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Implications of International Harmonization of IPR on Growth and Welfare among Developing Nations

Abstract:

Developing countries and enhancement of intellectual Property Rights (IPR) are the two subject that we discussed more during the last three decades. Even after the implementation of Trade Related Aspects of Intellectual Property Rights (TRIPS) mandate, it is not clear whether the developing countries are making out from the higher levels of IPR. On the assumption that international harmonization of IPR could make all countries better off, especially lower income countries, we considered 99 countries from various income group to test the hypothesis. The present study considers escalation in the welfare of a country as an outcome of stronger IPR, which encourages innovation in the first stage and welfare in the later stage. The study employs new indices, Global competitiveness index and IPRI respectively for welfare and IPR. We find that the role of IPR is different in different countries for promoting innovation and improving welfare and growth.

1. Introduction

Estimation of the relationship between Intellectual Property Right (IPR) and growth is not a new phenomenon in development economics. Theories and empirics revolving around two concepts; one line of research believe and proved that enhancement of IPR improves the economic conditions of the nation whereas the other line of research argues that improvement of property rights benefits only to developed nations, not to the developing one. Based on The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) mandate, developing nations

recently upgraded their standard of IPR protection in order to foster developmental process[1] Stronger IPR protection may generate both positive and negative impact on the economy that again depends on conditions prevailing in each nation (Fink and Maskus 2004). One of such conditions is the level of economic development prevailing in an economy. Hence, one can argue that strong IPR encourages innovation only in advanced industrialized economy. The argument is that developing countries not relied on IPR to foster their innovation as they were in favour of swift diffusion of technology. Keeping in view, IPR may not work both for developed and developing nations, in the same way, increasing the protection for innovation in these two sets of countries are always open to debate. Therefore, a further study, even if it is based on recent data set and new econometric technique, would not add much to the literature, rather it contributes one more study to the debate. The present study, therefore, looks the relationship from another angle- the contribution of stronger IPR on growth and economic welfare through innovation by giving special emphasis to developing nations. The study further gains its importance from one of the arguments of Helpman (1993), who stated that:

"Who benefits from tight intellectual property rights in less developed countries? My analysis suggests that if anyone benefits it is not the south" (Helpman 1993, pp1274). For him 'North' denote advanced developed nation that produces highly refined technologies and 'South' refers to the developing nation that adopts technology from North. Therefore, there arises a question- if the so-called 'South' is not at all benefitting from strengthening their IPR, why those nations should follow the stringent TRIPS obligations.

Two things are important here- economics welfare and its implications on developing nations. Alfred Marshall defines economic welfare in his text book *Principles of Economics* published in 1890 as "the level of prosperity and standard of living of either an individual or a group of persons". By a group of person here we refer to the state. Therefore any policies that lead to the prosperity of a nation can be considered as welfare. Developing countries are mainly known for their 'incremental innovations' and their objectives and mechanisms are different from that of developed nations. Most of the times, these countries have to respond to their local needs for outcomes. One of the example that we can cite here is Chile's experiment with mineral

[1] As per the TRIPs regulation, every member nation should mandatorily follow strict intellectual property law. Though the obligations of TRIPs equally apply to all member nations, least developed nations have had the time frame up to the year of 2013. The transitional period for developing nations, however, has run out in 2005.

extraction. Chile, the world's biggest copper supplier, has come up with smart mining technologies to improve their productivity and operational efficiency-with the objective of satisfying their local needs. Another instance is the so called 'inclusive innovation' in India with the aim of improving the welfare of middle-income household. The small segment four wheelers, Nano car is the best example. In both cases, these innovations are protected by IPR, but growth is not the direct aim of the innovations. Hence, it can be argued that in developing countries innovations are focused on welfare improvement.

It is added that the changing nature of the economy in terms of production and manufacturing could also affect the relationship. The successive paradigm shift in the manufacturing sector could also affect the determinants of innovation as time elapses. For example, during 1913-the second stage of paradigm- society's need was a 'customised product'. However, when it reaches the fifth stage of the production, what society will need is a 'clean product'. Moreover, the technology enabled in the production process has been changing from electricity to bio/material technology during the same period[2]. Therefore, what was not important to the innovation and welfare may be turn out as in important factor and vice versa, according to the present circumstances.

The present study, therefore, argues that stronger IPR induces greater innovations and these innovations further improve the economic and social welfare of developing nations. The study hence would like to analyse the effect of IPR on innovation at the first stage and the impact of innovation on the welfare in the second stage, separately for developed and developing nations. Further, the study would like to analyse the impact of strong IPR on the usual indicators of economic performance like 'growth' a nation. The present attempt tries to make a comparative report on what –welfare or economic growth- is most influenced by the IPR improvement.

1.1 Conceptual Framework

The core contribution of this is to present evidence, based on econometric analysis, of the impact of IPR on the welfare of nations, especially in developing countries. Many literatures identifies the various mechanism by which IPR could affect innovation and vis-à-vis welfare of a nation

[2] A detailed description of the paradigm shift is given in the Appendix (1)

(Grossman and Helpman 1991, Fagerberg et al.2003)[3]. These mechanisms or channels can have opposing influences in different nations and hence the impact of IPR on welfare and growth are ambiguous.

Global scale IP reform has encouraged much academic interest on the cost and benefits of a stronger IP system. One way to analyze the net benefits of the IP reform is the North-South Model (Krugman 1979). The model argues that innovation typically occurs in the North, the region of developed countries. Technologies produced in the North diffuse to South either through licensing or FDI with a lag. These technological lags give rise to trade, with North exporting new products to the south. In this situation, strengthening of IPR in developing countries has become important from the perspective of the developed nation. Effective enforcement of IPR accelerate technology transfer from developed nation to developing nations and hence contribute to economic benefits in the form of growth and welfare (Lai 1998; Glass and Wu 2007). This is however not possible when the transfer of technology is limited to rent transfer from developing to developed nations. Further, the stronger IP enforcement will hamper the ability of local firms in developing countries to experiment with foreign technology at a lower cost and hence diffusion of technology restricted (Glass and Saggi 2002; Branstetter et al. 2007).

The variety - growth model developed by Helpman (1993), on the other hand, explains the *Production shift effect*, in which stronger IPR in the south could lower the long run rate of innovation in the North. The tightened IPR reduces the scope of imitation and hence production back to the North. What is significant here is the modified version of the variety-growth model (Lai 1998). The modified version considers FDI as the major source of foreign technology, however, the model emphasizes a lag between southern and Northern firms in the production process. Stronger IPR believes attract more FDI and hence production occurs in the South through the local subsidiaries of Northern firms. Therefore, both agents will be benefitted and welfare of entire nation increases.

[3] , Economist proved that input growth in production process accounts for only 15% in output growth (Solow 1957, David 1990). Hence, the residual i.e. 85% in output growth is from the technological innovation.

All the models explained above argue that the invention process begins in the North and the South imitate the same with a lag and come to the market with a competitive price. The quality-ladder model argues that both South and North will be benefitted from this act as both sets of countries race to improve each of a continuum of industrial product, earlier for ‘ the last generation' and later for ‘next generation'(Grossman and Helpman 1989).

2. Review of literature

2.1 Discussion on why developing countries need to enhance their IPR strength

Developing countries usually follow the strategy of imitation as a source of their technological development. High cost and risk involved in development and appropriation of new technology are the main reasons. However, with the advancement of globalization and subsequent international trade, domestic recipients of the modern technology are required to provide the minimum standard of protection to the product and process manufactured in developed nations. The discussion therefore mainly concentrate on, is it necessary to maintain a global standard of protection even in the developing nations also?

TRIPS recommendation stipulate the minimum level of protection is followed by each WTO member nation. Based on TRIPS recommendation, recently member nations which are developing in nature began to implement or enhance their level of IPR. Now the question would be is it simply because of the pressure from the developed nations particularly from the United States (US) and European Union (EU) that the developing nations focus on strengthening their IPR?

The main argument for protecting IPR comes from the ‘Public good' attributes of the knowledge. The ‘Non-excludable' character of knowledge increases the possibility of copying or imitating the innovator's ideas which further reduces the potential profitability of the innovator. Since the imitation is less costly than innovation, it is necessary to protect the innovation from imitation from the view point of strengthening value innovation. IPR, therefore, provide adequate ownership of IP by giving a legal power to innovators to recoup from their costlier innovation. Although knowledge is ‘Non-rival' in nature and must be provided at free of cost to maximize the benefit out of innovation, it argues that the benefit will be maximized in the shorter period

only. In the long run, however, the principle will severely damage the incentive of further innovation.

Foreign trade and investment are the second and third reasons. International trade allows developing nations to acquire high value- added goods through import. Similarly, FDI inflows enhance the domestic innovative capacity of a nation by increased investment in R&D and better training. Sufficient protection of IP in developing countries is a pre- requisite to ensure cross border trade and investment into that nation. (Hassan 2010 et al.). Empirical evidence also showed that stronger IPR as a key decision making factor while deciding cross border investment and trade.

2.2.1 FDI Inflow: A case of developing nations versus developed nations

In this section, we examine the case of FDI inflow into developing and developed nation separately to analyze the proposed relationship. Figure (1) shows average growth rate in FDI inflows into developing as well as developed nations. The analysis display a clear difference in the inflow of FDI among these two nations. Developing nation's edge over developed one can be seen as an implication of enhanced protection of property rights in those nations. During 2007-2010 and 2013-2015, the growth rate in FDI inflow became even negative. However, such a negative trend in developing nations appears only once, i.e in 2010. This proves that investor seeks developing nations as the safest place to put their investment, though the motive behind this is unclear.

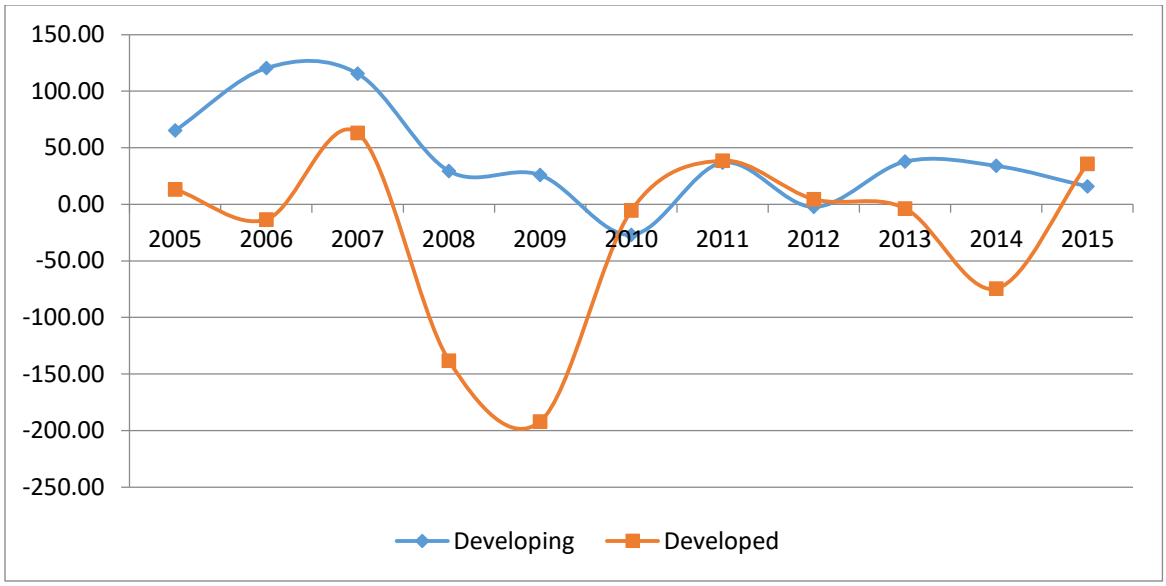
Firms' incentive to invest abroad has been better explained in Dunning's (1979) ownership-location-internalization theory. Transnational Corporation's advantage in 'ownership' is a necessary condition for their overseas investment. This may take in the form of new technologies, technical know- how, organizational skill and so on. In addition to this, 'location' and 'internalization' advantages are sufficient condition to invest abroad. Location advantages are associated with low transportation cost and input prices whereas internalization advantage allied with avoiding transaction cost with prospective licensees.

The strength of the relationship between IPR and FDI hence depends on how the level of IPR affects those three factors. In terms of ownership, it is unclear whether they would be able to

protect the whole part of their intellectual assets. It is however believed that the firm who created the intellectual knowledge is likely to invest in the foreign nation rather than extending a license to any external firms. The main argument behind this strategy is associated with lower technology transfer cost (Saggi 1999). Various levels of IPR protection may also influence the internalization decision and locational advantages of a firm. Given these facts, many argue a positive IPR-FDI relationship. One probable explanation could be the smaller risk of imitation due to the high protection and that leads to a high demand for protected goods (Mansfield 1994). On the other hand, some researchers argue that higher protection leads to licensing their knowledge rather than directly investing in the specific nation (Maskus and Penubarti 1995). Thus the theoretical support on the influence of IPR on FDI is ambiguous. When we come back to the statistics, we could see that transnational corporation is much relying on developing nation for their investment. It could be a case of 'locational' advantage because ownership advantage is greater in developed nation compared to developing nations as the level of IPR is already high in the developed nation.

Fourth, is believed that developing nations are always in the back seat in the production of technology and by largely they depend on developed nation for the same. Hence, without ensuring sufficient protection of their creation in developing nations, northern countries would not develop the technology needed for developing nations (Diwan and Rodrik 1991). Northern developed firms may react to the weak IPR in southern countries by enhancing their technologies more difficult to reproduce which will adversely affect developing nations (Yang and Maskus 2001).

Figure 1 Growth rate in FDI inflow: Developing nations versus developed nations



Source: Analysed from world development Report (various issues)

Domestic innovation consideration is also a matter of strengthening IPRs in developing countries. There are domestic innovative activities that would rise under strong IPR (Chen and Puttitanun 2005). It is quite ambiguous to say whether stronger IP protection encourages or discourages domestic innovation in developing nations. Theoretical models predict that stronger patent protection in developing countries may not add much to the productive R&D and further to the innovation and hence reduces output in the domestic economy (Chin and Grossman 1990; Deardoff 1992; Helpman 1993). Counter-argument affirms that stronger patent protection provides a favourable local environment for local innovators. Hence, even firms' in developing countries can also benefit from innovation. But according to Deardoff (1992), the benefits of such protection gradually diminish as and when more and more countries adopt stronger IPR protection for their creativity. The reason is that adopting a global level standard of IPR protection reduces the scope of extra innovation that can be stimulated by additional protection. Hence, there should be an optimum level of IPR in developing countries that would enable imitation of the foreign technologies as well as provide an incentive for domestic innovation. From these arguments, we could interpret that harmonization of IPR may or may not increases welfare and growth.

2.2. Factors affecting innovation and welfare/growth

The study estimates the relationship between IPR and welfare/growth indirectly through innovation. Since the study argues that IPR stimulates innovation and innovation further accelerate growth and welfare, this section concentrate on major determinant/s of innovation and welfare/growth. Strengthening IPR could lead to greater innovations in developed nations and hence indirectly benefits to developing nations (Taylor 1994; Kanwar and Evenson 2003; Kanwar 2006). These indirect benefits arise in the form of FDI, trade or licensing. By creating an environment conducive to human knowledge accumulation, IPR may spur innovation and growth. IPR could affect developing countries negatively when they are not in a condition to undertake R&D activities for further development of IPR based product and processes (Sakakibara and Branstetter 2001; Falvey et al. 2006; Horii and Iwaisako 2007). It is deduced from the literature that IPR is the major determinants of innovation and these innovations promote the welfare of a nation, at least in the developing nations. R&D expenditure (RDE), considered as an input of the innovation is the second major factor that affects innovation (Chen and Puttitanun 2005).

Qian (2007) finds that IPR, particularly National patent protection, alone do not stimulate economic growth and welfare. It requires a higher level of technological development along with educational attainment and economic freedom. We measure technological ability through annual per capita GDP growth rate as an explanatory variable. To measure education variable (EDU), we use the percentage of total enrolment in the tertiary sector among the school age population. To measure the openness of a nation (OPEN), we use international trade volume (import and export) as a percentage of GDP.

We consider three variables Resident Patent Application (PAT), OPEN and domestic investment (INV) as explanatory variables in the welfare equation. INV is the residual of the difference between FDI inflow and gross fixed investment. The same method adopted in Kumar and Pradhan (2002). Apart from these three variables, we have considered FDI inflows and RDE as independent variables in the growth equation.

Till 2005, IPR is conferred by national government and they will choose a strategy of what they perceived to be the best for the nation. Contrary, if it is enforced by a global agency, they could be in a position to decide the appropriate level of IPR which brings maximum benefit to all. The

present research, therefore, examines the conditions under which a nation could adopt strong IPR that will bring certain kinds of benefit to the nation. Hence the research would like to contribute to the following aspects:

1. Re-examining the direct link between IPR and growth both in developed and developing nations based on a recent set of data.
2. Find out the relationship between IPR and domestic innovation
3. Examine the relationship between IPR and welfare through innovation? i.e there could be an association among IPR and innovation in the first hand and between innovation and welfare in the second.

3. The model, Econometric issues, and data

The present model is formulated on the basis of a system of two simultaneous equations; one deals with innovation and other for growth and welfare.

$$INN=f\ (IPR, Xit) \qquad (1)$$

$$GCI/GROWTH= f\ (INN, Zit) \qquad (2)$$

Where INN is domestic innovation, represented by residents patenting, GCI is global competitiveness index- a measure of welfare and IPR is intellectual property right score. GROWTH denotes per capita income growth. Xit and Zit are the explanatory variable influences both innovation and welfare and Growth measures respectively.

To measure welfare, we use Global Competitiveness Report (GCR) published by World Economic Forum. The GCR, after considering the critical factors that drive to growth and competitiveness, constructed an index known as Global Competitiveness Index (GCI). GCI consists of nine pillars that include, (i) institutions, (ii) infrastructure, (iii) macroeconomy, (iv) health and primary education, (v) higher education and training, (vi) market efficiency, (vii) technological readiness, (viii) business sophistication and (ix) innovation. The impact of these variables on nation's welfare varies according to their characteristics. Hence, GCI has given adequate weight to each variable while constructing the index. The present study, however, does not consider GCI score per se for evaluating the relationship. The index includes 'innovation' as

one of the pillars. Therefore, we removed innovation score from the GCI score after considering the due weight associated with each country[4]. IPR could stimulate nation's growth as well. Therefore, the second dependent variable in the performance equation is growth, measured by per capita income growth. We consider per capita income growth instead of the level of per capita to tackle the business cycle aspect (Chen and Puttitanun 2005).

R&D expenditure and patent counts are the widely used measures of innovation, with earlier as the input and the later as out of the innovation (Ambrammal and Sharma 2014). We use patent application by residents (PAT) as a dependent variable in the innovation equation and as an independent variable in the welfare and growth model. R&D expenditure (RDE), percentage of GDP has been considered as an explanatory variable in all the models.

IPR is considered to be the major determinants of innovation (Hu and Jaffe 2007). We include the International Property Right Index, a publication of Property Rights Alliance, for measuring the IPR strength. The IPRI consists of three components, (i) legal and political environments, (ii) physical property rights and (iii) intellectual property rights[5]. We have also obtained data on several other variables that may affect innovation or welfare. Data on the measure of economic freedom (EF) obtained from www.freethewold.com (Gwartney et al. 2003). The index ranges from 0 to 10 with a higher index indicating a higher level of economic freedom. We have collected data from various sources. Most of the data come from the World Development Indicators (WDI), World Economic Forum and Freetheworld.

A large sample of countries say, 99, has been assembled for this study, covering the time period 2005– 2015. The selection of 2005 as a base year has its own important and justified in the sense that, developing countries have had to enhance their IPR by 2005. The sample of countries is diverse, representing different income groups and institutional environments[6]. Therefore, all the

[4] The exclusion factor will be (current innovation value X innovation weight in the current year) /100.
[5] The detailed descriptions are given in the appendix.
Available at : http://s3.amazonaws.com/ipri2016/IPRI+2016+Full+Report.pdf
[6] List of countries are given in Table A2 in Appendix

countries have been grouped into three, lower middle, upper middle and higher income countries, based on World Development Report (2005)[7].

3.1 Econometric specification

The empirical model is a system of two simultaneous equations. One for domestic innovation and one for welfare and growth. The system of equations can be expressed as:

$$INN = f(IPR, IPR^2, RDE, EDU, OPEN, GROWTH) \quad (3)$$

$$GCI[8] = f(INN, INV, OPEN) \quad (4.1)$$

$$GROWTH = f(INN, INV, FDIINF, OPEN, RDE) \quad (4.2)$$

For equation 3, based on theory, both EDU and R&D could have positive effects if they encourage innovation. According to literature, RDE is considered to be an endogenous regressor of innovation. Therefore, we have adopted the two-stage least square technique to tackle with endogeneity. For equations 4.1 and 4.2, we expect a positive relationship between INN and dependent variables, again if innovation encourages growth and welfare.

4. Empirical results

4.1 Description of the data

Table 1 provides a summary of data used in this analysis. For all those variable with a standard deviation less than or equal to 1 has been converted into natural logarithm format. All the other variables have considered in their original format.

Table 1: Summary statistics of the data

Variable	Obser:	Mean	Std. Dev.	Min	Max
GCI	1100	3.62	0.49	0.00	4.94
EF	1085	7.02	0.85	2.93	11.00

[7] Lower middle income ($1026-$4035), Upper Middle Income ($4036-$12475), Higher income countries ($12476 and above).

[8] Since GCI is a composite index of many variables that are supposed to be there as explanatory variables, we have considered only three as independent variables.

IPRI	1089	5.57	1.54	0.00	8.70
EDU	795	46.60	26.13	0.47	113.87
POPL	1089	6.11E+07	1.84E+08	403834	1.37E+09
INN	863	8865.04	31265.29	1.00	301075.00
RD	636	1.20	1.02	0.02	4.41
GDP CONSTANT	1087	8.57E+11	2.19E+12	9.35E+09	1.86E+13
OPEN	1078	94.65	66.52	21.45	455.42
INFLATION	1072	29.16	746.20	-4.86	24411.03
FDIINFLOW	1086	6.87	24.84	-58.98	451.72
INV	1066	17.20	26.24	-430.74	79.38
GDP GROWTH	1087	3.76	4.11	-17.67	26.28
PER GDP GROWTH	1089	2.34	3.90	-19.06	24.67

4.2 Regression analysis

The present section describes all the results obtained from regression analysis. Section 5.2.1 explains results from determinants of innovation. In section 5.2.2, we have the results of welfare equations followed by growth equation in the next section.

4.2.1 Factors influencing innovation

This section analyses the results obtained from innovation equations. We consider innovation as a function of IPR and other related variables. The results of gmm are given in Table (2) under three heads. Column 1 includes results from all countries whereas columns 2 to 4 show results of lower middle income, upper middle income, and higher income countries respectively.

The nonlinear relationship between IPR and domestic innovation is established in the regression as the estimated coefficients are negative for IPRI and positive for IPRI ^{2}. However, for HICs, the coefficient of IPRI is positive and IPRI^2 is negative though it is not significant. These results establish that IPRI may not work in the same way for both developed and developing nations. In developing countries, the impact of imitation dominating over innovation in the early stages. One of the probable reasons could be at the initial stages the countries technological ability well suit for imitating foreign technologies, rather than efficient domestic innovations. However, as the law becomes prominent, innovation getting dominating over imitation and showing some signs of improvement. Therefore, IPRI becomes positively significant in the later stages. This proves the 'U' shape relationship established in the literature (Maskus 2000; Primo Braga et al.2000).

This is true for the FULL, LMI and UMI countries whereas, HICs these relationship doesn't hold. The reason is for HICs, IPR is strong prior to 2005 and hence there is no improvement over the years. So, there is no reason to expect any kind of positive relationship between IPR and innovation. As we see from the literature, now HICs aim to focus their production with LMI countries to exploit the opportunities opened there.

Education, a proxy of quality of researcher, positively significant for FULL, LMI and UMI. However, this is not significant for HIC. Across the models, only LMI produce positive and significant coefficients of RDE. This implies domestic innovation in LMI has been supported by R&D expenditure.

Table 2: GMM estimation of innovation equations

	Full (1)		**LMI(2)**		**UMI (3)**		**HIC (4)**	
INN	Coef.	Std. Err/Z	Coef.	Std. Err/Z	Coef.	Std. Err/Z	Coef.	Std. Err/Z
IPRI	-0.153	0.152 (-1.01)	**-0.731**	**0.396** **(-1.85)***	**-2.795**	**1.676** **(-1.67)***	0.269	0.244 (1.11)
IPRI2	**0.033**	**0.015** **(2.26)****	0.053	0.047 (1.13)	**0.318**	**0.185** **(1.72)***	-0.007	0.02 (-0.33)
RDE	-0.380	0.355 (-1.07)	**0.408**	**0.185** **(2.21)****	-1.494	1.924 (-0.78)	0.163	0.491 (0.33)
EDU	**0.649**	**0.205** **(3.16)*****	**1.115**	**0.331** **(3.37)*****	**2.109**	**1.102** **(1.91)***	-0.169	0.189 (-0.9)
OPEN	-0.044	0.251 (-0.17)	0.554	0.33 (1.64)	-1.317	0.827 (-1.59)	0.065	0.365 (0.18)
GROWTH	0.013	0.031 (0.41)	0.045	0.075 (0.6)	-0.052	0.14 (-0.37)	-0.009	0.034 (-0.27)
LM stat	25.74 (0)***		4.84(.09)***		1.712(.42)		20.31(0)***	
Hansen J	0.079 (0.78)		0.66(0.42)		0 (.99)		4.079 (0.04)***	
Observation	354		58		81		215	

4.2.2 Innovation-welfare analysis

This section details the relationship between domestic innovation and nation's welfare. Regression with all nations shows that there is a certain improvement in nation's welfare from domestic innovation. Nation's welfare could increase by 0.003 per cent when there is a 10% increase in domestic innovation (INN). Among the group of countries, UMIs are the most benefitted, as the increment is about 0.007 for every 10 per cent increase in domestic innovation. And for LMIs it is estimated as 0.006. The important thing to be noted here is that INN does not influence the welfare of HIC. One of the probable reasons is, LMI and UMI group of countries

enjoy immediate benefits from stronger IPR in the form of GCI. HIC, on the other hand, would benefit from stronger IPR (both in North and South) in the form of economic growth. To test this, we have considered the growth of per capita income as a dependent variable and the result of the same will be discussed in the next session.

Openness, measure the volume of export and import as a percentage of GDP, produces mixed evidence on the welfare. Both LMI and HIC are negatively affected from the openness whereas, UMI is positively affected by it. The reason why LMI is negatively affected might be their strong dependence on import of fuel. For HICs, the case is however, attributed to income growth. What we can judge from UMI's positive response to OPEN is their dependence on import of high technology product. By providing sufficient environment for upgrading the imported high tech product, UMI is benefited in the form of welfare.

Table 3: Welfare equations

	(1) FULL		**(2) LMI**		**(3) UMI**		**(4) HIC**	
gci	Coef.	Std. Err/Z	Coef.	Std. Err/Z	Coef.	Std. Err/Z	Coef.	Std. Err/Z
INN	**0.034**	0.002 (14.6)***	**0.055**	0.010 (5.6)***	**0.068**	0.005 (14.3)***	-0.007	0.004 (-1.5)
INV	0.080	0.014 (5.7)***	0.215	0.038 (5.7)***	0.176	0.037 (4.8)***	-0.025	0.015 (-1.6)
OPEN	0.075	0.014 (5.3)***	-0.082	0.048 (-1.7)*	0.272	0.031 (8.9)***	-0.074	0.020 (-3.7)***
CONS	2.936	0.088 (33.4)***	3.013	0.223 (13.5)***	1.724	0.179 (9.6)***	4.179	0.135 (30.9)***
OBSER	779		200		189		390	

4.2.3 Innovation –Growth analysis

Analysis based on Per capita GDP growth as a dependent variable showed that it is not innovation but domestic investment (INN) play the crucial role in the growth process of nations from various income groups. The innovation elasticity (0.63) is high among UMI and low (0.32) for HIC. We could see that the innovation elasticity is 0.6 for LMI which is not so different from the elasticity of UMI. Another variable which is crucial for the growth of all countries is FDI. The variable is positively significant among all the group of countries. For LMI, openness affects

negatively whereas, for HIC, the variable produces a positive influence. For HIC, openness help them to grow positively, whereas for other countries the variable isn't produce any significant effect. It is remarkable to note that, the variable OPEN negatively influences HIC's welfare contrary to the positive influence on growth.

Table 4. Growth function

	(1) FULL		**(2) LMI**		**(3) UMI**		**(4) HIC**	
lgdp	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
INN	**0.027**	0.012 (2.27)**	0.019	0.045 (0.42)	0.038	0.043 (0.9)	0.009	0.021 (0.44)
INV	**0.402**	0.056 (7.11)***	**0.569**	0.182 (3.13)***	**0.631**	0.209 (3.02)**	**0.322**	0.065 (4.94)
FDIIN	**0.325**	0.031 (10.44)***	**0.263**	0.081 (3.25)***	**0.471**	0.097 (4.88)***	**0.292**	0.039 (7.4)
OPEN	0.021	0.048 (0.44)	**-0.356**	0.165 (-2.16)**	-0.086	0.125 (-0.69)	**0.183**	0.075 (2.42)
RDE	-0.227	0.026 (-8.71)***	0.044	0.059 (0.74)	0.013	0.128 (0.1)	**-0.214**	0.049 (-4.38)
CONS	-0.646	0.292 (-2.22)**	1.030	0.670 (1.54)	-0.888	0.646 (-1.37)	-1.046	0.540 (-1.94)

5. Discussion, Policy implications, and conclusion

In this paper, we discuss the impact of strong IPR on the welfare and growth of a nation. It has been argued that the effect of strong IPR varies across nations according to their level of development. The present study, therefore, considers three categories of nation separately, i.e LMI, UMI, and HIC. Based on the nature of the data, we follow suitable econometric strategies that take into account of issues like count data, endogeneity, and heterogeneity among the variables. There was an ambiguity among the previous researchers regarding how IPR stimulate growth and development of a nation. The study, therefore, consider domestic innovation as an intermediate variable connecting between IPR and welfare. The study showed that IPR encourages domestic innovation and that further stimulate growth and welfare. The statement, however, is not applicable in the same way for all group of countries. The results showed that for LMI and UMI group, IPR affects negatively at the initial stages but turn to be positive in the later stages, possibly with a 'U' shape. In these two set of countries, innovation is the crucial factor

for welfare improvement. Growth, however, has not influenced by innovation. For HIC, neither welfare nor growth has improved from IPR and domestic innovation.

It is proved that strong IPR does not directly influence welfare and growth, it has to be supported by domestic investment and innovation. Since there is a strong evidence on the influence of IPR on innovation and further to welfare and growth particularly among the LMI and UMI, the study proposes to keep the present levels of IPR among these two sets of countries.

The study is limited in the sense that we could not measure the welfare gains/losses to consumer due to stronger protection on intellectual property rights. According to theory, stronger IP could harm welfare of consumers, but the loss in consumer welfare might have been offset by entire welfare gains. Hence, we got a positive welfare effect due to strong IPR.

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Appendices

Table A1: Manufacturing: Successive paradigm shifts

Paradigm	Craft Production	Mass Production	Flexible Production	Mass Customization & Personalization	Sustainable Production
Paradigm started	1850	1913	1980	2000	2020
Society Needs	Customized products	Low cost products	Variety of Products	Customized Products	Clean Products
Market	Very small volume per product	Demand > Supply Steady demand	Supply > Demand Smaller volume per product	Globalization Fluctuating demand	Environment
Business Model	Pull *sell-design make assemble*	Push *design-make assemble-sell*	Push-Pull *design-make sell-assemble*	Pull *design-sell-make assemble*	Pull *design for environment -sell-make assemble*
Technology Enabler	Electricity	Interchangeable parts	Computers	Information Technology	Nano/Bio/ Material Technology
Process Enabler	Machine Tools	Moving Assembly Line & DML	FMS Robots	RMS	Increasing Manufacturing

Adapted from Jovane et al (2003)

Table A2: List of countries

HIC		UMI		LMI & low income countries	
Australia	Latvia	Albania	Malaysia	Armenia	Pakistan
Austria	Lithuania	Algeria	Mauritius	Bangladesh	Philippines
Bahrain	Luxembourg	Angola	Mexico	Bolivia	Sri Lanka
Belgium	Malta	Botswana	Panama	Cameroon	Tunisia
Canada	Netherland	Brazil	Paraguay	Egypt	Vietm
Chile	New Zealand	Bulgaria	Peru	El Salvador	Zambia
Croatia	Norway	China	Romania	Guatemala	Argentina
Cyprus	Poland	Colombia	Russia	Honduras	Ethiopia
Czech Republic	Portugal	Costa Rica	South Africa	India	Madagascar
Denmark	Quatar	Dominican Republic	Thailand	Indonesia	Malawi
Estonia	Singapore	Ecuador	Turkey	Kenya	Mali
Finland	Slovakia	Jamaica	Venezuela		Mozambique
France	Slovania	Jordan		Morocco	Nepal
Germany	South Korea			Nicaragua	Tanzania
Greece	Spain			Nigeria	Zimbabwe
Hong Kong	Swedan				
Hungary	Switzerland				
Ireland	Trinidad and Tobago				
Israel	UAE				
Italy	United Kingdom				
Japan	Uruguay				
Kuwait	US				