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Economic Research-Ekonomska Istraživanja

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rero20

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To cite this article: Shiue-Hung Lin & Leslie Wu (2022) Intellectual property rights and law enforcement in developing countries, Economic Research-Ekonomska Istraživanja, 35:1, 143-157, DOI: 10.1080/1331677X.2021.1889390

To link to this article: https://doi.org/10.1080/1331677X.2021.1889390

ECONOMIC RESEARCH-EKONOMSKA ISTRAŽIVANJA
2022, VOL. 35, NO. 1, 143–157
https://doi.org/10.1080/1331677X.2021.1889390

Intellectual property rights and law enforcement in developing countries

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ABSTRACT

The attitudes of developing countries for intellectual property rights (IPR) regulations and law enforcement are ambiguous. We seek to clarify this issue by structuring a model, simultaneously considering the IPR index and the strength of law enforcement of China in period 1996–2015. Firstly, the government of a developing country always holds the strictest attitude towards law enforcement. Secondary, the growing level of IPR leads to the decrease of the total welfare, but the decline of total welfare slows down. Third, the motivation of maximising total welfare induces the governments of developing countries to strengthen law enforcement. This provides internal motivation for development. The findings of this article show that developing countries have long-term internal motivations to improve their strength of IPR levels and law enforcement.

ARTICLE HISTORY
Received 2 June 2020
Accepted 7 February 2021

KEYWORDS
Vertical differentiation; intellectual property rights; law enforcement; quality

JEL CLASSIFICATION
I31; L15; O34

1. Introduction

The World trade and investment report (2018) by Japan External Trade Organization (JETRO) estimates that total global trade in 2017, measured by exports, rose 10.5% from a year earlier to $17.3162 trillion. At the same time, the reports by WTO and multinational corporations claim that, alongside the expansion of international trade and multinational corporations, there are more and more issues about intellectual property rights (IPR) across different countries.[1] Especially for developing countries, a relatively tight IPR regulation could inhibit economic growth during the early stages of economic development. This hampers the government's incentive for strengthening IPR legislation and related law enforcement. However, from the perspective of developed countries, a strict IPR regulation curbs the spillover effects of technology and avoid malicious imitations. Hence the question: Apart from international pressures, do governments of developing countries have endogenous motivations for strengthening IPR regulations and law enforcement? This means that in addition to the external

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pressures from the international community (such as TRIPS under the WTO framework) that generally require developing countries to raise their IPR levels, do developing countries themselves have internal motivations to actively raise their IPR levels and law enforcement? This is the research question of this article to investigate and answer.

Past studies have inconsistent viewpoints on whether developing countries have internal motivations to improve IPR levels. Markusen (2001) finds that the improving level of intellectual property protection in developing countries benefits the development of bilateral trade between developed countries and developing countries, hence improves the welfare level of both sides. Yang and Maskus (2001) establish a dynamic general equilibrium model of the product cycle, demonstrating that stronger intellectual property protection actually increases innovation and licensing rates. Mueller et al. (2013) believe that developing countries with low share of intellectual property have problems in acquiring intellectual property, affecting their economic competitiveness. However, this research also shows that only a small number of companies give up innovation due to the lack of intellectual property needed for production. To comply with existing IP policies, most companies seek to acquire IP or modify innovative projects. On the other hand, Deardorff (2011) finds that from the perspective of static partial equilibrium, strengthening the protection of IPR in developing countries inevitably strengthens the market power of developed countries and consequently raises the commodity price of the exports from developed countries and damage developing country's welfare. Helpman (1992) shows that, in the long run, developing countries face higher barriers to stronger intellectual property protection because the cost of imitating is higher and the availability of technology is lower. Grossman and Lai (2004) conclude that, viewing as a non-cooperative game, under the open economic system, small countries tend to implement weak intellectual property protection for the benefits of free riding. Empirical researches by Qian (2007) and Lerner (2009) show that, with an already high level of IP protection, further strengthening IP protection hampers innovation.

The recent literature also provides some different perspectives on the internal motivations of developing countries to arise IPR levels. Sweet and Maggio (2015) uses the index of economic complexity of 94 countries from 1965 to 2005 to test the impact of ever more rigorous IPR systems on innovation. The results of this article find that only countries with an initial above-average level of development and complexity have a positive effect of innovation by stronger IPR. Hwang et al. (2016) builds a vertically related market model to investigate the impact of IPR protection on less-developed countries. This paper finds there exists a U-shaped relationship between IPR protection and economic development. Moreover, the IPR protection will change with income increasing in less-developed countries. It implies that the governments of less-developed countries have sufficient motivations to appropriately adjust the IPR protection. Yang et al. (2016) investigates that how does a stronger patent system in developing countries to affect the quality of transferred technology and welfare. The results present that a stronger patent system would drive the decline of the quality of licensed technology. Furthermore, the presence of technology licensing would derive a government of developing country to adopt a stronger patent

system. It directly reflects the incentive of maximum welfare for developing countries. Furthermore, Bondarev (2018) indicates that a stronger IPR would arise R&D activities of the Multinational Enterprise (MNE). Moreover, the presence of productivity bias or variety bias in R&D process will be more suitable in technology-specific heterogeneous IPR protection regimes. It provides a recommendation of building a IPR system for developed (developing) countries. Sweet and Eterovic (2019) uses the dynamic panel regression analysis for 70 countries from 1965 to 2009 to test the effects of patent rights systems on total factor productivity growth. This article finds that stronger patent rights systems would derive insignificant effects on productivity growth in both developing and industrialised countries. It is different from the viewpoints of classic economic theory.

By reviewing the past and recent literature, this study observes that developing countries have inconsistent conclusions on the internal motivations of arising IPR levels. Some of the articles in the above-mentioned literature (e.g.,Bondarev, 2018; Hwang et al., 2016; Markusen, 2001; Mueller et al., 2013; Sweet & Maggio, 2015; Yang & Maskus, 2001; Yang et al., 2016) have a positive attitude towards the internal motivations of developing countries to improve IPR levels. Because this will allow developing countries to gain growth in welfare, innovation, and licensing rates. This is equivalent to having sufficient internal motivations to improve the level of IPR. On the contrary, some other literature (e.g., Deardorff, 2011; Grossman & Lai, 2004; Helpman, 1992; Lerner, 2009; Qian, 2007; Sweet & Eterovic, 2019) holds a negative attitude towards the impact of increasing IPR levels in developing countries. This also means that developing countries do not have sufficient internal motivations to actively improve IPR levels. Based on past literature on the pros and cons of developing countries for increasing IPR levels, as well as the external pressure from the international community on developing countries. The hypotheses development of this study is to explore whether there are internal motivations for developing countries to improve the level of IPR, and to further include the influence of the country's law enforcement of IPR. The intensity of law enforcement in IPR can better presents the internal motivations of a country's government to improve the level of IPR. At the same time, it also discusses the attitudes of the governments of developing countries towards IPR law enforcement at any given IPR level.

For most developing countries, they are probably not consistent between protection of static indicators and realistic protection (Han & Li, 2005). The above situation is directly reflected in the differences of law enforcement on IPR. We build on works by Han and Li (2005) and Qi et al (2008) to calculate the IPR indexes and law enforcement of China for the period 1996–2015. Based on these indicators, we structure a model of vertical product differentiation, simultaneously considering the IPR index and the strength of law enforcement. We further analyse the competition between domestic firms and foreign firms. It is worth to mention that this article uses the case of China as a representative of developing countries for analysis. The main reason lies in China's vast market and rapid economic growth. This helps us to observe the issue of the internal motivations of developing countries on the strength of IPR levels and law enforcement. China's vast market attracts investment from all over the world, as well as any form of technology transfer. For these multinational

companies, it is necessary for the investee countries to formulate a degree of IPR sufficient to avoid excessive technological spillover effects. Although for a developing country likes China, in order to protect its own industries and interests, imposes on foreign-funded enterprises for different levels of requirements and restrictions. But, this is often observed in the economic development of many developing countries, including various tariff, non-tariff barriers and administrative measures. In addition, China's rapid economic development also helps this article observe the Chinese government's internal motivations and attitudes towards IPR levels and law enforcement. Especially, the need of domestic enterprises for IPR and law enforcement in the process of rapid economic growth lies on an important key position. Based on above descriptions, the conclusions of this article will show consistent results in different developing countries. The only difference lies in the degree of impact of IPR levels and law enforcement on social welfare in different countries. Finally, the investigations of this paper are in three major findings. Firstly, the government of a developing country always holds the strictest attitude towards law enforcement in a specific interval at any given level of IPR index. Secondary, a stronger IPR protection derives the decline of total welfare in a developing country, but the speed of decline slows down as the level of IPR increases. Third, the motivation of maximising total welfare actuates the governments of developing countries to intensify law enforcement as the IPR protection rises. The implication is that a developing country has sufficient motivation to strengthen the IPR regulations and law enforcement alongside the development of economy.

This research proceeds as follows. Section 2 describes the basic settings of our vertical product differentiation model under quantity competition. The section also explains the IPR-mode. Section 3 demonstrates the IPR-mode equilibriums and presents the IPR indexes and IP law enforcement of China. Section 4 describes the simulations and comparative analysis. Section 5 concludes the paper.

2. The basic model

This model assumes that there are two countries in the world--foreign which represents developed countries and domestic which represents developing countries. These two countries respectively own a monopolistic firm for producing vertically differentiated goods which are sold in the domestic market. Foreign goods quality is opposite superior to domestic goods quality. Meanwhile, foreign goods are more expensive than domestic goods. In addition, the demand of differentiated goods exists in the domestic country. It implies that the foreign firm competes with the domestic firm in the home country. Furthermore, the market is uncovered, which means that not every consumer in the domestic market will purchase one unit of the goods. The paper discusses IPR-mode of trade. We analyse the competition between the ex-ante game, non-cooperative and two-stage firms. The assumed world is a foreign direct investment (FDI)-mode trade environment and domestic firm must face a IPR-limited competing structure. Taking the level of IPR as given, at each stage, both the firms simultaneously choose the quality level and quantity produced to maximise their profits. Firstly, the foreign firm is based on consumer preference to compete on

product quality with the domestic market. Secondly, the two firms simultaneously choose the quantity of their goods to maximise profits in the second stage.

2.1. The demand side

The consumer continuum distributes in the domestic market. Each consumer is identified by their own taste parameter θ. The taste of consumers is uniformly distributed over the interval $[0, \overline{\theta}]$. The size of the market is $\overline{\theta}$. The demand function of each consumer is given by:

$$\begin{cases} U = (\theta s_i - p_i) \ \textit{if a consumer buys one unit goods with the quality level } s_i; \\ 0 \ \textit{otherwise} \end{cases} \tag{1}$$

Quality (s_i) is endogenous. The foreign and domestic goods quality are denoted by s_h and s_l, and be assumed as $s_h > s_l$. In the uncovered market, we derive the marginal taste ($\hat{\theta}$) who corresponds to the consumer got the same utility on buying the foreign goods or domestic goods. Similarly, we also derive the marginal taste ($\sim \theta$) who got the same utility on buying domestic goods or none at all.

$$\theta s_h - p_h = \theta s_l - p_l \Rightarrow \hat{\theta} = \frac{p_h - p_l}{s_h - s_l} \ \ (\textit{assume that } \ p_h \geq p_l)$$

$$\theta s_l - p_l = 0 \Rightarrow \tilde{\theta} = \frac{p_l}{s_l}$$

It implies that in the interval $[\hat{\theta}, \overline{\theta}]$, consumers would buy foreign goods with quality s_h, and in the interval $[\tilde{\theta}, \hat{\theta}]$, they would purchase goods with quality s_l. Hence, the demands for the foreign goods and domestic goods are presented as follows:

$$x_h = \overline{\theta} - \frac{p_h - p_l}{s_h - s_l}; \ \ x_l = \frac{p_h - p_l}{s_h - s_l} - \frac{p_l}{s_l} \tag{2}$$

The inverse demands are presented as:

$$p_h = \overline{\theta} s_h - x_h s_h - x_l s_l; \ \ p_l = (\overline{\theta} - x_h - x_l) s_l \tag{3}$$

2.2. The supply side

Due to the foreign firm and the domestic firm manufacture products of different quality, they respectively face to their own cost function. The cost function expressed as:

$C(s_l, x_l) = \alpha x_l + (s_l)^2/2$ and $C(s_h, x_h) = \alpha x_h + (s_h)^2/2\gamma$.

The marginal cost is α, and is assumed to be a constant. Meanwhile, in order to analysis conveniently, the marginal cost (α) is also assumed to be zero for domestic and foreign firms both. On the other hand, the foreign firm is assumed to

technological advantage in the ability to improve quality. Hence, for the same quality level, the cost incurred by the foreign firm to improve quality is lower than that of the domestic firm. The symbol γ $(\gamma \geq)$ represents the foreign firm's technology advantage. For convenience in analysis, the foreign firm's technology advantage is taken as $\gamma =$. This implies that the foreign firm's quality improving cost is half that of the domestic firm. Hence, the cost functions will be reduced to:

$C(s_l, x_l) = (s_l)^2/2$ and $C(s_h, x_h) = (s_h)^2/4$.

For investigating the arguments in this article, we additionally consider the cost of domestic firm is influenced by ϕ and μ. Where, the level of law enforcement is μ, and it will affect the implementation of IPR.[2] And the symbol (ϕ) is represented as IPR determines the protection of patent rights.[3] The domestic firm is hard to imitate with a high IPR. Moreover, the foreign firm adopts the FDI mode to enter the domestic country but must be bearded a fixed cost (F). The profit functions of the domestic and foreign firm in IPR-mode are presented below.

IPR-mode:

$$\pi_h^{IPR} = p_h^{IPR} x_h^{IPR} - \frac{\left(s_h^{IPR}\right)^2}{4} - F$$

$$\pi_l^{IPR} = p_l^{IPR} x_l^{IPR} - \mu\overline{\theta} x_l^{IPR} - \frac{\phi^2}{2}\frac{\left(s_l^{IPR}\right)^2}{2}$$

The symbol *IPR* is used to represent the IPR-mode. As the above settings, the foreign firm would adopt the FDI strategy for competing with the domestic firm in the IPR-implemented home market. Moreover, the foreign firm must incur a fixed cost and which technology advantage is assumed to be double than the domestic firm. The commodity prices of two types under the FDI-mode are denoted by $p_h^{IPR}$and p_l^{IPR}. And the demand quantities of the high- and low-quality goods are respectively denoted by x_h^{FDI} and x_l^{FDI} in the home market. Under the IPR-mode assumption, the domestic firm faces the law-limited cost for foreign technical spillover effects. For analytical convenience, define $\mu = \overline{\mu}/\overline{\theta}$. Simultaneously, the level of law enforcement also plays a key role on the effect of IPR.

3. The equilibriums

Under the IPR-mode, we calculate the IPR index in China for the period 1996–2015. Based on China's IPR index, we further simulate the value of variables to investigate the motive and reaction of the developing country by adjusting strength of law enforcement. The equilibriums for IPR-mode with strength of law enforcement are illustrated in the following subsections.

3.1. The equilibrium of IPR-mode with strength of law enforcement

Under the two-stage, uncooperative, ex-ante game, the domestic firm must face the law-limited costs—IPR & law enforcement. Hence, the foreign and domestic firms

simultaneously select the qualities and the quantities of their goods to maximise their profits. Taking the level of IPR index as given, the domestic and foreign firms simultaneously decide the quality level of their outputs at the first stage. Then, both firms make their decisions on quantity levels simultaneously. By the above steps, this paper uses the backward induction to find the analytical solutions of endogenous variables. Moreover, this paper defines a proportional relationship between the high- and low-quality outputs, $\omega = s_l/s_h$ and $0 \leq \omega \leq 1$. In addition, we define $\lambda = \mu/s_l$. Hence, the first order conditions for the domestic and foreign firm's profit function are:

$$s_h^{IPR} = \frac{2(16-12\omega + (4-4\lambda^2)\omega^2 - (-1+\lambda^2)\omega^3)\overline{\theta}^2}{(4-\omega)^3} \tag{4}$$

$$s_l^{IPR} = \frac{2(4+\omega-8\lambda\omega + \lambda^2(-16+12\omega))\overline{\theta}^2}{\phi^2(4-\omega)^3} \tag{5}$$

Below, we describe the case in which the strength of law enforcement is in the interval $0 \leq \mu \leq \tilde{\mu}$. Here, the maximum strength of law enforcement is $\tilde{\mu}$, corresponding to the situation when the domestic firm earns zero profit but does not be crowded out of the home market. When the strength of law enforcement equals zero ($\mu = 0$), λ will also be zero. Hence, the relationship between ω and λ will reduce to:

$$\omega = \frac{4+\omega}{\phi^2(16-12\omega+4\omega^2-\omega^3)}$$

Moreover, the extreme case in which that the maximum strength of law enforcement would derive the domestic firm earns zero profit and still continues operating in the home market. Under the zero profit condition, we can derive the following relationship between $\tilde{\omega}$ and $\tilde{\lambda}$:

$$\tilde{\lambda} = \frac{3\tilde{\omega}-4}{2(5\tilde{\omega}-12)}$$

Giving any IPR index of China, we can solve for the roots of ω and make sure it would meet the $0 \leq \omega \leq 1$ condition. Using the above relationship, this paper finds that the ratio of qualities of extreme case, $\tilde{\omega} = \tilde{s}_l^{IPR}/\tilde{s}_h^{IPR}$ and the maximum level $\tilde{\mu}$ of law enforcement. In the subsection 4, we set a Table 1 to present the relevant intervals for ω and λ at any value of IPR index of China. Moreover, we can observe the relationship among μ and ω is negative in any relevant interval, as per the equation $\lambda(\omega)$ and here we have known that $d\mu/d\lambda > 0$. It means that $d\mu/d\omega < 0$. In the following subsections, we will calculate the simulation values by giving any IPR index of China, such as the prices, quantities and outputs, profits, the consumer surplus, and social welfare of home country.[4] And the simulation outcomes are listed in Tables 2, 3 and 4 below.

Table 1. The relevant intervals of a given IPR index.

$\phi = 3.19$	$0.022 \leq \omega \leq 0.025$
$\phi = 3.52$	$0.018 \leq \omega \leq 0.021$
$\phi = 4.19$	$0.013 \leq \omega \leq 0.014$

Source: Simulation values for this model.

3.2. The IPR and law enforcement

In this article, we consider the case of China as the domestic country to analysis. According to Ginarte and Park (1997), the China's IPR index of this paper is calculated for the period 1996–2015. Based on the calculation of China's IPR index at period 1996–2002 in Han and Li (2005), the calculations of China's IPR index for period 2002–2015 not only are calculated by their way, but also are adjusted in accordance with the amendments to intellectual property and civil law. Moreover, for those country which reforms judicial system, such as China, there is probably not consistent between protection of static indicators and realistic protection (Han and Li, 2005). By considering the four dimensions simultaneously, the adjusted index of China's IPR is further calculated. We follow Qi et al (2008) to readjust Han and Li (2005) in order to calculate the law enforcement of China for the period 1996–2015. The four factors of law enforcement were examined: (1) degree of legalisation,[5] (2) legal awareness,[6] (3) levels of economic development,[7] (4) international factors.[8] Each of these factors was scored a value from 0 to 1, but they were vested different weight. Due to the importance of domestic factors, the weight value given by four factors were: 0.3、0.25、0.25、0.2, correspondingly. Hence, the original indexes, adjusted indexes and law enforcement of China's IPR in period 1996–2015 would be presented as following Figure 1.

According to Figure 1, we can observe that the regulations of China's IPR and the law enforcement have significantly grown in nearly two decades. However, does it implies that the behave comes from the willing of government of China (as a developing country) or simply meets the international pressure? The following subsection would discuss and focus on this issue.

4. The simulation and comparative analysis

In this subsection, the simulation values are calculated by giving any IPR index of China, and systematically lists the prices, quantities and outputs, profits, the consumer surplus, and social welfare of home country. According to the IPR index of China in period 1996–2015, the relevant intervals for ω are as follows,

Based on Table 1, this paper further calculates the equilibrium of extreme situations respectively, that is the cases of zero-strength and maximum strength of law enforcement. For analytical convenience, we will assume that the highest taste parameter equals one and the exogenous fixed sunk cost, F, equals 0.001. Tables 2–4 systematically list the simulation values of equilibrium outcomes at given any real IPR index of China by considering the strength of law enforcement.

Here, this article uses the IPR index of China after China's accession to the WTO in 2001 as a case (i.e., $IPR = 4.19$), and further do analysis and discussions on this

Table 2. The equilibrium outcomes at $\phi = 3.19$.

Under the condition of that the level of law enforcement is zero:		
$s_h^{IPR^*} = 0.500020$	$s_l^{IPR^*} = 0.012598$	$\bar{s}^{IPR} = 0.256309$
$p_h^{IPR^*} = 0.248425$	$p_l^{IPR^*} = 0.003169$	$\omega^* = 0.025194$
$x_h^{IPR^*} = 0.496831$	$x_l^{IPR^*} = 0.251585$	$CS_{IPR}^* = 0.063686$
$\pi_h^{IPR^*} = 0.060920 - F$	$\pi_l^{IPR^*} = 0.000394$	$TW_{IPR}^* = 0.064080$
Under the condition of maximum level of law enforcement:		
$s_h^{IPR^*} = 0.500014$	$s_l^{IPR^*} = 0.011308$	$\bar{s}^{IPR} = 0.255661$
$p_h^{IPR^*} = 0.248115$	$p_l^{IPR^*} = 0.001913$	$\omega^* = 0.022248$
$x_h^{IPR^*} = 0.496216$	$x_l^{IPR^*} = 0.334601$	$CS_{IPR}^* = 0.064070$
$\pi_h^{IPR^*} = 0.060615 - F$	$\pi_l^{IPR^*} = 0$	$TW_{IPR}^* = 0.065011$

Source: Simulation values for this model.

Table 3. The equilibrium outcomes at $\phi = 3.52$.

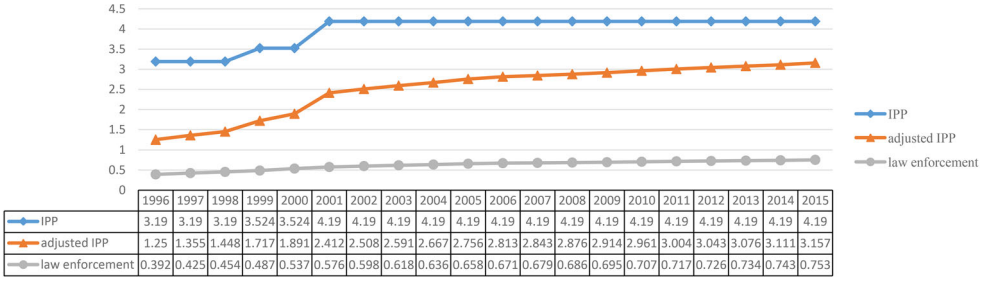
Under the condition of that the level of law enforcement is zero:		
$s_h^{IPR^*} = 0.500013$	$s_l^{IPR^*} = 0.010275$	$\bar{s}^{IPR} = 0.255144$
$p_h^{IPR^*} = 0.248716$	$p_l^{IPR^*} = 0.002582$	$\omega^* = 0.020549$
$x_h^{IPR^*} = 0.497418$	$x_l^{IPR^*} = 0.251291$	$CS_{IPR}^* = 0.063467$
$\pi_h^{IPR^*} = 0.061212 - F$	$\pi_l^{IPR^*} = 0.000321$	$TW_{IPR}^* = 0.063788$
Under the condition of maximum level of law enforcement:		
$s_h^{IPR^*} = 0.500009$	$s_l^{IPR^*} = 0.009207$	$\bar{s}^{IPR} = 0.254608$
$p_h^{IPR^*} = 0.248465$	$p_l^{IPR^*} = 0.001553$	$\omega^* = 0.018168$
$x_h^{IPR^*} = 0.496922$	$x_l^{IPR^*} = 0.334364$	$CS_{IPR}^* = 0.063778$
$\pi_h^{IPR^*} = 0.060965 - F$	$\pi_l^{IPR^*} = 0$	$TW_{IPR}^* = 0.064545$

Source: Simulation values for this model.

Table 4. The equilibrium outcomes at $\phi = 4.19$.

Under the condition of that the level of law enforcement is zero:		
$s_h^{IPR^*} = 0.500007$	$s_l^{IPR^*} = 0.007224$	$\bar{s}^{IPR} = 0.253616$
$p_h^{IPR^*} = 0.249097$	$p_l^{IPR^*} = 0.001812$	$\omega^* = 0.014447$
$x_h^{IPR^*} = 0.498188$	$x_l^{IPR^*} = 0.250906$	$CS_{IPR}^* = 0.063179$
$\pi_h^{IPR^*} = 0.061595 - F$	$\pi_l^{IPR^*} = 0.000226$	$TW_{IPR}^* = 0.063405$
Under the condition of maximum level of law enforcement:		
$s_h^{IPR^*} = 0.500005$	$s_l^{IPR^*} = 0.006458$	$\bar{s}^{IPR} = 0.253232$
$p_h^{IPR^*} = 0.248924$	$p_l^{IPR^*} = 0.001086$	$\omega^* = 0.012794$
$x_h^{IPR^*} = 0.497843$	$x_l^{IPR^*} = 0.334055$	$CS_{IPR}^* = 0.063397$
$\pi_h^{IPR^*} = 0.061424 - F$	$\pi_l^{IPR^*} = 0$	$TW_{IPR}^* = 0.063934$

Source: Simulation values for this model.



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
IPP	3.19	3.19	3.19	3.524	3.524	4.19	4.19	4.19	4.19	4.19	4.19	4.19	4.19	4.19	4.19	4.19	4.19	4.19	4.19	4.19
adjusted IPP	1.25	1.355	1.448	1.717	1.891	2.412	2.508	2.591	2.667	2.756	2.813	2.843	2.876	2.914	2.961	3.004	3.043	3.076	3.111	3.157
law enforcement	0.392	0.425	0.454	0.487	0.537	0.576	0.598	0.618	0.636	0.658	0.671	0.679	0.686	0.695	0.707	0.717	0.726	0.734	0.743	0.753

Figure 1. The IPR, adjusted IPR andlaw enforcement of China.
Source: The calculations of this model with the methods of Qi et al (2008) and Han and Li (2005).

basis. By this case, we observe that the difference between high- and low-quality narrows as the strength of law enforcement decreasing. It implies that the domestic firm get more possibility to imitate (or plagiarise) the rival competitor by the decline in

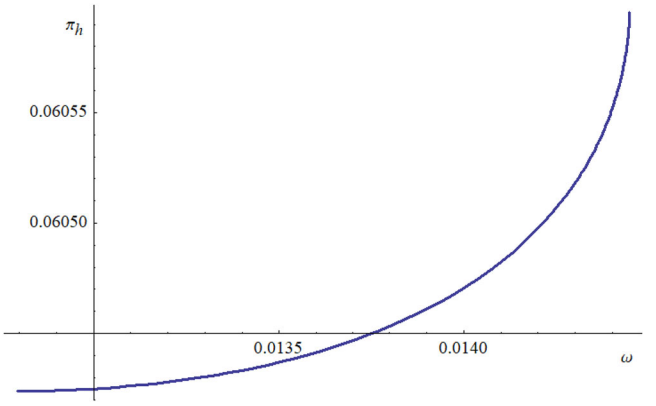


Figure 2. The profits of foreign firm with the strength of law enforcement.

the strength of law enforcement at a given IPR level. According to above reason, the consumer surplus of domestic country will decrease with the decline in scale of quality. Although the profits of domestic firm increase with the strength of law enforcement decreasing, simultaneously considering with the decline of consumer surplus in domestic country which will derive the social welfare of domestic country decreasing. It is worth mentioning that we observe the profit of foreign firm at the maximum strength of law enforcement is lower than the case at the zero degree of law enforcement. It may be reverse with economic intuition, but this is not the case. According to the following Figure 2, the finding of this article is that the profit of foreign firm declines the increasing speed as the strength of law enforcement increasing. It means the results still meet our expectations.

Moreover, the effects of domestic social welfare are also considered by the given different level of China's IPR. Based on the above results that the social welfare of domestic country at the maximum strength of law enforcement is larger than the case at the zero degree of law enforcement. Hence, we just compare with the cases of IPR = 3, IPR = 3.19, IPR = 3.542, IPR = 4.19, IPR = 4.5, IPR = 4.75, IPR = 5, IPR = 5.25, IPR = 5.5, IPR = 5.75 and IPR = 6 at the condition of the maximum strength of law enforcement. Where, the cases of IPR = 3.19, IPR = 3.542 and IPR = 4.19 are real values of China's IPR index, but the others are simulation values and use all of them to predict the changes of China's total welfare and law enforcement. The following Figure 3 is presented the variations of total welfare and law enforcement at any given China's IPR index.

Here, the finding of this paper shows that the total welfare is decreasing with China's IPR index increasing. It seems to meet our observations for the attitude of a developing country in IPR regulations. For developing country, to impose a relatively tight IPR regulations which will inhibit the economic growth in the early stages of development. However, the needs for foreign investments and the regulations of the agreement on trade-related aspects of intellectual property rights (TRIPS) which would drive a developing country to rise the threshold of IPR. Hence, with the level of IPR increasing, which derives a decline of total welfare of a developing country. Interestingly, the decreasing speed of total welfare is slowed down with the level of

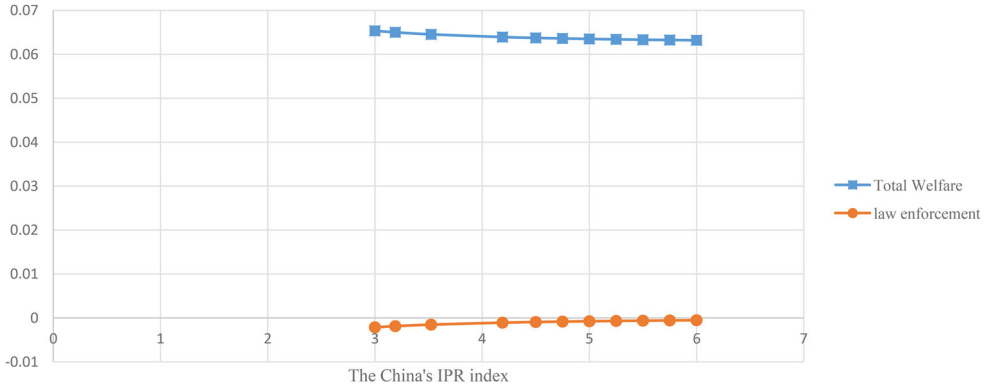


Figure 3. The total welfareand law enforcement of China (developing country).

IPR increasing. As the investigation of this paper represented that a government of developing country has a strong motive to impose the maximum strength of law enforcement at any given IPR regulation for confirming the maximum level of total welfare. This phenomenon also can be observed in Figures 1 and 3 simultaneously in which the law enforcement is increasing with the IPR index increasing. It means that a developing country (e.g., China) may benefit from the level of IPR increasing, such as the domestic high-technology providers also get the protections from a stronger IPR regulations when the economic development of a developing country at a mid-high level. Limited by the settings of the model in this article, the model cannot show that stronger intellectual property regulations have a more positive impact on domestic high-tech owners. It also means that the changes of total welfare may be underestimated. In other words, the changes of total welfare are restricted performances as the level of IPR increasing.

Proposition 1 Considering the IPR-mode with the strength of law enforcement simultaneously, the government of a developing country always holds the strictest attitude toward law enforcement in the interval $0 \leq \mu \leq \tilde{\mu}$ at any given level of IPR index. Moreover, for a developing country, with an ascent of level of IPR which will derive the total welfare decreasing. But the decreasing speed of total welfare is declined with the level of IPR increasing. It implies that a developing country has a sufficient motive to adjust the strength of IPR regulations and law enforcement with the development of economy.

5. Conclusions

In the field of international trade, IPR plays a critical role between the developed countries and the developing countries. The increasingly close trade activities among them further illustrates this point. For developed countries, strict IPR regulations curbs the spillover effects of technology and malicious imitations. However, for developing countries, relatively tight IPR regulations inhibit economic growth during the early stages of economic development. This explains the reluctant attitudes of developing countries towards strengthening the IPR legislation and related law enforcement. We structure a model of vertical product differentiation and simultaneously

considers the IPR index and the strength of law enforcement. This model seeks to investigate the attitudes of developing country towards the strengthening of IPR legislation and law enforcement. The finding of this research is the government of a developing country tends to carry out maximum level of law enforcement at a given IPR index. The social welfare performance of developing countries correctly reflects this. In addition, the governments of developing countries have sufficient motivations to defer the strengthening of IPR regulation, and this tendency can be observed in the real-world policymaking. However, the need for foreign investments and the regulations of the agreement on TRIPS lead to the rise of the threshold of IPR in a developing country. Moreover, the developing countries can also benefit from a higher threshold of IPR regulations and related law enforcement in the long term. The main reason is that the domestic high-technology providers also benefits from a stronger IPR regulations as the economic development reaches the upper-middle level. It is reasonable to estimate an even more significant positive influence of stronger IPR regulations to domestic high-tech providers. However, due to the limitation of this model, we were not able to demonstrate this fully. We believe that this positive influence provides the motivations for developing countries to strengthen their IPR regulations through international negotiations.

Based on the above results, the main contribution of this article is to understand the attitudes of developing countries towards the strengthening of IPR legislation and law enforcement in the process of national development. For developing countries, although a higher IPR levels in the early stage of low development will limit the scale and intensity of their development. However, as the economic development and innovation capabilities of developing countries have improved, domestic enterprises have also generated demand for the supervision of IPR, which gives the government sufficient endogenous motivations to increase the strength of IPR levels and law enforcement in the long term. The above explanations can be supported by simulation and comparative analysis in this article. Since the early research did not pay much attention to the internal motivation of developing countries in terms of the IPR levels and law enforcement. The conclusions of this article will fill the gaps in related research.

The conclusions of this article not only provide supporting evidence for the internal motivations of developing countries to improve the IPR levels and law enforcement, but also provide a systematic explanation for the pros and cons of the past literature on this topic. In terms of internal motivations, the results of this study indicate that developing countries will implement the most stringent law enforcement at any given IPR level, because this is in the national interest of sustainable development of developing countries. This means that if the governments of developing countries want to improve the overall social welfare by reducing law enforcement, it will be counterproductive. In addition, raising the level of IPR does make developing countries face the problem of declining the social welfare in the early stages of development. However, with the country's continuous development and the needs of enterprises, raising the level of IPR will lead a positive change in the overall welfare of the country. From the early development stage to the long-term, a developing country's internal motivations of setting IPR levels are in a dynamic adjusting

process, in which the internal motivations will change from low to high. This also implies that developing countries are not only due to the pressure of the international community to improve IPR levels and law enforcement, but also have their own internal motivations to improve IPR levels and law enforcement.

Finally, the shortcomings of this article and future work that can be extended will be explained as follows. The shortcomings of this article are mainly limited by the setting of the model. The demand for IPR and law enforcement of domestic enterprises in the middle and high development stage of a country cannot be observed to have a more positive impact on the national welfare. Therefore, the model will explain weakly the internal motivations of developing countries to increase the level of IPR in the long term. In addition, limited by the acquisition and collection of relevant data and the article length, it is impossible to conduct empirical analysis in this article. Therefore, model extra-building and empirical analysis are the works that can be extended in the future.

Notes

1. See details on WTO website: https://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm7_e.htm; World Trade Report (2018), p.6.
2. It refers to Qi et al (2008), the range of value allowed for law enforcement is 0 to 1.
3. It refers to Ginarte and Park (1997), which means an index of patent rights.
4. The domestic welfare is defined as the (without attaching weights) sum of the domestic low-quality firm's profits and the consumer surplus. Here, the consumer surplus is consistent with the net surplus of consumers purchasing the high- and low-quality goods. They are presented as $CS_h = \frac{1}{2}s_h\left[\overline{\theta}^2 - \left(\overline{\theta} - x_h\right)^2\right] - p_h x_h$ and $CS_l = \frac{1}{2}s_l\left[\left(\overline{\theta} - s_h\right)^2 - \left(\overline{\theta} - x_h - x_l\right)^2\right] - p_l x_l$, respectively.
5. Degree of legalization is an important part of social culture. It represents the completeness and importance of a country's laws. In the country with high degree of legalization, citizen is ruled by law. Generally, the ratio of lawyer in a country is an important legal index. In developed country or high industrial country, that ratio is more than five parts per ten thousand. Hence, if the ratio of lawyer in a country is reached five parts per ten thousand, the value of this factor is 1. Otherwise, the value of this factor is that actual ratio divided by five parts per ten thousand.
6. Legal awareness represents the degree to which citizens recognize and understand law. The legal awareness is stronger; the law is easier to be executed. And national schooling is employed to reflect legal awareness. Generally, the proportion of senior high students and college students(included junior college)in total population can reflect average national schooling. Refer to natural rate of population growth, if that proportion is reached five percent, the value of this factor is 1. If that proportion is less than five percent, the value of this factor is that actual proportion divided by five percent.
7. Rapp and Rozek (1990) find that economic development of country positively related to its level of intellectual property protection. Similarly, only when the granaries are full, then people will respect rites and obligations. Generally, a country will grow promptly and its consumer structure is upgrading in case of GDP per capita reached one thousand dollars. Therefore, if GDP per capita reached one thousand dollars, the value of this factor is 1. If it is less than one thousand dollars, the value of this factor is that actual GDP per capita divided by one thousand.
8. IPR protection is not only related to domestic legislation, but also to international trade. There are specific and clear protection scope, minimum protection requirements and

dispute settlement mechanism in the WTO framework (Blakeney 1996). Therefore, if a country is a WTO member, the value of this factor is 1. Nevertheless, the value is uniform variation. From the year of WTO accession negotiation to the year of formal WTO member, this value of China is gradually changing to 1 from 1986 to 2001.

Acknowledgement

The authors thank the anonymous reviewers for many suggestions which helped to improve the presentation and quality of the research, any shortcomings that remain in this research paper are solely our responsibility.

Dislcosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was financially supported by the fund of Department of Education of Guangdong Province (ID: 2019WTSCX149)

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