



Norwegian Institute
of International
Affairs

Globalization of intellectual property rights

Per Botolf Maurseth



NUPI Working Paper 882

Publisher: Norwegian Institute of International Affairs
Copyright: © Norwegian Institute of International Affairs 2018
ISSN: 1894-650X

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Published by the Norwegian Institute of International Affairs

¹ This paper has been prepared with financial support from the Research Council of Norway, project “Europe in transition – Small states and Europe in an age of global shifts (EUNOR)”, project No. 238017, funded during 2014-2017, is gratefully acknowledged

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Abstract

Recent decades have witnessed a strong globalization process. This has been so for international trade and international capital markets, but also in the field of Intellectual Property Rights (IPRs). IPRs were formerly in the domains of nation states. International treaties have dictated convergence in IPR institutions across the world. This paper gives a short overview of these developments. Incentives for IPRs are stronger for more innovative countries. Therefore, innovative countries traditionally had stronger IPR than less innovative countries. A negotiated global treatment (like the TRIPS agreement) is likely to be a compromise between the needs in innovative and less innovative countries. Such agreements may therefore be complemented with additional agreements among innovative countries. The European Patent Office (EPO), and the planned European unitary patent are examples. IPRs are also incorporated into new preferential trade agreements. Many believe that this trend will result in convergence of stronger IPRs across countries, to the benefit of innovative countries, but at the cost of less innovative countries.

Introduction

Trade negotiations in the Uruguay round in the GATTs resulted in the foundation of the World Trade Organization (WTO) in 1995. The negotiated trade agreements resulted in lower tariff rates, less regulations and freer trade. One important result of the negotiation round was the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). The TRIPS agreement sets minimum requirements for protection of intellectual property rights for all WTO members (with some temporary exceptions for developing countries and the least developed countries).

TRIPS marked a difference to traditional international cooperation in the field of IPR. Traditionally IPRs have been in the domain of the nation states. With the Paris agreement (from 1883) and the Bern Convention (1886) countries agreed on *national treatment* of domestic and foreign applications for patents and for copyrights. National treatment reduces the sovereignty of countries to design IPRs according to their own needs.² For instance, giving generous IPRs to domestic innovators and weaker IPRs to foreign innovators was no longer possible. Still, national treatment left the design of non-discriminatory IPRs to the nation states.

With the principle of national treatment as the main principle for international cooperation in the field of IPR, patent systems around the world became very different. In the pre-TRIPS period, many countries limited maximum patent period to less than 20 years (which is the TRIPS requirement) and patentable subject matters differed. Some developing countries, for instance, did not allow patenting of pharmaceuticals.

In developed countries, however, patent institutions converged. It is generally assumed that the high innovation potential and the research-intensive nature of these economies increased their incentives for

² Varian (2005) describes how Charles Dickens advocated stronger IPRs in terms of copyright protection in the United States in order to stop American publishers to pirate British works. It was not before 1891 that United States granted protection of foreign copyrights, and then only to foreign works that were typeset in the United States. This lasted until 1976. The United States did not adopt the Berne convention before 1989.

improved IPRs. In Europe, the EPO system is an umbrella covering the national patent offices in European countries.

Also after the TRIPS agreement was signed, strengthening and convergence of countries' IPRs is the general development. Developing countries that were temporarily allowed to deviate from TRIPS obligations have adjusted their patent systems. But technologically advanced countries have continued to strengthen their own IPRs and have demanded stronger IPR to be included into new trade agreements among themselves and in trade agreements with developing countries.

This short note discusses internationalization of IPR. The next section frames the discussion with a short review of patent theory and internationalization in the field of IPR. The TRIPS agreement was the result of negotiations where technologically advanced countries demanded stronger IPRs while developing countries opposed it. Since the result was the outcome of negotiations, and therefore a compromise, there is still scope for stronger IPRs. The recent developments, discussed in section 3, are seen in light of what was achieved in the TRIPS negotiations. Special attention is given to European developments. The European Unitary Patent (if implemented) is for EU-member countries only. The European Unitary Patent represents strengthening of IPRs in Europe on a unilateral, though non-discriminatory, basis. For countries that are members of EPO but not in the European Union the Unitary Patent may involve costs as well as benefits. Benefits include lower costs for seeking protection of IPRs in *all* EU member countries. Costs may include higher costs of seeking protection in individual EU member countries as well as domestically. Countries outside the Unitary Patent may both gain and lose from fewer foreign patent applications.

Patent theory

Patents represent a tradeoff between static inefficiency and dynamic efficiency. Patents give inventors temporary monopoly rights to exploit their innovations commercially. If the patent office considers the invention new, commercially exploitable and non-trivial, it may grant patent protection. Patents are granted for a temporary period, most often for a potential period of 20 years. Thereafter the patent expires and the described knowledge can be used by anybody. Patent documents are public so that others can use the described knowledge in research and development (R&D) also during the period of protection.

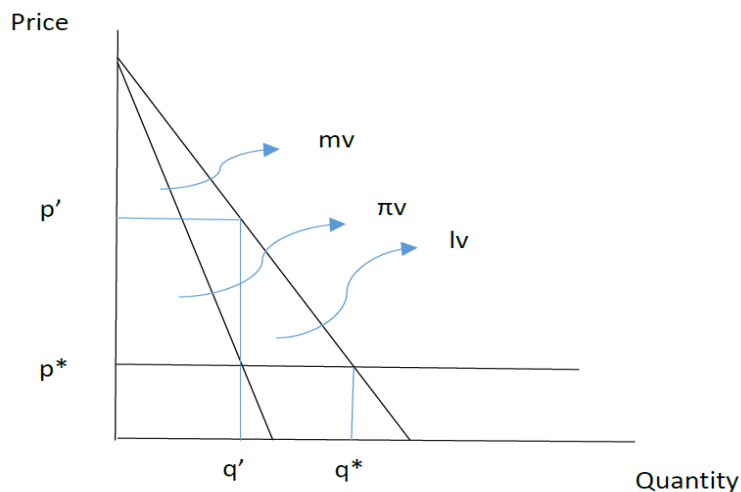
The inventors' monopoly position permits the owner to charge higher than competitive prices. Therefore, patented inventions can be profitable. This is the source of the social gain from patent protection: The profits incentivize innovators to invest in R&D that may result in new inventions in the future. Patents encourage both product innovations (creation of new products) as well as process innovations (e.g. lower production costs for a given product).

The social cost of patent protection is the deadweight loss involved with monopoly pricing. Due to higher prices, demand is restricted and purchased quantities are lower than under competitive pricing. In addition comes redistribution of consumer surplus to the inventor. Due to higher prices, consumers lose, and the inventor gains.

The model presented here is an extended version of the model discussed in chapter 11 in Scotchmer (2004). The model focuses on countries' choices of length of patent protection when domestic innovators also enjoy patent protection abroad, and when foreign innovators enjoy patent protection in the country in question. Others have analyzed the same issues. Of particular relevance is Grossman and Lai (2004). Their model is similar to the one presented here, but more complicated since that model is a general equilibrium model. Main conclusions from the present model framework and those of Grossman and Lai are similar, however.

The case of product innovations is illustrated in figure 1.

Figure 1:



The figure illustrates a market for some good. The vertical axis measures price. The horizontal axis measures quantity demanded in the market. Marginal costs are assumed to equal p^* (which is also the competitive price) and assumed to be constant. There is a downward sloping demand curve (the upper downward sloping curve) that indicates how demand falls when the price increases. If the market is monopolized, the seller can dictate the price. If the seller increases the price, demanded quantity falls. The extra revenue from selling one extra unit (the marginal revenue) is lower than the price (and therefore the demand curve) since selling one extra unit requires lower prices for *all* sold units. A profit-maximizing firm sets the price so that the marginal revenue equals the marginal cost. This results in the monopoly price p' and the quantity q' . Thus, prices are higher and quantities are lower in monopolized markets than in competitive markets.

Under perfect competition, introduction of the good in the market produces a social surplus equal to v . v is the area below the demand curve and above the marginal cost curve. I will use v as a measure of market size. It is seen that under perfect competition all social surplus accrues to the consumer.

In a monopolized market the seller charges a price that is higher than the competitive price. The seller therefore gains a profit from monopolization. This is a share, π , of the competitive social surplus so that total profits are πv . These profits come at the cost of reduced consumer surplus. In the monopolized market consumer surplus is mv .

But the cost also includes lv . lv is the reduction of consumer surplus that results from lower demand. This is denoted the *deadweight* loss.

While transfer of consumer surplus to profits is a re-distribution of social surplus, the deadweight loss is a pure social cost. It is a loss for consumers that are not compensated with higher producer surplus.

Patents do not last forever, but are only granted for a limited period of time, τ . In the following, I will use T as the resulting discount factor from a patent length of τ . Patent protection is characterized by patent length, the scope of patentable subject matters, requirement for patent breadth and height, and of patent costs. In the treatment here, I summarize this with T .³

Patenting gives discounted profits equal to πT and consumer surplus in the patenting period equal to mT . The total value of introduction of a good is thus $v(1/r - lT)$, i.e. the value of the perpetual of social surplus minus the discounted value of deadweight loss.⁴

The tradeoff in determining patent length is to weight the deadweight loss against the value of new innovations that occur due to increased profits. If innovation is profit motivated *increasing* patent length results in more innovations. The value of these innovations should be traded off against increased deadweight loss that occurs for *all* patented goods. This issue has been analyzed by many, as e.g. Nordhaus (1969) and Scherer (1972/84).

In a closed economy, only the national market matters for domestic innovators. Innovators are ready to pay costs, c , for innovations up to the private value of an innovation. Therefore, innovations with costs $c = \pi v T$ will occur.

In an international context, matters are somewhat more complicated. Assume that there are two countries, country a and country w . All countries gain from domestic as well as foreign innovations. The best possible situation for a country is if the foreign countries protect IPR strongly enough to generate the optimum level of innovation while

³ Profits are discounted according to $\int_0^{\tau} e^{-rt} dt = \frac{1 - e^{-r\tau}}{r} = T$.

⁴ Social welfare from an innovation is:

$$\int_0^{\tau} v(m + \pi) e^{-rt} dt + \int_{\tau}^{\infty} v e^{-rt} dt = v(m + \pi) \left(\frac{1 - e^{-r\tau}}{r} \right) + v \left(\frac{e^{-r\tau}}{r} \right) = v(1 - l) \left(\frac{1 - e^{-r\tau}}{r} \right) + v \left(\frac{e^{-r\tau}}{r} \right) = v \left(\frac{1}{r} - lT \right)$$

having no IPR itself. In that case, the country appropriates the full social surplus of innovation without paying the deadweight loss. Furthermore, granting IPRs to foreigners imply that foreigners appropriate the profit share accruing in the country for the foreign innovations.

First assume that country a and country w determines patent protection, T , unilaterally. This was the case before the Paris convention (1883) that introduced *national treatment* of patent applicants. National treatment implies that countries do not discriminate between domestic and foreign patent applicants.

In the unilateral case countries may discriminate between patents originating in the home country versus patents originating in the other country. The optimal patent regime in this case is to grant longer patents to domestic innovators than to foreign innovators. Patent protection for domestic innovators gives a surplus equal to $v(\pi+m)T$ (the sum of consumer and producer surplus) during patent protection and $v(1/r-T)$ after protection stops. Patent protection for foreign innovators gives a consumer surplus equal to vmT during patent protection and $v(1/r-T)$ after the patent expires. Thus gains from granting patents to foreigners are lower than granting patents to domestic applicants.

There are also possibilities for multiple equilibria when countries determine patent protection on their own will. If innovations have the same costs, c , required patents lives for innovations to occur is $c = \pi(v^a T_a + v^w T_w)$. If high protection in one country is sufficient to cover the costs, c , the other country has incentives to grant lower (or no) protection and free ride on the other country's protection. If the other country does not grant high enough protection, the first country may still find it in its interest to grant protection. Scotchmer (2004, p. 330) notes that the "combination of protections that arises can easily be a matter of historical accident and the initial historical accident can perpetuate inequities".

With national treatment, as mandated in the Paris convention, countries have to treat domestic and foreign patent applicants identically. This was, more or less, the global situation before the TRIPS treaty was signed in 1995. In Europe, however, EPO-countries had similar patent institutions. EPO countries, therefore, was a block of countries with national treatment and with similar patent regulations.

Optimal patent length

Let $F(c)$ denote the number of innovations that results from costs c . We assume that $F'(c) > 0$ so that higher costs lead to higher innovation. The total costs of innovation, $Y(c)$, are lower than $cF(c)$ since Y involves less expensive innovations as well ($Y(c)$ is the integral over $cf(c)$ where f is the density of F).

To parameterize, assume that $F(c) = c$ so that the number of innovations increases linearly with c . Also assume that total costs are quadratic:

$$Y(c) = \int_0^c z dz = \frac{1}{2} c^2$$

Inserting for the value of innovation in the costs, total welfare from innovations in a closed economy is:

$$W^c(T) = \pi v T v \left(\frac{1}{r} - lT \right) - \frac{(\pi v T)^2}{2}$$

The first term is the number of innovations ($\pi v T$) times the social value of them $v(1/r - lT)$. The second term is the costs for producing this number of innovations.

Maximizing W^c with respect to T gives the optimal length:

$$T^c = \frac{1}{r(2l + \pi)}$$

It is seen that the optimal patent length decreases with the share of deadweight loss, l , the share of social surplus that results in profits under monopoly pricing, π , and the discount rate, r .

It is intuitive that T^c decreases with l . The fact that T^c decreases with r is because the full gain from longer patent protection is discounted heavier relative to the costs. The fact that T^c decreases with π is because higher π means that less T is needed to stimulate a given level of innovation.

Now assume that there are two countries, the domestic country, a , and the foreign country, w . Here the two countries are identical to each

other except for two characteristics. First, the foreign country is allowed to differ from the domestic country in innovation capability. This assumption is parameterized with γ . That is, the number of innovations that results from costs c in country w is γc , $\gamma > 0$. If $\gamma > 1$, country w is more innovative than country a . If $\gamma < 1$, country w is less innovative than country a . Second, the two countries differ in size. Here, the total competitive surplus, v , is interpreted as a country's size. In the discussion below, country w will be assumed to be a small country with lower innovative capabilities relative to country a ($v^w < v^a$, $\gamma < 1$).

With national treatment, innovators will invest in innovation until $c = \pi(v^a T^a + v^w T^w)$. This will be so in both countries. Innovators in country a profit from protection in country a and in country w .

The same goes for innovators in country w . A measure for the aggregate level of protection is their resulting innovation costs. The aggregate level of protection is linear in T^a and T^w :

$$c(T^a, T^w) = v^a \pi T^a + v^w \pi T^w$$

Therefore, any linear combinations of T^a and T^w according to

$$\begin{aligned} T^A (v^a + v^w) &= v^a T^a + v^w T^w \\ \rightarrow \\ T^A &= \frac{v^a T^a}{(v^a + v^w)} + \frac{v^w T^w}{(v^a + v^w)} \end{aligned}$$

gives the same level of aggregate protection, T^A . Thus, patent length in each country may well vary also for optimally set levels of protection.

We first look at global welfare maximization. We consider the case when both countries are imposed a common T . Weighting welfare in both countries equally, gives the following maximand:

$$W^g = (1 + \gamma) \pi T (v^a + v^w) \left(v^a + v^w \right) \left(\frac{1}{r} - lT \right) - 2 \frac{(\pi (v^a + v^w) T)^2}{2}$$

The first term is welfare from the innovations. The second term is the total innovation costs. Maximizing with respect to T gives:

$$T^g = \frac{(1+\gamma)}{2r[(1+\gamma)l + \pi]}$$

Note that T^g is independent of v^a and v^w . Also note that if the countries are equally innovative, $\gamma=1$, $T^c=T^g$. Welfare maximization for two countries that are equally innovative gives the same patent length as the optimal patent length in a closed economy.

MFN patent protection

In the pre-TRIPS world, countries set their IPR protection at their own will, but restricted by the *most favored nations* (MFN) condition. Countries design their IPR regime according to their own needs, but IPRs have to be equal for domestic and foreign innovators.

In the setting of the present model, MFN protection for country a gives the maximand:

$$W^a = \pi(v^a T^a + v^w T^w) v^a \left(\frac{1}{r} - l T^a \right) + \gamma \pi(v^a T^a + v^w T^w) v^a \left(\frac{1}{r} - (l + \pi) T^a \right) \\ + \pi(v^a T^a + v^w T^w) v^w \pi T^w - \frac{(\pi(v^a T^a + v^w T^w))^2}{2}$$

Above, the first term is welfare from domestic innovations in country a . Their number, $\pi(v^a T^a + v^w T^w)$, depends on profit opportunities in both countries. The second term is welfare in country a from innovations in country w . It is taken into account that profits from these innovations are repatriated by innovators abroad. The third term is profits from domestic innovations in country a that accrue in country w . The last term represents innovation costs in country a .

Welfare maximization in country a is clearly different from global welfare maximization. Innovation in country w (the second term) only matters for country a through the consumer surplus. Gains from domestic innovations patented abroad (the third term) only matters to the extent that domestic innovators profit from them. And country a only takes into account its own innovation costs (fourth term).

Maximizing with respect to T^a gives

$$T^a = \left(\frac{1 + \gamma}{r} \right) \frac{1}{2(1 + \gamma)l + \pi(1 + 2\gamma)} - T^w \frac{v^w}{v^a} \frac{(1 + \gamma)l + \gamma\pi}{2(1 + \gamma)l + \pi(1 + 2\gamma)}$$

Country w 's welfare is:

$$\begin{aligned}
W^w &= \gamma\pi(v^a T^a + v^w T^w) v^w \left(\frac{1}{r} - l T^w \right) + \pi(v^a T^a + v^w T^w) v^w \left(\frac{1}{r} - (l + \pi) T^w \right) \\
&+ \gamma\pi(v^a T^a + v^w T^w) v^a \pi T^a - \frac{(\pi(v^a T^a + v^w T^w))^2}{2}
\end{aligned}$$

Maximizing with respect to T^w gives:

$$T^w = \left(\frac{1 + \gamma}{r} \right) \frac{1}{2(1 + \gamma)l + 3\pi} - T^a \frac{v^a}{v^w} \frac{(1 + \gamma)l + \pi(2 - \gamma)}{2(1 + \gamma)l + 3\pi}$$

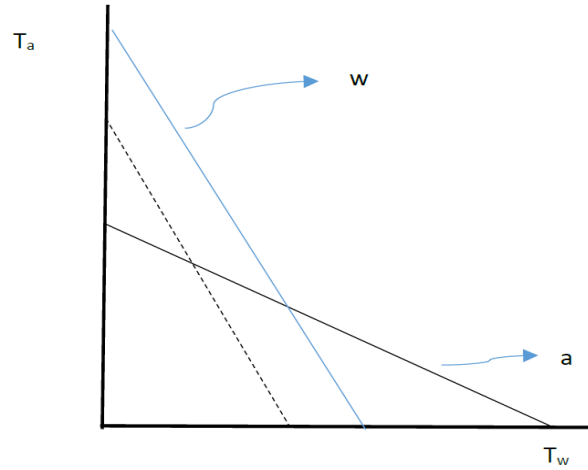
The two countries' choices of T depend negatively on the other country's choice of T . The above expressions are therefore the two countries' reaction curves (best response functions) to the other country's choice.

Note that in the absence of protection in country w , ($T_w=0$), country a will still prefer its own protection to be positive. With increasing protection in country w , country a gains (the number of innovations increase which benefits consumers, and profit opportunities for innovators in country a increases from protection in country w). However, the costs of high protection in country a also increases (costs are given by the deadweight loss in the home country for domestic innovations and the combined deadweight loss and profits flows stemming from foreign innovations as well as the outright innovation costs). Therefore, country a prefers lower protection the higher is protection in the foreign country. The similar reasoning goes for the foreign country. If country w chooses a very high level of protection, country a will prefer a lower level of protection.

The best possible levels of protection for the two countries are when the country's own level of protection is zero (or low) while the other country's level of protection is very high. In that case a country's innovators earn profits in the other country while domestic consumers gain the complete social surplus from foreign innovations. Due to the other country's reaction to such a strategy (which is a lower level of protection), this is not feasible.

The reasoning above gives rise to figure 2. In that figure, countries' best response to each others' patent policies are graphed.

Figure 2:



In the figure, T^a is measured along the vertical axis and T^w is measured along the horizontal axis. The two reaction curves are downward sloping (reflecting that the optimal patent length in each country depends negatively on the patent length in the other country).

Where the two lines cross each other, the first country's reaction to the second country's protection is in accordance with the level of protection in the second country. Only in that point the two countries' best response to each other is in line with what the other country chooses. This will be the equilibrium outcome of a game in patent length (Nash-equilibrium).

Stability of the Nash-equilibrium requires that country a 's reaction curve in the (T^a, T^w) diagram is less steep than country w 's reaction curve. Existence of the Nash equilibrium requires that the two curves cross. Uniqueness of the Nash equilibrium requires that two curves cross only once. Existence and stability are discussed in the appendix.

First assume that the two countries are identical. This means that $v^a = v^w$ and that $\gamma = 1$. When the two countries set their patent length unilaterally, the Nash equilibrium gives suboptimal protection. In this case:

$$T^a = \left(\frac{2}{r}\right) \frac{1}{4l + 3\pi} - T^w \frac{2l + \pi}{4l + 3\pi}$$

$$T^w = \left(\frac{2}{r}\right) \frac{1}{4l + 3\pi} - T^a \frac{2l + \pi}{4l + 3\pi}$$

The Nash equilibrium is:

$$T^{NAa} = T^{NAw} = \frac{1}{r(3l + 2\pi)} < \frac{1}{r(2l + \pi)} = T^s \Big|_{\gamma=1}$$

Therefore, an uncoordinated Nash equilibrium with two identical countries gives a lower level of protection than an optimal level of protection.

When the two countries differ, the aggregate level of protection, T^{NA} becomes (see the appendix):

$$T^{NA} = \left(\frac{1+\gamma}{r} \right) \left(\frac{1}{2(1+\gamma) + 2\pi} \right) < \frac{(1+\gamma)}{2r[(1+\gamma)l + \pi]} = T^s$$

The aggregate level of protection in a patent game between asymmetric countries is therefore lower than the optimal level when welfare in both countries have equal weights.

The following conclusions are easily obtained:

When the countries decide on their levels of protection unilaterally, their level of protection increases in their size relative to the other country. This effect comes from the slope of the reaction functions that become less negatively sloped. This is readily seen from the reaction functions.

When the countries decide on the level of protection unilaterally, their level of protection increases in their innovativeness relative to the other country. From the reaction functions we find:

$$\frac{dT^a}{d\gamma} < 0$$

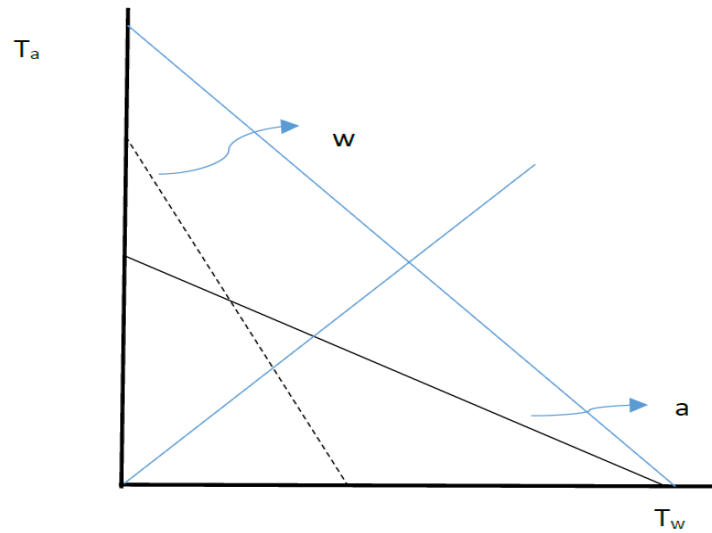
$$\frac{dT^w}{d\gamma} > 0$$

The effect of innovativeness influences both on the reaction curves' slopes and on their intersection with the respective (T^a , T^w) axes.

From our reasoning above, however, it is clear that global optimal combinations levels of protection will produce more innovations than what individual policies give. In the graph below, the straight line outside the reaction curves for the two countries indicates this.

This line is also the *efficient contract locus* (Bowles, 2004). It is characterized by outcomes that maximize common levels of welfare. On this line, improvement for one country is not possible without worsening the welfare for the other country.

Figure 3:



The TRIPS agreement – negotiations

Now assume that the countries negotiate about a common level of protection. In this case the countries welfare levels are given by (superscript p denotes preferences in negotiations):

$$\begin{aligned}
 W^{pa} &= \pi T (v^a + v^w) v^a \left(\frac{1}{r} - lT \right) + \gamma \pi T (v^a + v^w) v^a \left(\frac{1}{r} - (l + \pi)T \right) \\
 &+ \pi T (v^a + v^w) v^w \pi T - \frac{(\pi T (v^a + v^w))^2}{2} \\
 W^{pw} &= \gamma \pi T (v^a + v^w) v^w \left(\frac{1}{r} - lT \right) + \pi T (v^a + v^w) v^w \left(\frac{1}{r} - (l + \pi)T \right) \\
 &+ \gamma \pi T (v^a + v^w) v^a \pi T - \frac{(\pi T (v^a + v^w))^2}{2}
 \end{aligned}$$

It is seen that the welfare expressions differ both from the global welfare and the maximands for unilateral decisions on patent length. The first term is welfare from domestic innovations. The second term is welfare from foreign innovations patented in the domestic country. The third term is profits from domestic innovations patented in the foreign country. The last term represents the costs of domestic innovations.

Here, the two countries' welfare depend on the common T they negotiate about. The two welfare expressions differ when the two countries are different. Their maximum will be the two countries' preferred outcome of the negotiations. Maximization gives:

$$\begin{aligned}
 T^{pa} &= \frac{(1 + \gamma)}{r \left[2l(1 + \gamma) + \pi(1 + 2\gamma) - \pi \left(\frac{v^w}{v^a} \right) \right]} \\
 T^{pw} &= \frac{(1 + \gamma)}{r \left[2l(1 + \gamma) + 3\pi - \pi(2\gamma - 1) \left(\frac{v^a}{v^w} \right) \right]}
 \end{aligned}$$

In the symmetric case, the two countries will easily agree on the efficient level of protection in negotiations:

$$\begin{aligned}
T^{pa} \Big|_{\gamma=, v^a=v^w} &= T^{pw} \Big|_{\gamma=, v^a=v^w} = \frac{(1+\gamma)}{r \left[2l(1+\gamma) + \pi(1+2\gamma) - \pi \left(\frac{v^w}{v^a} \right) \right]} = \frac{(1+\gamma)}{r \left[2l(1+\gamma) + 3\pi - \pi(2\gamma-1) \left(\frac{v^a}{v^w} \right) \right]} \\
&= \frac{1}{r(2l+\pi)}
\end{aligned}$$

This is the global optimum and the same T that two closed economies would choose. The two countries' preferred T s are identical when the two countries are identical. If the two countries also have similar negotiation strengths, they will agree on the optimal T .

If the two countries negotiate on a solution, we find that their preferred common levels of protection have the following derivatives:

$$\begin{aligned}
\frac{dT^{pa}}{d\gamma} &= \frac{-\pi \left[1 + \frac{v^w}{v^a} \right]}{r \left[2l(1+\gamma) + \pi(1+2\gamma) - \pi \left(\frac{v^w}{v^a} \right) \right]^2} < 0 \\
\frac{dT^{pw}}{d\gamma} &= \frac{3\pi \left[1 + \frac{v^a}{v^w} \right]}{r \left[2l(1+\gamma) + 3\pi - \pi(2\gamma-1) \left(\frac{v^a}{v^w} \right) \right]^2} > 0
\end{aligned}$$

$$\begin{aligned}
\frac{dT^{pa}}{d\left(\frac{v^w}{v^a}\right)} &= \left(\frac{1+\gamma}{r}\right) \left[\frac{\pi}{\left[2l(1+\gamma) + \pi(1+2\gamma) - \pi \left(\frac{v^w}{v^a} \right) \right]^2} \right] > 0 \\
\frac{dT^{pw}}{d\left(\frac{v^a}{v^w}\right)} &= \left(\frac{1+\gamma}{r}\right) \left[\frac{\pi}{\left[2l(1+\gamma) + 3\pi - \pi(2\gamma-1) \left(\frac{v^a}{v^w} \right) \right]^2} \right] > 0
\end{aligned}$$

These results indicate that countries, in negotiations, argue in favor of a higher common level of protection the more innovative they. The more innovative a country is, the higher are the profits they repatriate from their innovations patented abroad.

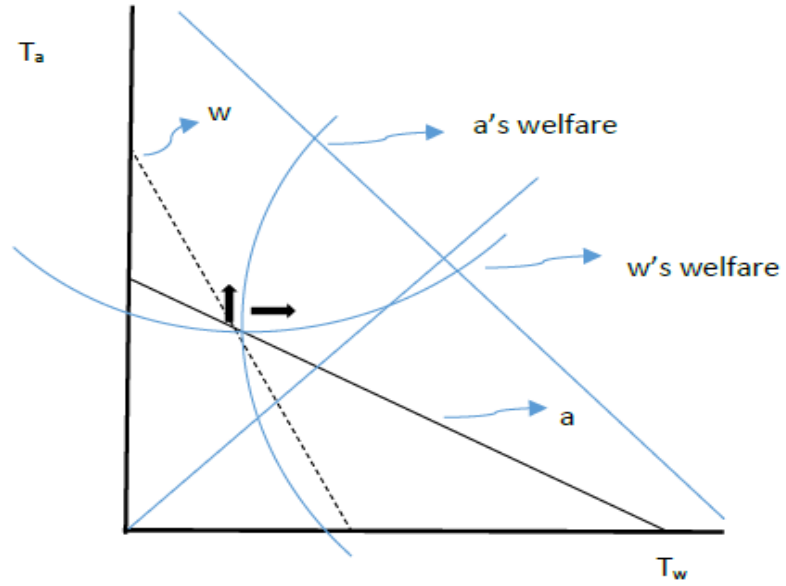
Also, the two countries argue in favor of stronger protection the smaller they are relative to their counterparties. This reason is that the larger is the other country, the higher are the profit incomes that can be repatriated from domestic innovations patented in the other country and the larger is the number of foreign innovations that benefits a country's consumers. This result is opposite of the result from unilateral MFN patent lengths. In that case, larger countries would tend to prefer longer patent lengths than small countries.

In the negotiations about the TRIPS agreement, large and innovative countries like Japan and the USA were in favor of strong IPRs, but so were small and innovative countries like Switzerland and the EU countries. For the large and innovative countries, therefore, it seems that the effect of being innovative dominated the effect of being large.

The graphs above illustrate countries' best response to each other's IPRs. They therefore indicate optimal levels of welfare given the other countries' IPR. Iso-welfare lines in the graph represent combinations of T^a and T^w where countries have the same welfare levels. Since the best response function for country w denotes country w 's best policy given country a 's policy, country w cannot deviate from the chosen T^w without higher T^a . Therefore, the iso-welfare lines are flat and bending upwards for country w in the (T^a, T^w) dimension and vertical and bending to the right for country a . The highest welfare for country w is the intersection of w 's reaction function with the T^a axis. The similar highest welfare for country a is the intersection of country a 's reaction function with the T^w axis. In figure 4, the bold arrows illustrate movements that improve welfare in country a (horizontal direction) and in country w (vertical direction).

Figure 4 gives a graphical presentation with the Nash equilibrium as point of departure. It is seen that negotiated solutions that improve both countries' welfare levels are possible. A solution that improves welfare for both countries must contain increased T in both countries. Without side payments (for instance through improved market access for country w 's products), such solutions are within the lens of the two countries' iso-welfare curves crossing through the Nash equilibrium. An optimal solution is on the downward sloping negative line. On this line, iso-welfare curves of the two countries are tangent to each other.

Figure 4:

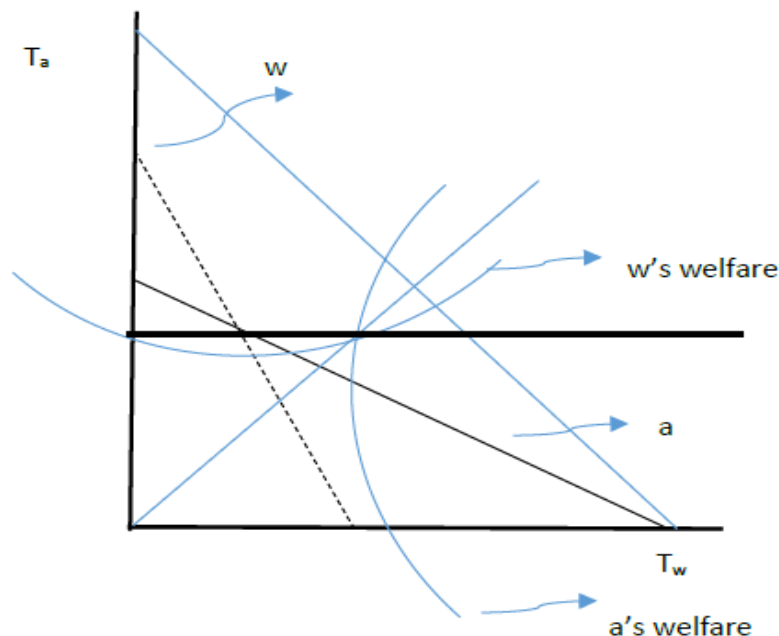


The TRIPS agreement – results

The TRIPS agreement departed from this. Through side payments, such as improved market access for agricultural products and termination of the multifiber agreement, low innovative countries were compensated for a move on the horizontal direction in the (T^a, T^w) diagram. The negotiated TRIPS agreement is illustrated with figure 5. In that figure T^a remains as before while T^w increases to the same level (so that the common T is on the 45 degree line). Both countries are off their reaction curves. Welfare has increased in country a and has decreased in country w (gross of side payments).

Note, however, that the horizontal movement is along flat parts of country w 's iso-welfare curve. This indicates that welfare reductions due to TRIPS may have been low. Welfare improvements in country a may have been large, however. Countries like country a captured more than the entire gain from increased IPRs in the world economy.

Figure 5:



Another important aspect of the TRIPS agreement is visible from the graph. The 'negotiation lens' has moved from the larger area in figure 4 downwards to the smaller area indicated in figure 5. The negotiation

lens is seen from the iso-welfare graphs crossing the negotiated solution on the 45-degree line. Movement toward the efficient contract locus *from* this negotiated solution will now result in new negotiated solutions closer to the T^w axis as compared to the point of departure in figure 4.

This may shed light on IPRs in new trade agreements (TRIPS-plus agreements). The new negotiation lens has made low or non-innovative countries more willing to agree to include IPR in free trade agreements after TRIPS than before TRIPS.

IPR and innovation

From the above discussion, it is clear that IPRs introduce efficiency costs. The efficiency costs from the TRIPS agreement outweigh dynamic efficiency gains for countries like country w . A major concern is also distributional issues. Consumer surplus is redistributed to profits. In the international context, surplus is also redistributed from less-innovative countries to more innovative countries. The motivation for introduction of IPRs is that the resulting profits stimulate innovation. In the modelling framework above, the number of innovations was assumed to increase quadratically with innovation costs. The degree to which IPRs stimulate innovation is an empirical issue. Economists have disagreed about the impact of and the functioning of the patent system.

Moser (2005) have studied innovations in the 1900 century. Her hypothesis is that innovation in countries with stricter IPRs should be higher in industries where patenting is common. Her results indicate higher innovation in patent intensive industries in countries with stricter IPRs. Lerner (2002), on the other hand, finds that IPR reforms mainly increase foreign patent applications and to a far lesser extent domestic patent applications. This is evidence that the international redistribution effects are the largest. Maskus (2014) reviews several studies. His reading of the literature is that there is a causal impact of patent rights on innovation. He notes, however, that these effects are largest in rich countries. The effects are mixed and partially negative in developing countries.

A major problem in measuring the impact of patent institutions on innovation is endogeneity issues. Are patent rights strengthened because strong innovators lobby for it, or do strong patent rights increase innovation? Bilir *et al.* (2011) find strong effects from the US accession of the Paris convention in 1887. The number of patent filings in the United States from inventors residing in other signatory states increased significantly. This is also evidence that increased patent protection in individual countries redistributes from consumers to innovating firms.

Sakakibara and Branstetter (2001) do not find any evidence that Japanese patent reforms in 1988 increased R&D or innovation. Similar findings are presented by Scherer and Weisburst (1995) based on Italian data.

Branstetter *et al.* (2006) find that stronger IPRs in the 1982–99 period increased technology transfer *within* US multinationals.

An impact of IPRs that was not captured in the modelling framework is that on trade and international investments. Exporting goods to countries with weak patent rights may be followed by imitation. With stricter IPRs foreign markets may be more tempting for potential exporters. Similarly, investing in production in foreign markets may be less tempting when IPRs are weak. Maskus's survey indicates that the literature is suggestive about this. He writes (p. 276) that "this is the most heavily studied question by economists in the wake of TRIPS and here the answer is more conclusive: patent reforms have strongly positive effects on such flows, at last to larger and middle income countries".

The main motive for the patent system is to stimulate R&D that results in new inventions. Some authors have questioned whether the monopoly situation permitted by patents is the only, or even the main, reason why innovating firms apply for patent protection. The classic Levin *et al.* (1987) study reported results from a survey among US firms. The results indicate that many firms do not regard patenting as the main means to appropriate the rewards from innovations. Alternative means are trade secrecy, lead-time, reputation, sales and service effort and moving down the learning curve. Cohen *et al.* (1996) discuss that firms have several reasons to patent in addition to obtaining monopoly rights. Firms may, for instance, use patents as a means to block rivals from patenting related inventions.

The empirical literature on patents includes both studies of the determinants of patent strength and the impact of patent strength on innovation. Studies indicate that countries characterized by high R&D levels and GDP, market freedom and openness have stronger patent protection than others (Ginarte and Park, 2017). Kanwar and Evenson (2003) find that there is a positive correlation between the strength of patent protection and R&D intensity for a sample of 29 countries. Similar findings are provided by Chen and Puttitanum (2005) for developing countries.

TRIPS and post TRIPS

The TRIPS agreement is mandatory for member countries in the WTO. WTO membership guarantees countries market access in other countries on most favored nation basis (MFN). WTO has become a global organization. The number of member countries is 164 (since July, 2016). Noting the importance of WTO membership, Maskus (2014, p.268) notes that TRIPS “is an involuntary agreement”.

The TRIPS agreement mandates strong IPRs in WTO member countries. Patents must be provided for at least 20 years. Trademarks and copyrights must be protected, including computer software.

As with the Paris and the Berne conventions, also the TRIPS agreement contains MFN principles as well as the principle of national treatment (so that domestic applicants are treated no better than foreign applicants). This implies that when stronger IPRs are included in new free trade agreements, the stronger IPRs are granted also to applicants who originate in other countries.

The TRIPS agreement mandates minimum protection of intellectual property rights for WTO member countries. Since this minimum protection was the result of negotiations, some countries maintained stronger protection in some areas. For instance, in EPO, protection of pharmaceuticals can be extended to more than the minimum 20 years, due to delayed market authorization after the filing date of the basic patent. Thus, the negotiated solution for IPRs that resulted from the TRIPS agreement is less strong than EPO countries choose on their own.

Apart from patent length, nation states have some sovereignty also in other dimensions of IPRs within the TRIPS. They can choose (MFN) cost structure at their own will. There is some sovereignty in choosing subject matter. And countries are free to choose stronger IPRs than those mandated by the TRIPS agreement.

In the aftermath of the TRIPS agreement coming into force, intellectual property rights have become stronger through additional agreements reached through the World Intellectual Property Organization (WIPO), demands in the context of preferential trade agreements and unilateral reforms in many countries. Mercurio (2006) writes that (p. 215) “...the US and other developed nations almost immediately began negotiating

for the inclusion of more protectable subject matter, stronger enforcement mechanisms, and a weakening of ‘flexibilities’ and ‘special and differentiated treatment’ granted to developing and least developed countries in the TRIPS.” In the domain of IPRs, Mercurio proposes that there is a rotating cycle between bilateralism, regionalism and multilateralism, and that such cycles strengthen IPRs across nations. The discussion revolving figure 5 above gives support to this view. Harmonization of patent rights (a horizontal move to the 45-degree line), shifts, and narrows, the negotiation lens in the direction of increased but equal IPRs across different countries.

Almost two decades after the TRIPS-agreement came into force, Maskus (2014) writes that (p. 262): “Demands that countries strongly protect property rights (IPRs) – patents, copyrights, trademarks and a host of related policies – currently sit at the top of the global commercial policy agendas of the United States, the European Union, Japan and other technologically advanced countries”.

This is in line with a negotiated solution in the TRIPS agreement. Since some countries wanted even stronger protection of intellectual property rights than the agreement mandates, they are free to strengthen their IPRs. They can do so unilaterally or groups of countries may negotiate stronger property rights within their jurisdictions.

There are now many treatments about stronger IPRs than the TRIPS agreement mandate. Above, conflicts of interest between high innovative countries and low innovative countries were discussed as one reason for this development. The high innovative countries did simply not have strong enough negotiating power to dictate their will in full on the rest of the world. There are also other reasons why the innovative countries seek stronger IPRs internationally. Maskus (2014) discuss some of these. First, globalization has increased technology flows in the global economy. Through trade and foreign investments and licensing, technologies have become more internationally mobile. IPRs are important for how and where technology flows are directed. Relatedly, more production processes are internationally vertically integrated. Thus, globalization increases the need for IPRs in many countries.

Coelli *et al.* (2016) investigate the impact of trade reforms on international patenting and find strong effects. They estimate that about 7 percent of the increase in knowledge production during the 1990s can be explained by trade policy reforms.

Second, new technologies have expanded the scope of invention. This includes software, digital goods and electronic communications Also

technological advance in bio-technology, medicines and agricultural life sciences are costly to develop and easy to copy. Finally, Maskus notes, increasing political strength of large multinational firms may have changed policy preferences in their favor.

Large and technologically advanced countries such as the United States and the European Union typically demand the extension of IPRs in new free trade agreements. They are denoted TRIPS-Plus extensions. Such extensions have been incorporated in US free trade agreements with many countries (in Europa, Asia, Latin-America and Oceania) as well as in the North-American free trade agreement, NAFTA and the less comprehensive Central-American counterpart, CAFTA, and also in the recent EU-Canada free trade agreements.

IPR topics were included in negotiations about the transatlantic free trade agreements (TTIP) as well as the transpacific free trade agreement (TPP). These developments are discussed in Maskus (2014), Mercurio (2006), Seuba (2013) and Morin (2009). Roffe (2004) gives a detailed overview of IPR regulations in the Chile-USA free trade agreement.

Stronger standards for IPR include limits on revealing test data, extended duration and extension of pharmaceutical patents, elevated protection of geographical indicators and regulations on use of digital goods and Internet materials. Also, IPR issues are included in bilateral investment treatments and international investment agreements.

In the CAFTA agreement, Nicaragua agreed to forgo its implementation period and immediately comply with its TRIPS obligations in exchange for increased access to US markets (Mercurio, 2006).

In US preferential trading agreements, TRIPS-Plus provisions are often identical to aspects of US domestic law. The US law providing the President with the power to conclude trade agreements ('fast track') promotes IPRs that 'reflect a standard of protection similar to that found in United States law (Mercurio, 2006, p. 220).

Seuba (2013) gives an overview of developments of IPRs in preferential trading agreements. He shows that IPRs are very often included in preferential trading agreements between developed countries, but also in preferential trading agreements between developed and developing countries, and increasingly, also in agreements between developing countries. In 2013 there were 141 treaties that regulated IPRs. This is in line with the theory section above: If, for some reason, one country adopts a stronger than preferred IPR protection, for instance due to a preferential treaty with the US or the EU, they will prefer other trading partners to follow.

When countries reduce tariff rates vis-à-vis each other with preferential trading agreements, they discriminate between their trading partners. Tariff rates differ between the countries who sign the agreements and countries relying on WTO provisions. Preferential trading agreements are therefore exemptions to the general MFN rule in the WTO that countries should not discriminate between trading partners. For TRIPS-Plus agreements there is no such exemption. Therefore, countries that strengthen their IPRs as part of a preferential trading agreement, does so for all trading partners, and therefore provide stronger IPRs for inventors from all over the world. Mercurio (2006) argues that this serves to 'ratchet up' international IPRs. When TRIPS-Plus agreements become widespread, their IPR provisions may become the new minimum standard in new negotiation rounds in the WTO. Upreti (2016, p.60) notes that "Therefore, with more FTAs, a new provision is added; as a result with the passage of time it is likely to be a norm."

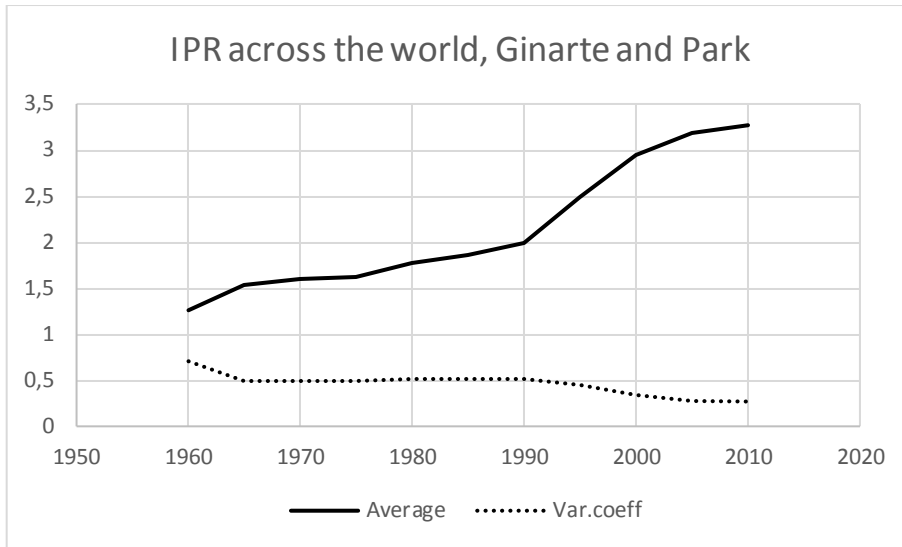
The TRIPS agreement and the post TRIPS development has therefore resulted in convergence and strengthening of patent rights in the global economy.

Ginarte and Park (1997) and Park (2008) have developed an index of IPRs. That index captures patent length, extent of patent coverage, provisions for loss of protection, enforcement mechanisms and membership in international agreements. The index is continuous and ranges from zero (no protection) to five. The index covers the period from 1960 to 2005 for 122 countries. The updated version of the index also includes the TRIPS agreement as well as other international treaties covering IPRs, such as NAFTA, EPO and the African Regional Industrial Property Organization (ARIPO). As such, the index does not measure the impact of TRIPS and international IPR cooperation on IPR since this is included in its definition. But the development over time in the index demonstrates convergence in IPR in the global economy.⁵

Figure 6 presents average scores as well as the coefficient of variation for the 122 countries covered by the index. It is seen that average scores increase over time and that this development accelerated in the aftermath of the TRIPS agreement. Also the coefficient of variation decreases. Recent years have therefore witnessed increasing and converging IPRs among countries in the world.

⁵ The reference is Park (2008). The data is updated to include 2010 at the webpage http://fs2.american.edu/wgp/www/?_ga=2.90715994.1914350328.1516200151-1898180829.1516200151

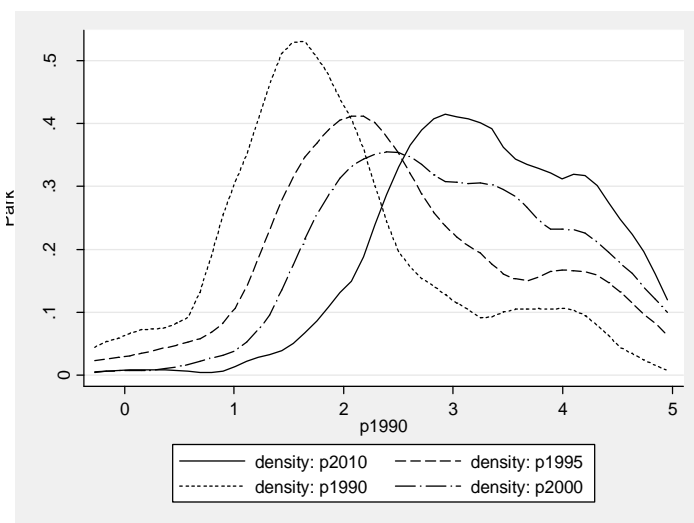
Figure 6:



Source: Park 2008

The evolving distribution is described by Figure 7. Figure 7 shows kernel density graphs for the global distribution of IPRS in the period from 1990 to 2010. It is seen from the graph that countries' IPR strengthened considerably when the TRIPS was introduced but also after. The left hand side of the distribution is almost emptied. The modal and the right hand side increases.

Figure 7:

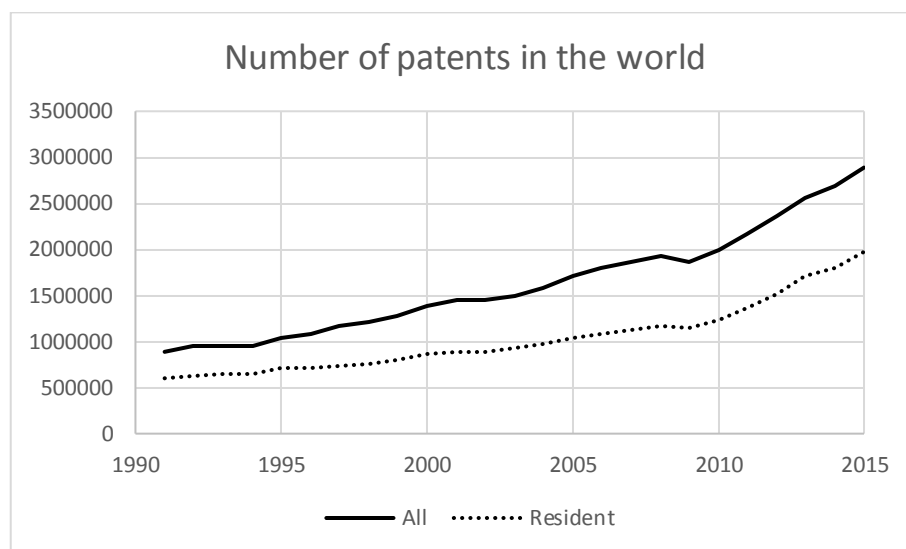


Source: Park 2008

EPO

Recent developments with faster technological change, growth in worldwide patenting as well as fast growth in developing countries, raise questions whether national patent institutions are a well-suited instrument since many innovations are developed for international use. Figure 8 graphs global developments in patenting. The graph shows the number of patent applications from residents as well the total (including non-residents) for the world economy.

Figure 8:



Source: WIPO (2017)

The graph shows that the number of patents is increasing. This applies for domestic patents (applied for at the national and regional patent offices) as well the total number of patents. The graph demonstrates that patent applications from residents constitute the major share of all patents. For a sample of small and medium sized Swedish firms, Maurseth and Svensson (2014) find that most patents are applied for only in the applicant's homeland.

EPO developed as a supplement to national patent institutions. EPO was established in 1977 after the European Patent Convention was signed in 1973. There are also other regional patent offices, in Africa as well as South America.

EPO is a European institution and not an EU institution. Thus, EPO is open for other European countries. In order to become members, countries need to have standardized patent laws and regulations. Membership in EPO is mandatory for EU countries. Countries retain their national patent institutions as member countries in EPO. EPO is an umbrella over the national institutions and supplements them.

Inventors can seek patent protection in Europe via three channels. First, they can apply for patent in their domestic countries first and thereafter in their selection of EPO countries. Second, they can apply for patent protection to EPO directly and thereafter a selection of EPO countries. Third, they can obtain European patent protection in selected countries via the international patent system (PCT).⁶

EPO facilitates patent protection in EPO member countries. Via EPO, a single application covers the applicant's home country as well as the other member countries in the EPO the applicant prefers. Thus, EPO makes protection in these countries easier and less costly.

The main ingredient in EPO is harmonization and standardization of granting procedures of patents in the member states. Patent applications are filed with the EPO which is responsible for examination and granting of the patent. The patent owners must validate their patents in each national patent office where they want their patent to be valid. In the EPO therefore, patents remain national rights. Validation requires prior designation during the grant process. Once granted, patentees must pay validation fees as well as translation cost (with some exceptions due to the London agreement where some countries do not require translation). Patents have to be kept in force in each individual country by paying renewal fees. For an EPO patent to be protected in a country therefore, it is required that patentees pay all costs associated with the grant of an EPO patent and specific costs incurred in each nation state.

EPO also facilitates foreign patent applications in all EPO countries, both by other EPO member as well as applicant originating in countries outside the EPO (via national treatment as required by the Paris convention and also the TRIPS agreement).

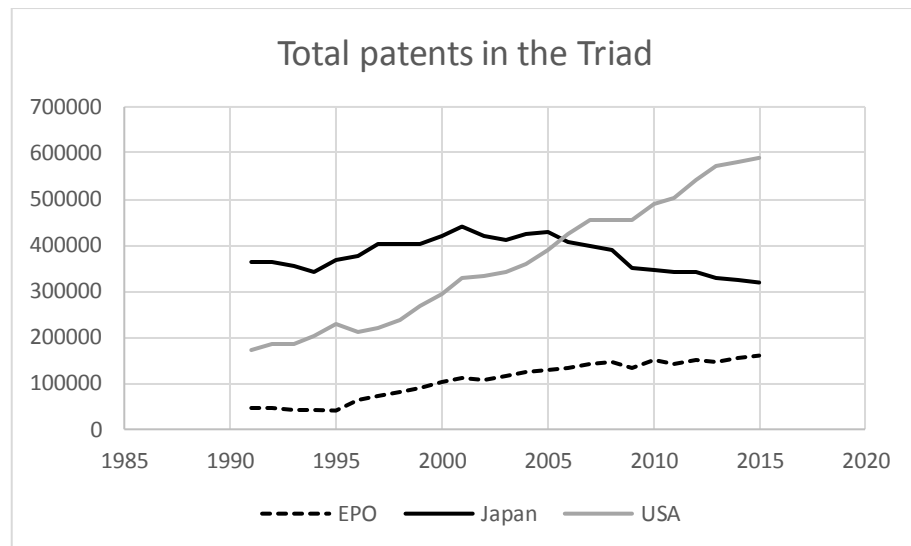
EPO has grown in number of members since its foundation in 1977. The founding countries were Belgium, France, Germany, Luxembourg, Switzerland and UK. EPO expanded with western European countries

⁶ The PCT route for patent applications leaves granting the patent to the national patent office.

until 2000. In 2000 Turkey joined. Turkey was followed by Eastern European transition countries post 2000. Iceland and Norway joined in 2004 and 2008, respectively. Since the establishment of EPO, the number of member countries has increased from seven to 38.

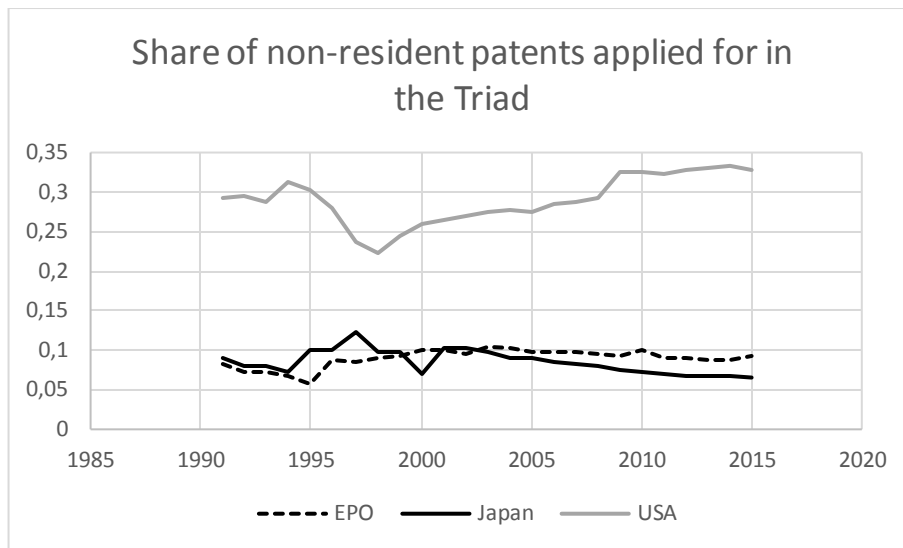
EPO is one of the three largest patent offices in the world economy. The two others are the United States patent office and Japan's patent office. These are often called the *triad* countries. Figures 9 and 10 shows developments in relative patenting in the triad countries. The first shows the total number of patent applications going to the three institutions. The second shows the share of world *non-resident* patent applications applied for in these institutions.

Figure 9:



Source: WIPO (2017)

Figure 10:



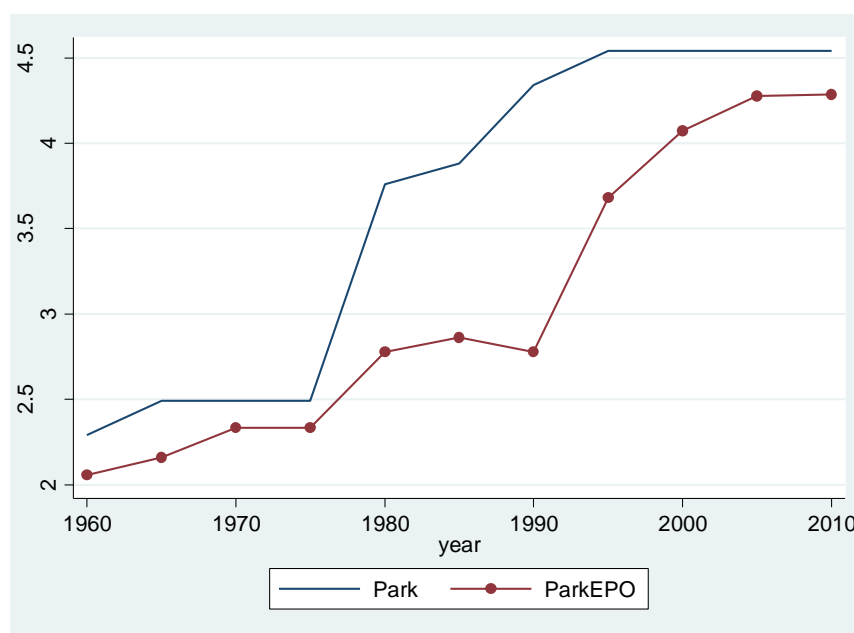
Source: WIPO (2017)

The first graph underlines the importance of the United States in the global innovation system. There are many more patent applications in the United States than in Europe or in Japan. This is the result of an increasing trend over the past 25 years. Patenting has become more popular in the USA. The development in Japan is different. The number of patent applications in Japan has been more constant with a decreasing trend after 2005. The number of patent applications to EPO has been increasing, but slower than the similar trend in the United States.

Comparing the total number of patent applications in different countries is, however, like comparing apples and oranges. The reason is differences in institutions, differences in industries due to differing propensities to patent as well as other reasons. The second figure therefore graphs the three institutions' share of total world *non-resident* patent applications. Again the dominance of the United States is demonstrated, while EPO is stagnant and Japan's share is declining. Note that the figures involve double counting. One innovation can be applied for in more than one country. Rather than demonstrating the absolute importance of the three knowledge markets, the figure may indicate their relative importance: Innovators may rank United States as more important than the two other markets and therefore more often apply for protection there. It is interesting therefore, that Europe has reversed its position vis-à-vis Japan.

IPRs in EPO countries have strengthened over time. Figure 11 shows the average Park index for all EPO countries (*ParkEPO*) as well as the Park index for United Kingdom (*Park*) (chosen because it is one the three main patent countries in Europe and representative for the initial EPO countries). The graph shows that IPRs have indeed strengthened in EPO countries.

Figure 11:



Source: Park (2008)

The increase in IPRs in Europe is in line with the modelling approach above. First, merging two economies increases their preferred level of protection, T . In essence, externalities between the two countries are internalized. Second, in the modelling framework, larger countries prefer higher T vis-à-vis smaller countries. Thus, the establishment and the subsequent growth of EPO may have, endogenously, strengthened Europe's preferences for stronger protection. As such, EPO may have made Europe a more aggressive proponent in the pre WTO negotiations and in subsequent negotiations about free trade agreements.

Third, if patents work as intended, they should stimulate innovations and increase expenditures on R&D. More innovative countries prefer higher T in the modelling framework above.

Hall and Helmers (2012) analyse effects of EPO membership. They investigate the impact on total domestic patent applications before and

after EPO accession. Their conclusion is that (p. 11) “there was no visible trend change in overall patent filings across the 12 countries included in the sample ...”. They also investigate residents’ preference for applications through their national patent office before and after EPO accession. With EPO membership, inventors face the opportunity to gain protection in their home country via EPO rather than via their national office. Hall and Helmers conclude that there was a (p. 12) “slight downward trend in national filings”. Similarly, they investigate foreigners’ patent applications at the national patent offices. They demonstrate that there was an “(expected) dramatic effect of accession to the EPC on filings by non-resident applications at the national offices. Non-residents’ filings drop between the pre-accession and post-accession quarters by nearly 70 % ...”.

One indication that EPO is attractive for innovators comes from table 1. The table is taken from Maurseth and Svensson (2014). They investigated Swedish patents that were granted to small and medium sized firms in 1998 and the extent to which these patents were also applied for in other countries. Most patents were applied for only in Sweden. But about 40 per cent were also applied for in other countries. The maximum number of such patent *equivalents* was 24. In total patent protection was applied for in 35 other countries than Sweden. The table reports regression results for the probability that patents were applied for in these countries (probit regressions). Included as explanatory variables are country specific variables. One of these is EPO membership. Other country specific explanatory variables are market size (GDP), the growth rate of GDP, GDP per capita, R&D expenses, the distance from Sweden, the share of Swedish exports going to the country, an index of patent costs and of the strength of patent protection as well as the country’s specialization in the same patent category as the Swedish patent. Patent specific variables are the size of the firm as well as the year that the patent was first applied for in Sweden. In the table, only results for the country specific variables are reported.

The result indicates significant effects of EPO membership. If other countries were members of EPO, Swedish inventors more likely applied for patents there. This is evidence that inventors consider that EPO membership provides protection that is more valuable than elsewhere. The results survive also when the Park index for patent protection is included as explanatory variable.

It may be argued that the likelihood that Swedish patent holders want to extend protection of their inventions to other European countries is not surprising. But importantly, in 1998 fewer countries were members

of EPO (Norway joined in 2008). Also inclusion of country specific variables such as GDP, GDP per capita, distance from Sweden and the share of Swedish exports going to the individual countries should control for specific European effects.

Table 1: Estimation results, random effects probit model.

<i>Variable</i>	
<i>GDP</i>	0.54*** (0.032)
<i>GROWTH</i>	0.10*** (0.020)
<i>R&D as share of GDP</i>	0.11*** (0.035)
<i>GDP per capita</i>	0.07 (0.074)
<i>Specialisation in patent class</i>	0.48*** (0.068)
<i>Distance from Sweden</i>	-0.11*** (0.040)
<i>Share of Swedish exports</i>	5.66*** (0.982)
<i>Strength of patent protection</i>	0.20*** (0.068)
<i>EPO membership</i>	0.43*** (0.053)
ρ	0.72*** (0.019)
n	27,744

Note: The dependent variable is the existence of patent equivalent of patent i in country j . Std. errors in parentheses. ***, ** and * indicate significance at the 1%-, 5%- and 10%-level, respectively. All estimations include 30 industry dummies (not reported). Source: Maurseth and Svensson (2014).

In 2008, Norway became member of EPO. The debate about this had lasted long (since EPO was founded). Norwegian membership in the European Economic Area made Norway fully integrated into EUs internal market. Thus, also patent laws were included. Main arguments about national sovereignty in IPR policy therefore vanished.

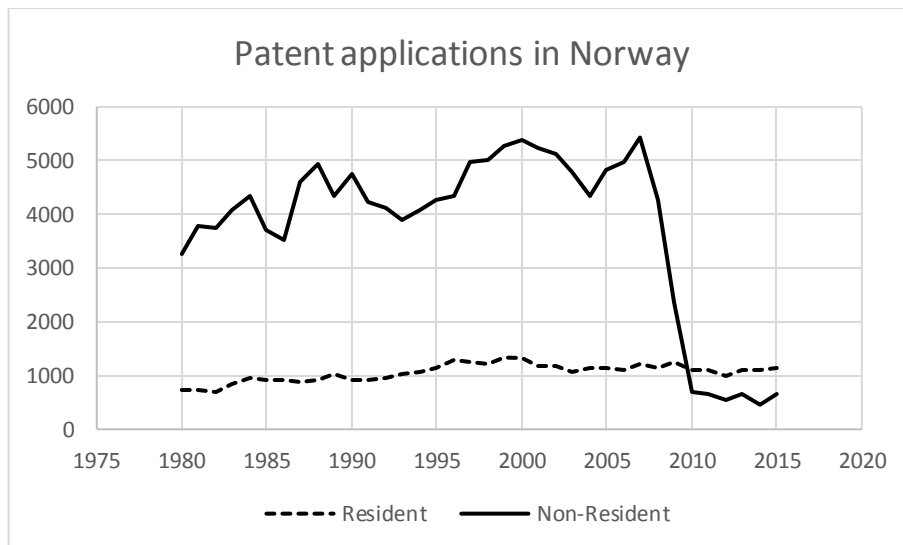
The effects of EPO membership seem to reflect the findings by Hall and Helmers (2012) quite well. Figure 12 graphs resident and non-resident patent applications to the Norwegian patent office in the period from

1980 to 2015. The drop in non-resident patent applications following EPO membership is remarkable.

Figure 13 graphs the number of patent filings and applications from and grants to Norwegian applicants in EPO over time.

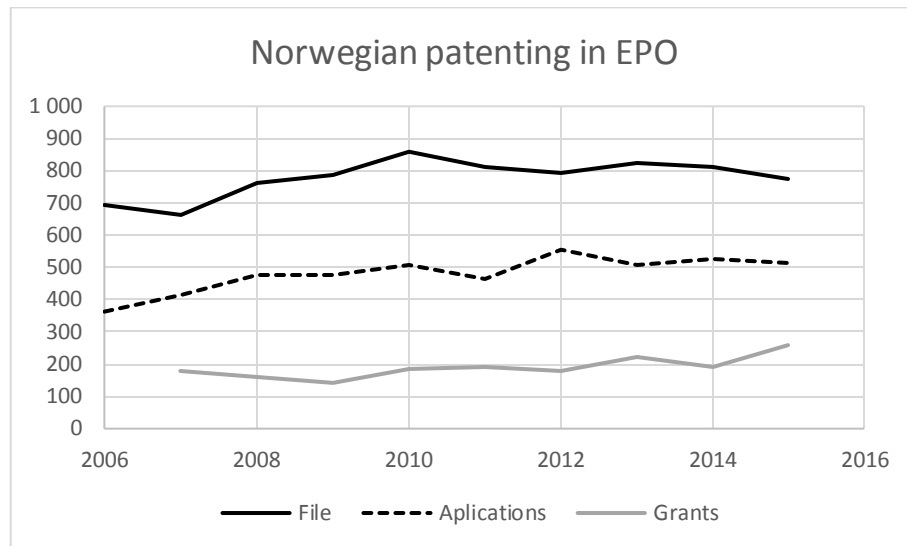
The graph indicates no clear effects of EPO membership. Filings are on a slightly downward trend, while patent applications seems to have increased slightly and reached a somewhat higher level. The number of granted patents increased slightly at the end of the period, but it cannot be concluded that this is due to EPO membership. Therefore, the Norwegian data gives support to the conclusion from Hall and Helmers that effects from EPO membership on innovation are limited. The main effects seem to be that foreigners obtain protection of their patents in Norway via EPO rather than via the national patent office.

Figure 12:



Source: Statistics Norway (Statistikkbanken).

Figure 13:



Source: EPO

European Unitary Patent

The plans for a European Unitary Patent go further than EPO. With the Unitary Patent, validation of valid EPO patents is no longer required for a patent to enter into force. While the traditional EPO patent consists of a bundle of 38 *potential* patents, the unitary patent confers a single patent covering the 25 participating member countries in the EU (all the 28, except Poland, Croatia and Spain⁷). With the unitary patent, there will be single fees and a single court (the unified patent court, UPC). Paris, Munich and London are planned to be the locations of the UPC central division.

The most likely effect of a unitary patent is far more valid patents throughout Europe. The largest increase will probably be in the small and most peripheral markets since these are the least attractive for patent applicants today. With the unitary patent, protection in many countries is granted through one patent grant rather than through grants in individual countries. Thus, small and peripheral markets will be automatically included in patent grants.

The overall positive impact is the potential stimulus from strengthened IPR protection on innovation. The most innovative countries may gain more from the unitary patent than less innovative countries. The reason is again that the profits from increased protection accrue to the innovators. Deadweight losses occur in non-innovative countries, but deadweight costs are also higher in large countries (with large markets). Also, improved IPRs implies a further re-distribution of consumer surplus to profits.

A second likely effect is a change in cost structures for patents. One motive for the unitary patent is to reduce costs. A likely consequence is that costs for the most valuable patents (those that are applied for in all EPO countries today, for instance), will have reductions in their costs. Costs for less valuable patents (for instance those that are applied for only in the nation states) will (at least relatively) increase.

By construction, the unitary patent excludes many countries (those that are not EU members). With the unitary patent, patenting through

⁷ The unitary patent system will be trilingual (English, French and German). This is the reason why Spain rejects to participate.

EPO will still be possible. Thus, it is not clear whether the unitary patent will change foreign patenting in EPO member countries that do not participate in the unitary patent.

Inventors in EPO countries that are not included in EPO will experience lower costs for patent applications in unitary patent countries compared to the present situation if they patent in all EU countries. This is a benefit and may increase the number of patent applications to unitary patent countries from outside countries.

The plans for a European unitary patent are now in limbo land (see e.g. Uphoff and Morelli, 2016). The agreement has to be approved by all member countries, and it is mandatory that the UK participates. The agreement can only be implemented if the UK ratifies. UK cannot however, participate in the unitary patent after Brexit.

Therefore, the agreement has to be renegotiated. The unitary patent agreement states that the unitary patent can be launched only after it has been ratified by 13 member countries, including France, Germany and UK. The UK has signaled that it will ratify the agreement even if future participation is uncertain.

Whether the future unitary patent involves UK or not, is still not decided. Farrand (2017), Cook (2016) and Jaeger (2017) discuss the potential consequences of including UK versus a unitary patent among the other EU countries.

It has been questioned whether the Brexit substantially reduces the value of the unitary patent. A main benefit of the patent would be to reduce the need for multiple applications of the same patent. With Brexit, innovators will still need to double-apply for patents (if they are relevant in the large UK market).

The unitary patent has been planned for a long time. It has been regarded as natural extension of European economic integration. Given the modelling framework presented here, enhanced European integration in the area of IPR, does not only affect Europe, but also other countries. Europe becomes a more attractive destination for foreigners' patent applications. But stronger European IPR may well influence on Europe's position in the international political economy in the field of IPT.

Conclusions

IPRs across countries have converged considerably. While traditionally the domain of the nation states, almost all countries are now bound by international commitments in the design of their IPS. International commitments have evolved from most favored nations treatment to detailed specifications about IPRs. The TRIPS agreement requires all WTO member countries to have minimum IPR. But many countries go further. In recent trade agreements, stronger IPRs are now often included.

A simple model of international IPR demonstrates both common interests in international IPR (the Nash solution for national IPR is sub-optimal) as well as conflicts of interests (the optimal global level IPR can be combined with a variety of combinations of national IPRs). The model indicates that the TRIPS solution, in which countries have committed to a common minimum level of IPR have increased welfare in some countries and reduced welfare in other countries (gross of side payments).

In Europe, EPO was established long before TRIPS. Europe is a block of countries with standardized and strong patent rights. EPO has been successful in the sense that it has attracted an increasing number and an increasing share of worldwide patent applications. EPO may also have contributed to stronger European preferences for stricter IPRs in international trade agreements.

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Appendix

Stability and existence of Nash equilibrium

The Nash equilibrium is stable, but may not exist. The two reaction functions are:

$$T^a = \left(\frac{1+\gamma}{r} \right) \frac{1}{2(1+\gamma)l + \pi(1+2\gamma)} - T^w \frac{v^w}{v^a} \frac{(1+\gamma)l + \gamma\pi}{2(1+\gamma)l + \pi(1+2\gamma)}$$

$$T^w = \left(\frac{1+\gamma}{r} \right) \frac{1}{2(1+\gamma)l + 3\pi} - T^a \frac{v^a}{v^w} \frac{(1+\gamma)l + \pi(2-\gamma)}{2(1+\gamma)l + 3\pi}$$

.

First, stability requires that T^w is steeper than T^a in the (T^a, T^w) dimension. This is always the case:

$$\left. \frac{dT^a}{dT^w} \right|_a = - \frac{v^w}{v^a} \frac{(1+\gamma)l + \gamma\pi}{2(1+\gamma)l + \pi(1+2\gamma)}$$

$$\left. \frac{dT^a}{dT^w} \right|_w = - \frac{v^w}{v^a} \frac{2(1+\gamma)l + 3\pi}{(1+\gamma)l + \pi(2-\gamma)}$$

It is easy to show that

$$\left. \frac{dT^a}{dT^w} \right|_a > \left. \frac{dT^a}{dT^w} \right|_w$$

It may be that the two functions do not cross. This will occur if the intersection of a 's reaction curve with the T^a axis is above the intersection of w 's reaction curve on the T^a axis. This will happen if a 's choice of T^a when $T^w=0$ makes country w choose $T^w=0$. Formally, this occurs if:

$$\begin{aligned}
T^w &= \left(\frac{1+\gamma}{r}\right) \frac{1}{2(1+\gamma)l+3\pi} - \left(T^a \Big|_{T^w=0}\right) \frac{v^a}{v^w} \frac{(1+\gamma)l+\pi(2-\gamma)}{2(1+\gamma)l+3\pi} \leq 0 \\
&\rightarrow \\
&\left(\frac{1+\gamma}{r}\right) \frac{1}{2(1+\gamma)l+3\pi} - \left(\left(\frac{1+\gamma}{r}\right) \frac{1}{2(1+\gamma)l+\pi(1+2\gamma)}\right) \frac{v^a}{v^w} \frac{(1+\gamma)l+\pi(2-\gamma)}{2(1+\gamma)l+3\pi} \leq 0 \\
&\rightarrow \\
\frac{v^w}{v^a} &\leq \frac{(1+\gamma)l+\pi(2-\gamma)}{2(1+\gamma)l+\pi(1+2\gamma)}
\end{aligned}$$

This is the condition that country w would choose no protection given that country a sets a positive level of protection as a response to no protection in country w .

It is seen that this can occur for low levels of v^a relative to v^w and if country w has low innovation capabilities.

Thus, in the present model, small and non-innovative countries could well have chosen to have no protection of IPRs. In the pre-TRIPs world, many countries had very weak IPRs (see figure 6 and 7).

The aggregate level of protection in Nash equilibrium with asymmetric countries.

The two countries' reaction functions are:

$$\begin{aligned}
T^a &= \left(\frac{1+\gamma}{r}\right) \frac{1}{2(1+\gamma)l+\pi(1+2\gamma)} - T^w \frac{v^w}{v^a} \frac{(1+\gamma)l+\gamma\pi}{2(1+\gamma)l+\pi(1+2\gamma)} \\
T^w &= \left(\frac{1+\gamma}{r}\right) \frac{1}{2(1+\gamma)l+3\pi} - T^a \frac{v^a}{v^w} \frac{(1+\gamma)l+\pi(2-\gamma)}{2(1+\gamma)l+3\pi}
\end{aligned}$$

Inserting the reaction functions into each other gives:

$$\begin{aligned}
 T^a &= \left(\frac{1+\gamma}{r} \right) \frac{1}{2(1+\gamma)l + \pi(1+2\gamma)} - \\
 &\frac{v^w}{v^a} \frac{(1+\gamma)l + \gamma\pi}{2(1+\gamma)l + \pi(1+2\gamma)} \left[\left(\frac{1+\gamma}{r} \right) \frac{1}{2(1+\gamma)l + 3\pi} - T^a \frac{v^a}{v^w} \frac{(1+\gamma)l + \pi(2-\gamma)}{2(1+\gamma)l + 3\pi} \right] \\
 T^w &= \left(\frac{1+\gamma}{r} \right) \frac{1}{2(1+\gamma)l + 3\pi} - \\
 &\frac{v^a}{v^w} \frac{(1+\gamma)l + \pi(2-\gamma)}{2(1+\gamma)l + 3\pi} \left[\left(\frac{1+\gamma}{r} \right) \frac{1}{2(1+\gamma)l + \pi(1+2\gamma)} - T^w \frac{v^w}{v^a} \frac{(1+\gamma)l + \gamma\pi}{2(1+\gamma)l + \pi(1+2\gamma)} \right] \\
 T^a &= \left(\frac{1+\gamma}{r} \right) \left[\frac{(2(1+\gamma)l + 3\pi) - \left(\frac{v^w}{v^a} \right) ((1+\gamma)l + \gamma\pi)}{(2(1+\gamma)l + \pi(1+2\gamma))(2(1+\gamma)l + 3\pi) - ((1+\gamma)l + \gamma\pi)((1+\gamma)l + \pi(2-\gamma))} \right] \\
 T^w &= \left(\frac{1+\gamma}{r} \right) \left[\frac{(2(1+\gamma)l + \pi(1+2\gamma)) - \left(\frac{v^a}{v^w} \right) ((1+\gamma)l + \pi(2-\gamma))}{(2(1+\gamma)l + \pi(1+2\gamma))(2(1+\gamma)l + 3\pi) - ((1+\gamma)l + \gamma\pi)((1+\gamma)l + \pi(2-\gamma))} \right]
 \end{aligned}$$

The aggregate level of protection is the weighted average of the two countries levels of protection:

$$T^A = \frac{v^a T^a}{(v^a + v^w)} + \frac{v^w T^w}{(v^a + v^w)}$$

This gives:

$$T^{NA} = \left(\frac{1+\gamma}{r} \right) \left(\frac{1}{2(1+\gamma) + 2\pi} \right)$$



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