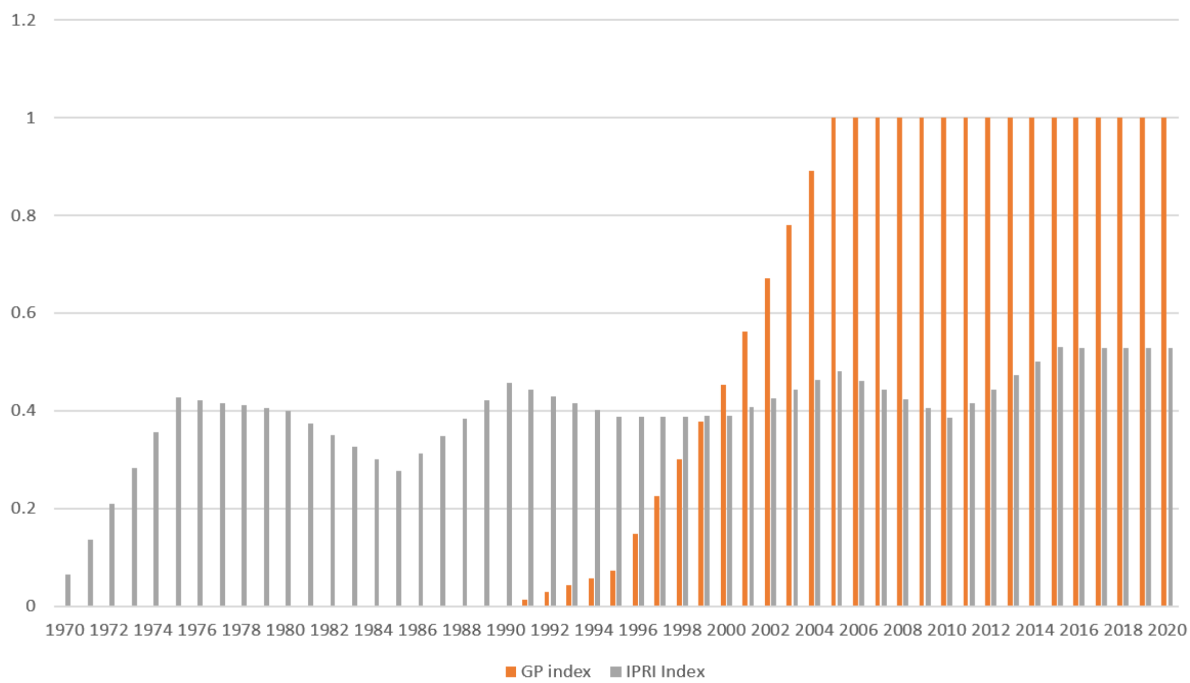
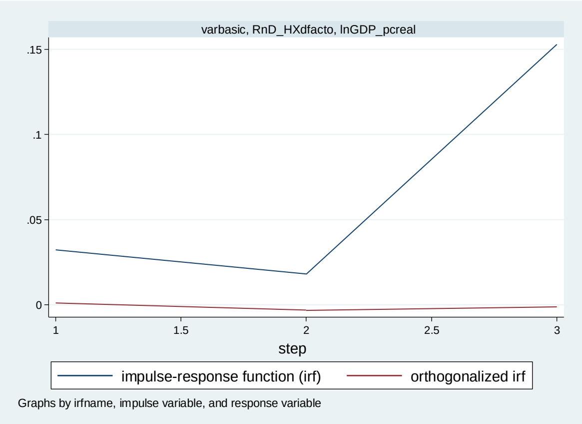
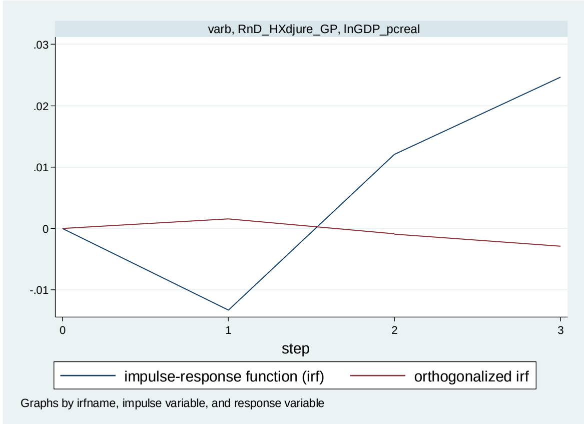


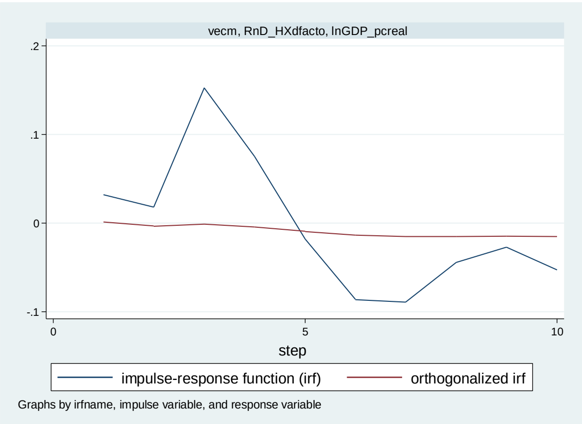
Figure 11: Impulse Response Functions: High Innovation State



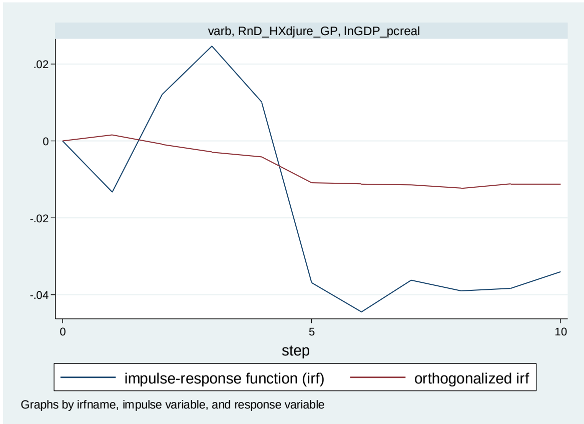
Panel (i): De facto X High innovation: Two steps IRF function



Panel (ii): De jure X High innovation: Three steps IRF function

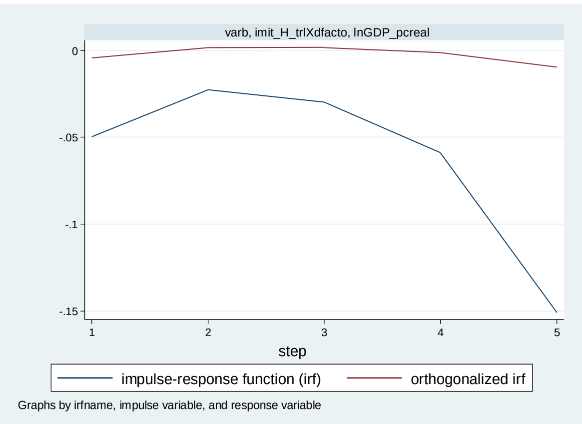


Panel (iii): De facto X High innovation: Ten steps IRF function

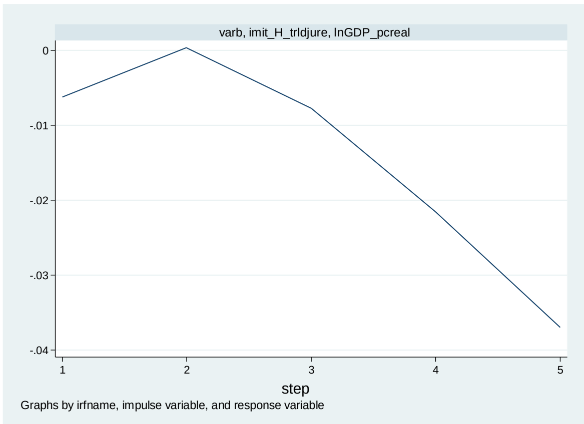


Panel (iv): De jure X High innovation: Ten steps IRF function

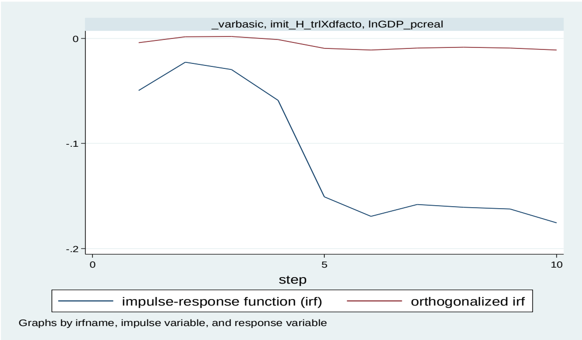
Figure 12: Impulse Response Functions: High Imitation State



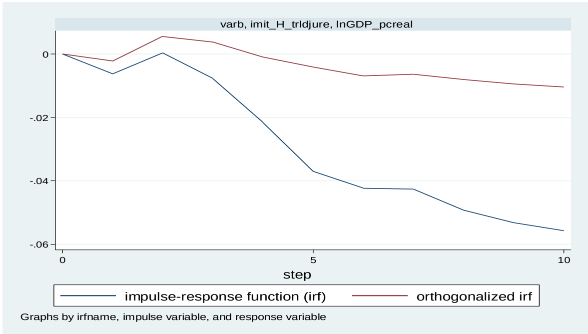
Panel (i): De facto X High imitation: Four steps IRF function



Panel (ii): De jure X High imitation: Four steps IRF function

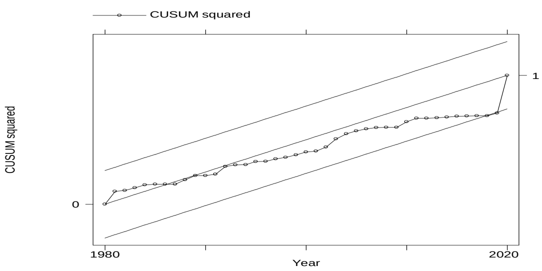


Panel (iii): De facto X High imitation: Ten steps IRF function

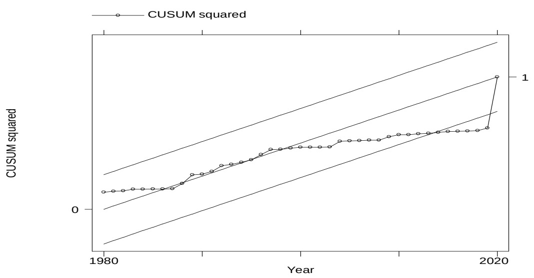


Panel (iv): De jure X High imitation: Ten steps IRF function

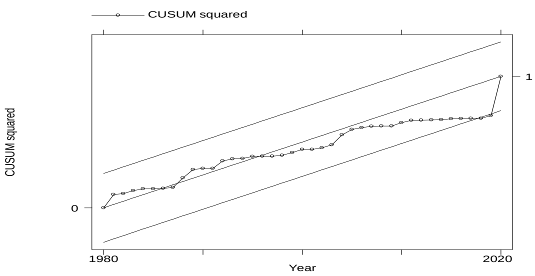
Figure 13: CUSUM Graphs: Model Stability Check for Model 4 Using All 5 Versions of IPR Implementation Index



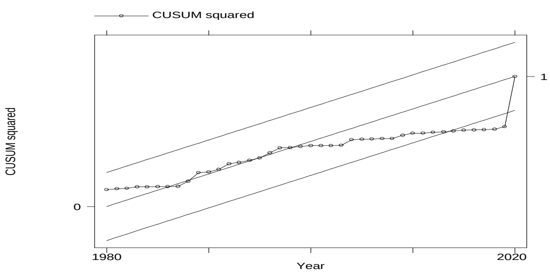
De facto



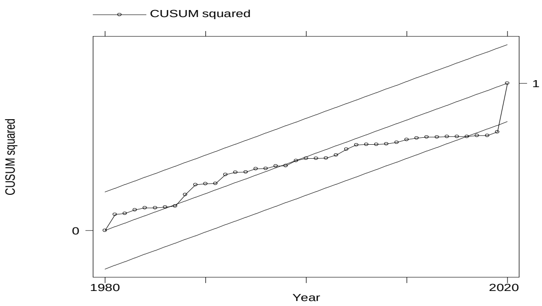
De jure



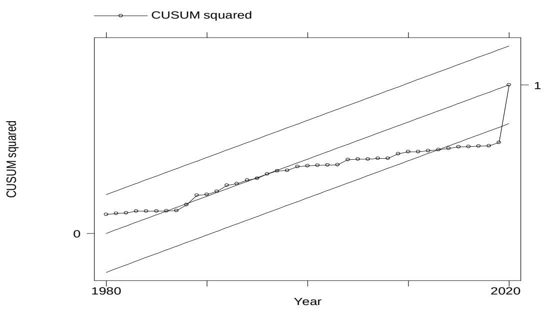
R&D_H X De facto



R&D_H X De jure



Imit_H X De facto



Imit_H X De jure