Compulsory Licensing and Patent Protection: A North-South Perspective*

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Abstract

In a stylized model involving two agents – a developing country (called South) and a foreign patent-holder – we analyze how the incidence and social value of compulsory licensing (CL) depends upon the South's patent protection policy. We show that if the South is free to deny patent protection, not only does CL fail to arise in equilibrium, the option to use it makes both parties worse off. Furthermore, being able to use CL reduces the South's incentive for patent protection. However, if the South is obligated to offer patent protection (say due to its membership in an international organization such as the WTO), CL occurs in equilibrium and can even make both parties better off. CL is more likely to occur if price is negotiated between the two parties compared to when it is set unilaterally by the patent-holder. If the South can impose a price control, the patent-holder is willing to sell at a lower price if its patent is protected relative to when it is not. Thus, the ability to dictate price makes patent protection more attractive to the South while the option to use CL has the opposite effect.

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1 Introduction

The ratification of the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) by the World Trade Organization (WTO) in 1995 was a watershed event in the history of the multilateral trading system. The expansion of the WTO into the sensitive realm of intellectual property had profound implications for both developed and developing countries since international violations of intellectual property rights (IPRs) became subject to the potent dispute settlement mechanism of the WTO.[1] It is no secret that, prior to TRIPS, imitation and piracy of products protected in the West by copyrights, trademarks, and patents – such as DVDs, designer consumer items, software, and pharmaceuticals – was pervasive in the developing world. Indeed, even today most developing countries capable of successfully imitating such products see few advantages, if any, to restricting local imitation and reverse-engineering.

On the other side of the spectrum, developed countries generally argue for stronger IPRs world-wide in order to ensure that holders of IPRs (most of whom reside in the developed world) can profit adequately from their creative efforts and investments in research and development (R&D).[2] Indeed, TRIPS negotiations during the Uruguay Round (1986-1995) were motivated by a deep-rooted sense of dissatisfaction in the United States and major European nations with the lack of IPR protection in major developing countries such as Brazil, India, and China.[3]

To some extent, the clashing interests of developing and developed countries over IPR protection are embodied in the very nature of the TRIPS agreement that eventually emerged from the lengthy Uruguay Round negotiations. On the one hand, TRIPS obligates all WTO members to offer and enforce certain minimum standards of IPR protection (such as twenty years for patents).[4] On the other hand, TRIPS contains some important *flexibilities* that allow national governments some discretion in the implementation and enforcement of IPRs within their territories. Perhaps the most important such flexibility is contained in Article 31 of TRIPS that provides conditions under which

[1] Articles 63 and 64 of TRIPS explicitly specify member obligations with respect to dispute prevention and settlement.

[2] See Maskus (2000 and 2012) for comprehensive overviews of the economics of IPRs in a global setting.

[3] Annual reports of the United States Trade Representative (USTR) routinely list countries in which the lack of IPR protection is perceived to be seriously harmful to US interests. A sense of the US perspective prior to the Uruguay Round negotiations can be obtained from US-Chamber of Commerce (1987) and United States International Trade Commission (1988).

[4] In accordance with the notion of special and differential treatment that exists in other parts of the WTO contract, developing countries were given fairly long time horizons within which they had to make their IPR regimes TRIPS compliant, with greatest accommodations being made for the least developed countries.

WTO members can permit the "use of the subject matter of a patent without the authorization of the right holder, including use by the government or third parties", or what is commonly referred to as the compulsory licensing (CL) of a patent.[5]

CL was not a TRIPS innovation. Indeed, CL was explicitly recognized in the Paris Convention for the Protection of Industrial Property that was first ratified in 1883 and then amended several times up until 1979.[6] However, actual incidents of CL in the international context have started to emerge only during the post-TRIPS era. During 1995-2011 there were 24 "episodes" of CL of patented foreign medicines (Beall and Kuhn, 2012).[7] By contrast, during the pre-TRIPS era, we observed very little, if any, such international episodes of CL.[8] The lack of CL prior to 1995 is fundamentally linked to the virtual absence of IPR protection in most developing countries during the pre-TRIPS era: after all, the issuance of a compulsory license is premised on the legal recognition of a patent. If the patent itself is not protected, there is essentially nothing to license. With developing countries increasingly coming under pressure to strengthen their IPR regimes, a greater role for CL as a tool for improving consumer access to patented products in such countries should have naturally emerged during the post-TRIPS era.

As an illustration of the implications of TRIPS for developing countries, consider the case of India's pharmaceutical industry. Prior to TRIPS, Indian patent law did not recognize product patents in pharmaceuticals; only process innovations were given protection and these too were protected only for seven years. As a result, Indian entrepreneurs and firms were free to reverse-engineer and imitate pharmaceuticals that were patented in rest of the world. It is widely acknowledged that India's weak patent regime during the pre-TRIPS era generated significant benefits for not just Indian consumers

[5] The other major TRIPS flexibility (that we do not analyze here) is specifed in Article 6 which states that "nothing in this Agreement shall be used to address the issue of the exhaustion of intellectual property rights." The economic implications of the freedom that WTO members have to implement exhaustion policies of their choice have been widely studied. See, for example, Malueg and Schwarz (1994), Ganslandt and Maskus (2004), Valleti (2006), and Roy and Saggi (2012).

[6] Article II of TRIPS says that "Members shall comply with Articles 1 through 12, and Article 19, of the Paris Convention" and Article 5(2) of the Paris Convention says that "Each country of the Union shall have the right to take legislative measures providing for the grant of compulsory licenses to prevent the abuses which might result from the exercise of the exclusive rights conferred by the patent, for example, failure to work." See http://www.wipo.int/treaties/en/text.jsp?file_id=288514#P213_35515.

[7] Beall and Kuhn (2012) defined a CL episode to be one where CL was explcitly and publicly discussed between government officials of a country and foreign patent-holders (although it need not have been the end result of such negotiations).

[8] The limited use of CL by developing countries during the pre-TRIPS era likely reflects another aspect of WTO rules pertaining to CL: prior to 2001 a country could only issue a compulsory license to a local producer, requirement that essentially made CL inaccessible to many technologically backward countries. This local production requirement was loosened by the WTO in 2003 by allowing the import of necessary pharmaceuticals via compulsory licenses issued to firms in other countries.

but also for consumers in many other countries since India became a cheap source of pharmaceuticals for the developing world.[9] However, to become TRIPS compliant, India was forced to reform its intellectual property law and introduced product patents for pharmaceuticals for the first time in 2005.[10] A recent press article (Chatterjee and Hirschler, Feb 6, 2014) reports that faced with increasing pressure from global pharmaceutical companies to put an end to ongoing imitation of patented drugs, the Indian government is currently reviewing whether compulsory licenses and more stringent price controls should be used to bring down the prices of patented foreign drugs.[11]

With imitation becoming increasingly difficult to sustain during the post-TRIPS era, CL has naturally become more attractive to developing countries as means for ensuring access to patented products at low prices. In this paper, we develop a simple model that captures this insight and use it to evaluate the costs and benefits of CL as well as those of strengthening patent protection in developing countries. Our stylized model involves two parties: a developing country (called South) and a Northern firm who owns a patent over its product that lasts for T periods. In the first period, the South chooses whether or not to protect the patent-holder from imitation while the patent-holder decides whether or not to enter the Southern market. If the South offers patent protection and the patent-holder chooses not to enter in the first period, for the remaining duration ($T-1$ periods) of the patent the South has the authority to issue a compulsory license to a local producer who is required to set price equal to marginal cost.[12] If the South does not protect the patent, a competitive local industry producing an imitated version of the patented good comes into existence. Due to the limited technological capability of the South, the quality of production under imitation (as well as CL) is lower than that of the patent-holder.[13] If the patent-holder chooses to enter despite the lack of patent

[9] For empirical evidence regarding the effects of patent protection on the welfare of consumers in developing countries, see Lanjouw (1998 and 2005), Chaudhuri et. al. (2006), Dutta (2011), and Duggan and Goyal (2012).

[10] Similarly, patent protection was strengthened in China in 1997 and in Brazil during 2002. As per the popular Ginarte-Park index of patent protection (see Park 2008) TRIPS induced major changes in the degree of patent protection in India and China: the value of the index for India increased sharply from 1.03 in 1995 to 3.76 in 2005 while that for China almost doubled from 2.12 to 4.08 over the same time period. We thank Walter Park for providing us the most updated version of this index.

[11] In 2012, frictions between India and the pharmaceutical company Bayer flared up when India decided to issue a compulsory license for Bayer's cancer drug Nexavar. Bayer challenged the compulsory license in Indian courts but was unsuccessful in getting it over turned. More recently, the National Pharmaceutical and Pricing Authority of India has expanded the list of medicines subject to price controls by imposing new controls on the anti-diabetes and cardiovascular segments of the pharmaceutical market (see Dey, Business Standard, October 24, 2014).

[12] The qualitative nature of our results is unaffected by allowing for an arbitrary delay period before a CL can be issued by the South.

[13] Bond and Saggi (2014a) provide an extensive discussion of the problems that developing countries have in implementing CL. In particular, they note that the available case-study evidence shows that

protection, it competes with the imitative industry – an outcome under which Southern consumers enjoy the highest surplus due to greater variety and competition in the local market.

By endogenizing the South's decision regarding patent protection, we significantly expand the analysis of Bond and Saggi (2014a) who examine the effects of CL under the assumption that the South necessarily offers patent protection. Thus, the present paper is able to shed light on two major issues that are outside the scope of Bond and Saggi (2014a). One, it allows us to evaluate how the possibility of CL affects Southern incentives for patent protection. Two, we can assess whether and how the role of CL as a tool for gaining access to patented products has been modified due to developments in the multilateral trading system that have made it mandatory for developing countries to offer patent protection.

We first analyze a benchmark scenario similar to Saggi (2013) where the option to use CL does not exist. This benchmark model delivers an interesting insight: the South grants patent protection iff doing so is necessary to induce the patent-holder to sell locally *and* the quality of local production under imitation is quite low. Thus, both the size of the local market (relative to the fixed cost of entry) and the technological capability of the local economy determine Southern incentives for patent protection. The South lacks the incentive to offer patent protection both when its local market is lucrative for the patent-holder as well as when it is too small to induce entry. Similarly, if local imitation is of sufficiently high quality, the South has little to gain from patent protection.[14] In order to draw out the implications of TRIPS, we also identify circumstances under which forcing the South to offer patent protection increases or decreases joint welfare in the benchmark model.

We next incorporate CL in the benchmark model. In accordance with WTO rules which require that a patent-holder be first given an opportunity to work its patent before a CL can be issued, we assume that the South can invoke CL only if the patent-holder does not sell the South in the first period. As per Article 31 of TRIPS, measures such as CL "may only be permitted if, prior to such use, the proposed user has made

even countries such as Brazil and Thailand have found it difficult to produce world class products under CL. See also Baron (2008) and Daemmrich and Musacchio (2011) for further discussion.

[14] Our model suggests a non-monotonic relationship between a country's level of development and its degree of patent protection. Countries that are poor imitators have incentives to offer patent protection in order to obtain access to high quality foreign products. Countries that can imitate well but are not yet competitive in innovation, will prefer not to offer patent protection since doing so transfers local consumer surplus to foreign patent-holders without inducing much in the way of local innovation. Finally, countries with the ability to innovate will choose to provide patent protection. Evidence of a U-shaped relationship between per capita GDP and the strength of intellectual property rights, as suggested by our results, is reported by Maskus (2000) and Chen and Puttitanun (2005).

efforts to obtain authorization from the right holder on reasonable commercial terms and conditions and that such efforts have not been successful within a reasonable period of time." We first study the role of CL by allowing the patent-holder to fully control price. This approach helps isolate the role that the availability of CL plays independent of any effects that arise from price bargaining between the two parties during the licensing process. Later, in section 5 of the paper we extend the model to allow price negotiations at the time of entry in order to capture the idea that the South could be unwilling to allow monopoly pricing and may be able to exert pressure on the patent-holder to sell at a lower price.

When the patent-holder unilaterally controls price, we show that the option to use CL reduces the South's willingness to offer patent protection, i.e., there exist parameter regions under which the South offers patent protection *only if* CL is unavailable. The intuition for this result follows from a two-step logic. First, the royalties involved under CL increase the patent-holder's payoff from not entering the South (and letting CL occur). Second, imitation dominates CL from the Southern viewpoint since it does not incur royalties and also avoids the (one-period) delay involved under CL. As a result, whenever the patent-holder prefers CL to entry, the South chooses not to offer patent protection since it prefers imitation to CL.

The patent-holder has too weak an incentive to enter since it does not fully internalize the benefits of its entry to Southern consumers while the Southern government has an inadequate incentive for patent protection because it does not take into account the profitability of the patent-holder. These twin distortions imply that there exist circumstances where the patent-holder stays out but entry is socially efficient just as there are cases where the South should offer patent protection but it does not. However, from a joint welfare perspective, the South never offers patent protection when it should not. Thus, if the South is free to deny patent protection, not only does CL fail to arise in equilibrium, *the option to use it makes both parties worse off since the possibility of CL further reduces the South's incentive to offer patent protection* thereby undermining the patent-holder's incentive to enter.

We also consider the consequences of requiring the South to implement patent protection (i.e. shutting down local imitation) when CL is an available option. As expected, such forced patent protection benefits the patent-holder at the expense of the South. However, more interestingly, CL now emerges as an equilibrium outcome. This result formally confirms the insight that with imitation becoming difficult, developing countries have an incentive to turn towards CL as a means for accessing patented products at low prices. Furthermore, we also identify circumstances where joint welfare of the two parties decreases (as well as when it increases) due to the shutting down of Southern imitation. We find that given patent protection, the option to use CL can even make both parties better off.

Since developing countries, particularly those with clout, may not allow patent-holders to exercise unrestricted monopoly power, we extend the model to incorporate price negotiations between the patent-holder and the South. We find that if the patent-holder can make a take-it-or-leave-it price offer to the South, incorporating price negotiations does not alter the South's optimal patent protection policy if CL is not an available option. But if CL is possible, the South can secure the product at a more favorable price even if the patent-holder makes a take-it-or-leave it offer. Price negotiations matter in another important sense: given that the South offers patent protection, CL is more likely to arise in equilibrium when price is negotiated between the two parties relative to when it is set unilaterally by the patent-holder.

We also show that if the South has the ability to fully control price, the patent-holder is willing to sell in its market at a *lower* price when it receives patent protection relative to when it does not. This result implies that the strengthening of patent protection should make it possible for developing countries to tighten their price controls on foreign patent-holders as opposed to having to weaken them. We show that the set of parameter values over which the South chooses to extend patent protection expands dramatically when it has all of the bargaining power. In particular, the outcome where the patent-holder enters without patent protection does not arise in equilibrium. We also show that while the ability to dictate price makes patent protection more attractive to the South, the option to use CL makes it less so. The possibility of CL raises the disagreement payoff to both parties, which in turn worsens the payoff to the party that has the ability to make a take-it-or-leave-it offer. Thus, while CL and price controls can both help improve consumer access to patented foreign products (such as pharmaceuticals) in developing countries, the two instruments have rather different affects on their incentives to protect foreign patents.

2 Benchmark model

We study the decision of a patent-holder regarding entry into a developing country (South) where its technology is potentially subject to imitation. The benchmark model is a two stage game between the patent-holder and the South. In the first stage, the South chooses whether or not to allow imitation (denoted by subscript I), where imitation generates local competition for the patent-holder. Next, the patent-holder decides whether to enter the South by incurring the fixed cost φ.[15]

[15] Any fixed costs involved under local production (either via CL or imitation) are normalized to zero. The parameter φ should be interpreted as the additional fixed costs that are faced by the patent-holder

Later, we extend this model by adding a third stage at which the South can issue a compulsory license to a local firm in order to ensure that the patented good is supplied locally. As per WTO rules, we assume that the South has the authority to issue a compulsory license *only if* the patent-holder chooses not to sell in its market.

2.1 Demand and payoffs

There are a continuum of Southern consumers of measure 1, each of whom buys (at most) one unit of the product. If a consumer buys the product at price p, his utility is given by $U = \theta q - p$ where q measures quality and $\theta \geq 0$ is a taste parameter that captures the willingness to pay for quality. For simplicity, we assume that θ is uniformly distributed over the interval $[0, 1]$.

The patent-holder's patent lasts for T periods provided it is protected by the South. Let $\beta \in [0, 1)$ be the per period discount factor and let the marginal cost of production equal zero. Normalizing utility under no purchase to zero, the per-period demand $d(p, q)$ in the South for the patented product in the absence of imitation equals $d(p, q) = 1 - p/q$. Over the life of the patent, in each period the patent-holder chooses its price p to maximize

$$\max \pi_E(p) = p\,(1 - p/q) \tag{1}$$

The present value of the patent-holder's entry profits (gross of fixed costs) as a function of its price p equals

$$v_E(p) = (1 + \Omega)\pi_E(p) \text{ where } \Omega = \sum_{t=1}^{T} \beta^t \tag{2}$$

The per-period consumer surplus that accrues to the South from purchasing the patented product at price p equals

$$s_E(p) = \int_{p/q}^{1} (q\theta - p)d\theta = \frac{(p - q)^2}{2q} \tag{3}$$

which implies that Southern welfare over the duration of the patent under entry at price p equals

$$w_E^S(p) = (1 + \Omega)s_E(p) \tag{4}$$

relative to local producers. Such additional costs could arise from not just production activities but also from having to secure approval from the local government prior to selling locally and/or from having to establish a marketing and distribution network in an unfamiliar environment.

Solving the problem in (1) yields the patent-holder's optimal monopoly price $p^m = q/2$. Thus, the maximized payoff from entry to the patent-holder when its patent is protected equals

$$v_E(p^m) = (1+\Omega)p^m\,(1 - p^m/q) \tag{5}$$

while that to the South equals

$$w_E^S(p^m) = (1+\Omega)s_E(p^m) \tag{6}$$

When the South does not protect the patent-holder's patent, imitation results in the emergence of a competitive industry that produces a lower quality version of the patented product. Quality of the Southern imitation is denoted by γq where $0 < \gamma \leq 1$. Southern consumers are assumed to have complete information in the sense that they can fully distinguish between the original patented product and the imitative version produced by the local industry.[16]

Competition within the Southern industry ensures that the imitated good is sold at marginal cost. When two different qualities are available for purchase at prices p (high quality) and 0 (low quality), Southern consumers can be partitioned into two groups: those in the range $[0, \theta_h(p;\gamma)$ buy the low quality whereas those in $[\theta_h(p;\gamma), 1]$ buy the high quality where

$$\theta_h(p;\gamma) = \frac{p}{q(1-\gamma)}$$

When facing competition from imitation, the patent-holder chooses its price p to maximize

$$\max \pi_I(p;\gamma) = p[1 - \theta_h(p;\gamma)]$$

with the associated value $v_I(p) = (1+\Omega)\pi_I(p)$. The patent-holder's profit maximizing price when facing competition from the imitative industry equals

$$p_I^m(\gamma) = q(1-\gamma)/2 = (1-\gamma)p^m$$

Observe that $p_I^m \leq p^m$ since $0 < \gamma \leq 1$. At the price p_I^m, we have $\theta_h(p;\gamma) = \frac{p_I^m}{q(1-\gamma)} = 1/2$. Thus, competition from imitation lowers the patent-holder's gross entry payoff to

$$v_I(p_I^m;\gamma) = (1+\Omega)(1-\gamma)\pi^m = (1-\gamma)v_E(p^m) \tag{7}$$

where $\gamma \leq 1$.

[16]It is worth emphasizing that in the context of the pharmaceutical industry the imitated product is best viewed as a generic that can only be sold in the South. The quality differential between the two products then represents the value consumers associate with the brand of the patent-holder.

If the South permits imitation and the patent-holder does not enter then local consumers obtain access (only) to the lower quality imitated good at a price equal to marginal cost (set to zero). Under this scenario, Southern welfare equals

$$w_N^S(\gamma) = (1+\Omega)s_N(\gamma) \text{ where } s_N(\gamma) = \int_0^1 \gamma q\theta d\theta \tag{8}$$

However, if the patent-holder enters the Southern market despite imitation, Southern welfare equals

$$w_I^S(p_I^m;\gamma) = (1+\Omega)s_I(p_I^m;\gamma) \text{ where } s_I(p_I^m;\gamma) = \int_0^{1/2} \gamma q\theta d\theta + \int_{1/2}^1 [q\theta - p_I^m]\, d\theta \tag{9}$$

Note that $w_I^S(p_I^m;\gamma) - w_E^S(p^m) = (1+\Omega)3\gamma q/8 > 0$. Thus, provided the patent-holder enters, Southern welfare increases due to imitation. When the South permits imitation, those Southern consumers that are unwilling to pay the price for the higher quality product sold by the patent-holder gain access to a lower quality version that sells at a lower price. This *variety enhancing effect of imitation* is one reason the South benefits from imitation. The second reason, of course, is that the imitated product competes with the patented product and this competition lowers the price of the high quality.

In the absence of competition form imitation, in equilibrium, only half of the market in the South is covered since $\theta_h(p^m) = p^m/q = 1/2$. By contrast, when imitation occurs, all those consumers that buy the high quality in the absence of imitation continue to do so although they now pay a lower price for it. In addition, all consumer in the range $[0, 1/2]$ end up buying the low quality imitative good so that the entire Southern market ends up being covered when the South permits imitation.

2.2 Equilibrium

The patent-holder's entry decision depends upon the South's policy regarding patent protection. Given patent protection, the patent-holder sells in the South iff

$$v_E(p^m) - \varphi \geq 0 \Leftrightarrow \varphi \leq \varphi_E \equiv v_E(p^m) \tag{10}$$

Similarly, when facing imitation, the patent-holder chooses to enter iff

$$v_I(p_I^m;\gamma) - \varphi \geq 0 \Leftrightarrow \varphi \leq \varphi_I \equiv v_I(p_I^m;\gamma) \tag{11}$$

Since $\varphi_I \leq \varphi_E$, the lack of patent protection makes the patent-holder *less willing* to sell in the South.

Consider now the South's decision regarding patent protection. Suppose the South protects the patent-holder. Then, if $\varphi \leq \varphi_E$ the patent-holder enters and Southern welfare equals $w_E^S(p^m)$. But if $\varphi > \varphi_E$, the patent-holder does not enter and Southern welfare equals zero. If the South permits imitation, the patent-holder enters provided $\varphi < \varphi_I$ in which case its welfare equals $w_I^S(p_I^m; \gamma)$. This trade-off generates the following optimal policy for the South:

Proposition 1: *In the benchmark model (where compulsory licensing is not possible), the South offers patent protection if and only if (i)* $\varphi_I < \varphi \leq \varphi_E$ *and (ii)* $\gamma \leq \gamma^S \equiv 1/4$.

When $\varphi < \varphi_I$, the patent-holder's fixed entry cost is so low that it enters the market even if imitation occurs in the South. Given that, shutting down imitation simply lowers local consumer surplus by reducing competition and variety. When $\varphi > \varphi_E$, the patent-holder's fixed entry cost is so high that it does not sell in the South even when its patent is protected. In such a scenario, the South clearly has no incentive to grant patent protection since doing so eliminates even the low quality version of the patented product from the local market.

Now consider the more interesting case where $\varphi_I < \varphi \leq \varphi_E$. Here, the patent-holder enters iff the South offers patent protection. Under such a situation, the South faces a trade-off: imitation provides consumers access to the low quality product while *simultaneously denying* access to the high quality. As a result, the South's decision is determined by the quality gap $(1/\gamma)$ between products. When this gap is large (i.e. $\gamma \leq \gamma^S$) , the South offers patent protection; when it is small, it does not. Thus, the main insight behind Proposition 1 is that the South grants patent protection iff such protection is *necessary* to induce the patent-holder to sell locally *and* the quality of local production under imitation is quite low so that shutting down imitation to ensure access to the high quality product raises local welfare.

Figure 1 illustrates Proposition 1. Only in region **B** that is defined by the horizontal line (that plots φ_E), the downward sloping line (that plots φ_I), and the dashed line (that shows γ^S) does the South chooses to offer patent protection to induce entry. Everywhere else, the South allows imitation. Below the downward sloping line (region **A**), the patent-holder enters even though imitation is permitted whereas above the horizontal line (region **D**) it does not even if it is prohibited.

[Figure 1 here]

To investigate the welfare properties of the equilibrium, define the joint welfare of the two parties as the sum of their individual welfare levels. One basic property of the model is that the patent-holder's decision-making fails to fully take into account the surplus its entry generates for Southern consumers. Thus, in general, its incentive to enter the South is too weak from the perspective of joint welfare of the two parties. On the other hand, the Southern government's decision regarding patent protection does not take into account the welfare of the patent-holder. As a result, the South's incentive for patent protection is weaker than what joint optimality requires. The tension between these two distortions drives the welfare analysis that follows.

Given that the South offers patent protection, joint welfare under entry equals

$$w_E(p^m) = (1+\Omega)s_E(p^m) + v_E(p^m) - \varphi$$

Given patent protection, if the patent-holder does not enter (which it does not whenever $\varphi > \varphi_E$), the welfare of each party equals zero. Therefore, entry is jointly optimal iff

$$w_E(p^m) \geq 0 \;\Leftrightarrow \varphi \leq \varphi_E^m = 3q\,(1+\Omega)\,/8$$

where $\varphi_E^m > \varphi_E$ which reflects the fact that the patent-holder ignores local consumer surplus. Through-out the paper we assume that $\varphi < \varphi_E^m$.

Similarly, we have

$$w_I(p_I^m;\gamma) = (1+\Omega)s_I(p_I^m) + v_I(p_I^m) - \varphi$$

Given that the patent-holder enters, imitation raises joint welfare by generating competition and increasing variety:

$$w_I(p_I^m;\gamma) - w_E(p^m) = q\gamma\,(1+\Omega)\,/8 \geq 0$$

Thus, for all $\varphi < \varphi_I$, the South's decision to not offer patent protection is socially optimal (even though it makes the patent-holder worse off).

It is clear that whenever the South chooses to offer patent protection (i.e. for $\varphi_I < \varphi \leq \varphi_E$ and $\gamma < \gamma^S$), it is jointly optimal do so. However, there are instances where the South should offer patent protection but it fails to do so. Using

$$w_N(\gamma) = (1+\Omega)s_N(\gamma)$$

we have

$$w_I(p_I^m;\gamma) \geq w_N(\gamma) \text{ iff } \varphi \leq \varphi_I^w = 3q\,(1-\gamma)\,(1+\Omega)\,/8$$

i.e. given imitation, entry raises joint welfare iff $\varphi \leq \varphi_I^w$.

Next note that

$$w_E(p^m) \geq w_N(\gamma) \text{ iff } \varphi \leq \varphi_E^w = q\,(3-4\gamma)\,(1+\Omega)\,/8$$

i.e. joint welfare is higher if only the high quality product is sold at the monopoly price relative to when only the imitated good is available at the competitive price so long as the fixed cost of entry lies below φ_E^w. Observe that if $\gamma \geq 3/4$ then it can never be jointly optimal to offer patent protection to induce entry. Here, the quality disadvantage of imitated production is rather small and allowing imitation to occur is jointly efficient even if it induces the patent-holder to stay out of the South.

A welfare comparison of the various outcomes is as follows:

Proposition 2: *(i)* $w_I(p_I^m;\gamma) \geq w_E(p^m)$; *(ii)* $w_I(p_I^m;\gamma) \geq w_N(\gamma)$ *iff* $\varphi \leq \varphi_I^w$ *and (iii)* $w_E(p^m) \geq w_N(\gamma)$ *iff* $\varphi \leq \varphi_E^w$.

To gain further insight into the welfare properties of the equilibrium of the benchmark model, it is useful to consider a comparison of the various cost thresholds that determine the social desirability of each regime vis-à-vis those that determine the South's equilibrium decision:

Lemma 1: *(i)* $\varphi_E^w \geq \varphi_E$ *iff* $\gamma \leq \gamma^S = 1/4$; *(i)* $\varphi_E^w \geq \varphi_I$ *iff* $\gamma \leq \gamma^w = 1/2$; *(iii)* $\varphi_I^w \geq \max\{\varphi_E^w, \varphi_I\}$ *and (iv)* $\varphi_I^w \geq \varphi_E$ *iff* $\gamma \leq \gamma_I^w = 1/3$.

Using this lemma and Proposition 2 we can conclude the following. First, as noted earlier, the South's decision to deny patent protection is jointly optimal for all $\varphi \in [0, \varphi_I]$ (region **A** in Figure 2) as well as for $\varphi > \varphi_E$ (region **D**). For parameters in region **A**, the outcome is socially optimal because the patent-holder enters even though the South does not offer patent protection; for parameters in region **D**, the patent-holder would not enter the South even if its patent were protected which makes it socially optimal for the South to not protect it. Second, for $\varphi \in [\varphi_I, \varphi_E]$ and $\gamma < \gamma^S$ (region **B** in Figure 2), patent protection is socially optimal and the South chooses to offer it. Here, even though the patent-holder acts as a monopolist, its quality advantage over Southern imitators (if allowed to operate) is so large that it is optimal to restrict competition from imitation. Third, for $\varphi \in [\varphi_I, \varphi_E^w]$ and $\gamma \in [\gamma^S, \gamma^w]$ (region **C1** in Figure 2), the South chooses not to give patent protection even though it is jointly optimal to do so. Here, from the South's perspective, the technological superiority of the patent-holder is outweighed by the cost to the Southern consumers of allowing it monopoly power. But taking account of the profits earned by the patent-holder (which the South ignores) tips the balance in favor of patent protection. Fourth, for $\max\{\varphi_I, \varphi_E^w] < \varphi < \varphi_E$ and (region **C2** in Figure 2), the South's decision to deny patent protection is again optimal. Here, the quality of the imitated product is high enough to render monopoly pricing for the patented product socially suboptimal and the costs of entry are low enough that the patent-holder enters despite imitation.

[Figure 2 here]

We now extend the benchmark model study the interaction between the South's incentive for patent protection and its ability to use compulsory licensing.

3 Model with compulsory licensing

In the benchmark model, if the patent-holder does not enter and the South lacks the freedom to allow imitation then local consumers have no means for accessing the product. As noted earlier, WTO rules permit the issuance of a compulsory license if a patent-holder chooses not to work its patent locally. Accordingly, we now extend the model to include a third stage where the South decides whether or not to grant a compulsory license. If the product has not been sold in the market in the first period, the South can issue a compulsory license to a local firm who pays the per-period royalty R to the patent-holder for the duration of the patent. The royalty fee R reflects the TRIPS requirement of a "adequate remuneration" to the patent-holder. We assume in this section that the patent-holder's entry into the South market satisfies the WTO requirement that the patent-holder work the product in the domestic market, and thus precludes the issuance of a compulsory license.

Under CL, the Southern government requires the local firm to set price equal to marginal cost (in order to maximize local consumer surplus).[17] Furthermore, as under imitation, the quality of production under CL equals γq, where $\gamma < 1$ captures the quality disadvantage of CL. Thus, in terms of the product market, the outcome under CL mirrors imitation in our model.

A compulsory license granted at stage three provides the licensee with the right to produce the good for $T - 1$ periods. With these assumptions, the welfare of the South under a compulsory license equals:

$$w^S_{CL}(\gamma, R) = \Omega \left[s_N(\gamma) - R\right] \tag{12}$$

CL is a credible threat for $w^S_{CL}(\gamma, R) \geq 0 \Leftrightarrow \gamma \geq \gamma_m = \frac{R}{p^m}$. Thus, CL is a credible threat so long as the quality of licensed production is not so low that the total surplus generated for Southern consumers is insufficient to cover the royalty R paid to the patent-holder.

[17] Thus, we assume that under CL the South subsidizes the local firm to cover the royalty payments made to the patent-holder.

3.1 How CL changes the equilibrium

When making its entry decision the patent-holder now takes the possibility of CL into account. If given patent protection by the South, the patent-holder has to decide whether to (a) incur the fixed cost φ and collect the payoff $v_E(p^m)$ or (b) to not enter and wait for CL to occur in the next period under which its payoff is ΩR. The patent-holder prefers entry to CL iff

$$v_E(p^m) - \varphi \geq \Omega R \Leftrightarrow \varphi \leq \varphi_E(R) \equiv v_E(p^m) - \Omega R \tag{13}$$

Thus, the patent-holder chooses entry for all $\varphi \leq \varphi_E(R)$ whereas it waits for CL if $\varphi > \varphi_E(R)$. Note that we assume that if the patent-holder enters, it does so before a CL has been issued. One could instead imagine a scenario where the patent-holder waits for a CL to be issued and then enters the Southern market. Implicitly, we are assuming that even though entry may be profitable post CL, it is relatively more profitable in the first period. More specifically, entry at $T = 0$ yields a higher payoff to the patent-holder than entry post CL iff $(1 + \Omega)\pi^m - \varphi > \Omega[R + (1 - \gamma)\pi^m] - \beta\varphi$ which is the same as $\pi^m - (1 - \beta)\varphi > \Omega[R - \gamma\pi^m]$. Intuitively, for $\beta \simeq 1$ this assumption requires that the royalties under CL are not so large that the patent-holder is better off delaying entry to collect these royalties even though it loses a share of its profit to competition from the local product that is sold at marginal cost under CL.[18]

Observe that,

$$\varphi_E(R) = \varphi_E - \Omega R$$

i.e., the possibility of CL makes the patent-holder *less willing* to enter the Southern market by allowing it to collect royalty payments for the duration of the compulsory license if it chooses to stay out. As before, if imitation is allowed by the South, the patent-holder's payoff from entry falls to $(1-\gamma)v_E(p^m) - \varphi$. Observe also that $\varphi_E(R) = \varphi_I \Leftrightarrow v_E(p^m) - \Omega R = (1 - \gamma)v_E(p^m)$ which holds when $\gamma v_E(p^m) = \Omega R$. Since imitation precludes CL, the patent-holder's decision becomes trivial: it prefers entry to staying out iff $\varphi \leq \varphi_I$. Foreseeing the patent-holder's decision, the South sets the following patent protection policy:

Proposition 3: *When compulsory licensing is an available option, the South chooses to extend patent protection iff (i)* $\varphi_I < \varphi \leq \varphi_E(R)$ *and (ii)* $\gamma \leq \gamma^S$.

[18] This assumption is quite reasonable and it helps limit the number of different scenarios that we need to consider. Furthermore, the observed royalties under CL have been quite low: Beall and Kuhn (2012) report that of the 12 international episodes of CL that occurred during 1995-2011, patent holders received royalties ranging from 0.5% of the generic price to 2% of revenues from the sale of the product. Finally, we have not really observed any international case of CL where a patent-holder chose to enter after a compulsory license for its product had been issued by a developing country.

Observe that for $R > 0$, $\varphi_E(R) < \varphi_E$: given that CL yields a strictly positive royalty payment to the patent-holder, *the South is less willing to offer patent protection when it has the option to use CL*. More specifically, over the parameter region $max\{\varphi_E(R), \varphi_I\} < \varphi < \varphi_E$ (the shaded region **B1** in Figure 3) the option to use CL leads the South to not offer patent protection since, over this set of parameter values, the patent-holder would prefer to stay out to collect royalties under CL *even if* it is protected from imitation. It is important to note that though CL does not arise in equilibrium, by raising the patent-holder's payoff from staying out the *possibility* of CL increases the likelihood that the South denies patent protection.

[Figure 3 here]

3.2 Welfare effects of CL

How does the option of CL affect the two parties? The result here is surprising and clear:

Proposition 4: *Given that the South is free to allow imitation, not only does CL fail to arise in equilibrium but the option to use CL makes both parties worse off.*[19]

The intuition for this result is as follows. We noted above that when $max\{\varphi_E(R), \varphi_I\} < \varphi < \varphi_E$ and $\gamma \leq \gamma^S$ the possibility of CL induces the South to not offer patent protection since, for this set of parameter values, the patent-holder prefers to stay out of the South in order to collect royalty payments under CL if its patent is protected. This, in turn, makes patent protection counter-productive for the South: since Southern welfare under imitation dominates that under CL (due to the delay involved and the royalties incurred under CL), the South is better off permitting imitation to preclude CL. But the important point is that for this set of parameter values, the South would actually be better off if only the patented product were to be sold in its market since the local industry's product is of fairly low quality ($\gamma \leq \gamma^S$). Similarly, the patent-holder would be strictly better off under entry since $v_E(p^m) > \varphi$ for $\varphi < \varphi_E$. *It follows then that if imitation is possible then a credible commitment on the part of the South to not use CL would make both parties better off when* $max\{\varphi_E(R), \varphi_I\} < \varphi < \varphi_E$ and $\gamma \leq \gamma^S$. As we shall see below, the option to use CL can never make both parties worse off if the South cannot allow local imitation.

[19] Both parties strictly lose when $max\{\varphi_E(R), \varphi_I\} < \varphi < \varphi_E$ and $\gamma \leq \gamma^S$ whereas they are unaffected otherwise.

4 If South must offer patent protection

What are the consequences of forcing the South to offer patent protection, say due to an international agreement such as TRIPS? When imitation is not permitted, the patent-holder chooses entry for all $\varphi \leq \varphi_E(R)$ whereas it waits for CL to occur when $\varphi > \varphi_E(R)$.

If $\varphi > \max\{\varphi_E(R), \varphi_I\}$, (regions **B1**, **C3**, and **D** in Figure 4) in the absence of TRIPS, the South permits imitation whereas the patent-holder stays out of the South. Shutting down imitation converts the market outcome from one where a competitive local industry supplies the low quality product to one where the same product is supplied by the local licensee (at price equal to marginal cost) under CL. While the price and quality under CL and imitation are the same, CL occurs with *delay* since, as per WTO rules, the South is required to gave the patent-holder a chance to work its patent. Furthermore, the South has to pay royalties under CL whereas it does not compensate the patent-holder under imitation. The delay involved under CL and the compensation paid to the patent-holder make the South worse off. The patent-holder obviously benefits: absent CL, it stays out and collects no profit from the Southern market.

Next consider the parameter range where $\varphi_E(R) < \varphi < \varphi_I$ (region **A1** in Figure 4). Over this range, in the absence of TRIPS, the patent-holder enters the South despite the fact that South permits imitation. With TRIPS in place, the patent-holder chooses to stay out and wait for CL to occur since the value of royalty payments under CL exceeds its payoff under entry (even though entry is profitable in an absolute sense). When this happens, the South loses because the high quality product is eliminated from the market (i.e. variety declines). It is worth noting here that for $\varphi_E(R) < \varphi < \varphi_I$ it is *patent protection that induces the patent-holder to stay out of the Southern market*, as opposed to the lack of such protection. This happens because the payoff under CL to the patent-holder exceeds that under entry even though it chooses to enter when patent protection is missing. The key insight is that when the South does not offer patent protection, the option of CL is automatically taken off the table since imitation makes CL redundant from the Southern viewpoint. Indeed, patent protection is a *necessary precondition* for CL: once a patent has been violated (via imitation), CL is no longer an option.

Over the range $\varphi_I < \varphi < \varphi_E(R)$ the consequences of requiring South to extend patent protection depend upon whether or not $\gamma \leq \gamma^S$. When this inequality holds (i.e. region **B2** in Figure 4), local production suffers from a large enough quality gap that the South willingly offers patent protection in order to induce the patent-holder to sell locally. Thus, the South is coerced to offer patent protection only when $\gamma > \gamma^S$ (i.e. regions **C11** and **C2** in Figure 4). Suppose this inequality holds. Then, forcing the South to implement patent protection converts the local market from a competitive imitative industry selling the low quality product to one where the patent-holder sells the high quality at its optimal monopoly price. This switch benefits the patent-holder at the expense of the South (who does not find it worthwhile to offer such protection due to the relatively small quality gap between the patented and the imitated product). Furthermore, this switch also increases joint welfare for $\varphi \in [\varphi_I, \varphi_E^w]$ and $\gamma \in [\gamma^S, \gamma^w]$ (region **C11** in Figure 2). But for parameters outside these ranges (i.e. in region **C2** in Figure 4) this change reduces joint welfare.

Finally, over the range where $\varphi < \min\{\varphi_I, \varphi_E(R)\}$ (i.e. region **A2** in Figure 4) the patent-holder enters the South regardless of whether or not its patent is protected. Under such a scenario, shutting down local imitation hurts the South because it reduces competition as well variety in the local market. For the same reasons, joint welfare declines. Of course, the patent-holder benefits from these changes.

[Figure 4 here]

We summarize this discussion below:

Proposition 5: *Requiring the South to offer patent protection benefits the patent-holder at the expense of the South. In addition, it has the following effects:*

(i) If $\varphi > \max\{\varphi_E(R), \varphi_I\}$*, imitation is replaced by CL and joint welfare of the two parties declines.*

(ii) If $\varphi_E(R) < \varphi < \varphi_I$*, CL replaces a market structure where the patent-holder competes with the imitative industry and joint welfare declines.*

(iii) Over the range $\varphi_I < \varphi < \varphi_E(R)$*, when* $\gamma > \gamma^S$*, the low quality Southern imitative industry is replaced by the high quality patent-holder and joint welfare increases iff* $\varphi \in [\varphi_I, \varphi_E^w]$ *and* $\gamma \in [\gamma^S, \gamma^w]$*.*[20]

(iv) For $\varphi < \min\{\varphi_E(R), \varphi_I\}$*, joint welfare declines because competition from the imitative industry is eliminated.*

An important insight provided by Proposition 5 is that *when forced to offer patent protection, the South turns towards CL as a means for securing the product at a low price.* Indeed, recall that when imitation is possible, CL does not even arise in equilibrium since, from the Southern viewpoint, it is dominated by imitation. Thus even though CL predates the TRIPS agreement, our model shows that one should expect it to be observed more frequently during the post TRIPS era during which member countries of the WTO have had to clamp down on imitation.

[20] The two parties are unaffected if $\gamma \leq \gamma^S$ since the South willingly offers patent protection and the patent-holder chooses to enter.

In light of Proposition 5, it is worth asking how the option to use CL affects the two parties when the South can no longer avail of imitation. For $\varphi \leq \varphi_E(R)$, the patent-holder enters with and without CL so neither party if affected. For $\varphi \in (\varphi_E(R), \varphi_E]$ the possibility of CL induces the patent-holder to stay out of the market in order to collect royalty payments under CL. While the patent-holder necessarily gains from this switch, the South benefits from it iff

$$(1+\Omega)s_E(p^m) \leq \Omega\left[s_N(\gamma) - R\right]$$

which is the same as

$$\gamma \geq \gamma_{CL} \equiv \left(1 + \frac{1}{\Omega}\right)\gamma^S + \frac{R}{p^m} \tag{14}$$

Note that the minimum value at which the South prefers CL to entry, γ_{CL}, exceeds the minimum value at which imitation is preferred to entry, γ^S, because CL involves delay in obtaining the product as well as royalty payments. The term $1 + \frac{1}{\Omega}$ captures the importance of the delay relative to the overall life of the product and the term $\frac{R}{p^m}$ reflects the importance of the royalty payment. Of course, for $\gamma \geq \gamma_{CL}$, the South is actually better off under CL but the patent-holder preempts it by entering. We can now state:

Proposition 6: *Given that the South offers patent protection, the option of using CL has the following effects:*

(i) For $\varphi \leq \varphi_E(R)$, entry occurs whether or not the South can use CL. However, for $\gamma \geq \gamma_{CL}$ the South is better off with CL but the patent-holder preempts it via entry.

(ii) When $\varphi \in (\varphi_E(R), \varphi_E]$, the patent-holder chooses to stay out and wait for CL. If $\gamma < \gamma_{CL}$ the patent-holder gains while the South loses; otherwise, both parties gain.

(iii) For $\varphi > \varphi_E$, the option of CL benefits both parties.

In part (i), when $\gamma \geq \gamma_{CL}$ the South has sufficient technological capability that it is better off producing the product under CL but the patent-holder's entry costs are low enough that it chooses to enter thereby precluding CL. In part (ii), the possibility of CL can hurt the South when its technological capability is relatively weak (i.e. $\gamma < \gamma_{CL}$) but the costs of entry are high enough for the patent-holder to prefer royalty payments under CL to entry. Figure 5 illustrates how the option of CL affects the two parties given that the South offers patent protection.

[Figure 5 here]

Since the interests of the two parties can conflict, it is worth asking when CL yields higher joint welfare than entry. We have:

Lemma 2: *(i)* $w^S_{CL}(\gamma, R) > w_E(p^m)$ *iff* $\varphi > \varphi_{CL} = \frac{q[3(1+\Omega)-4\Omega\gamma]}{8}$ *and (ii)* $\varphi_{CL} > \varphi_E$ *iff* $\gamma < \gamma^w_{CL} = \frac{1+\Omega}{4\Omega}$.

Our analysis has shown that the desirability of the CL option hinges very much on whether or not the South is free to deny patent protection. When the South can do so, CL is essentially counter-productive – not only does it not arise in equilibrium, but the option to use it makes both parties worse off; when South must offer patent protection, CL can play a much more useful role and can even make both parties better off.

Our analysis thus far has assumed that the patent-holder is free to charge its optimal monopoly price p^m when selling in the South. We now extend our analysis to the scenario where the price under entry is negotiated between the patent-holder and the South.

5 Entry with price negotiations

Thus far it has been assumed that the patent-holder can preempt CL by entering and selling in the South at its optimal monopoly price. However, as noted in the Introduction, entry by patent-holders in developing countries is often accompanied by price negotiations.[21] In the context of our model, the South may not equate the availability of the patented product at monopoly price to having access to it at "reasonable commercial terms" so that an unacceptably high price may serve as reasonable grounds for CL. Therefore, we now extend the model to allow for price negotiations between the South and the patent-holder.

Incorporating price negotiations in the model introduces two new elements to the analysis. First, with price negotiations, there is a range of feasible prices at which the product can be supplied to the South market. Since the chosen entry price is affected by the relative bargaining power of the two parties, we can examine how their relative bargaining power influences the South's decision of whether or not to provide patent protection. Second, the existence of price negotiations introduces a new role for compulsory licensing, since it affects the disagreement payoff of the South. The option of CL makes it possible for the South to deny entry and issue a compulsory license if it finds the price proposed by the patent-holder to be too high.

[21] In Bond and Saggi (2014b) we analyze a finite-horizon alternating offers game in which the patent-holder bargains with the South over the local price of its patented good. The focus of that paper is on how the presence of international price spillovers (between the South and the patent-holder's home market) and the threat of CL alter the equilibrium of the bargaining game.

5.1 Price negotiations without CL

For the case where the South does not have the option of issuing a compulsory license, we analyze a two stage game in which the South chooses whether or not to offer patent protection in the first stage and then negotiates with the patent-holder over price in the second stage.

We begin by characterizing the payoff frontier for the bargaining subgame that takes place in the second stage, given that the South has already made its decision regarding patent protection. If the South has granted patent protection at the first stage, the maximum price that the South would accept is q, since it receives a payoff of zero if the patent-holder does not enter. For the patent-holder, the disagreement payoff is also zero because it cannot enter the market if the two parties fail to reach agreement. The minimum price that the patent-holder would accept is the solution to $v_E(p) = \varphi$ which yields

$$p_E^{\min}(\varphi) = p^m \left[1 - \left(1 - \frac{4\varphi}{q(1+\Omega)}\right)^{1/2}\right] \tag{15}$$

Any price above the monopoly price p^m is Pareto dominated by the monopoly price, so the interval $[p_E^{\min}(\varphi), p^m]$ is the set of agreement prices that are Pareto undominated and individually rational. These prices yield a strictly concave payoff frontier for the bargaining problem.[22] The set of feasible agreements is non-empty for $p_E^{\min}(\varphi) \leq p^m$, which holds for $\varphi \leq \varphi_E$.

If the South had chosen not to provide patent protection in the first stage, imitation occurs. Post imitation, the minimum price that the patent-holder will accept is the price at which it earns zero profits when facing competition from imitators, which is

$$p_I^{\min}(\varphi, \gamma) = p_I^m \left[1 - \left(1 - \frac{4\varphi}{q(1-\gamma)(1+\Omega)}\right)^{1/2}\right] \tag{16}$$

where $p_I^m = (1-\gamma)p^m$. The maximum price that the patent-holder would ever charge is p_I^m, so the outcome of an efficient bargain is a price that lies in the interval $[p_I^{\min}(\varphi), p_I^m]$ when the South does not provide patent protection. The set of feasible agreements is non-empty for $p_I^{\min}(\varphi) \leq p_I^m$, which holds for $\varphi \leq \varphi_I$. Note that due to competition

[22] We can invert the South's payoff function to express the negotiated price p as a function of the South's welfare, $p(w^S) = q\left[1 - \left(\frac{2w^S}{q(1+\Omega)}\right)^{1/2}\right]$. This price can then be substituted into the patent holder's profit function to obtain the payoff frontier $v = v_E(p(w^S)) = -2w^S + \left[2w^S q(1+\Omega)\right]^{1/2}$. This frontier is strictly concave in w^S, and is downward sloping for $w^S \geq w_E(p^m)$. The maximum payoff that the South can obtain is $w_E(p_E^{\min}(\varphi))$, in which case the patent holder's net return is driven to 0.

from imitators we have $p_I^{\min}(\varphi) > p_E^{\min}(\varphi)$: the loss of sales to imitators requires a higher price per unit in order for the patent-holder to cover its fixed cost of entry.

Rather than assuming a specific bargaining protocol for price negotiations, we illustrate the impact of these negotiations on the South's incentive for patent protection by comparing the case where the patent-holder achieves its most preferred outcome on the frontier with that when the South achieves its best outcome. If the patent-holder has all of the bargaining power, it makes a take-it-or-leave-it offer of p^m if the South offers patent protection and an offer of p_I^m if it does not. The analysis in this case is identical to the case without price bargaining, so the South's choice of patent policy in the absence of CL is identical to that reported in Proposition 1. For the case in which the South has all of the bargaining power, it makes a take-it-or-leave-it offer of $p_E^{\min}(\varphi)$ if it offers patent protection and an offer of $p_I^{\min}(\varphi)$ if it does not. Observe that $p_E^{\min}(\varphi)$ is increasing in φ, and equals the optimal monopoly price p^m at the highest level of fixed cost at which the patent-holder is willing to enter: i.e. $p_E^{\min}(\varphi) = p^m$ when $\varphi = \varphi_E$. The range of fixed costs for which the patent-holder enters with patent protection is the same as before, but the South obtains the product at a price below the monopoly price for $\varphi < \varphi_E$. When the South does not offer patent protection it can also use its market power to obtain the product at a lower price for $\varphi \leq \varphi_I$, since $p_I^{\min}(\varphi, \gamma) < p_I^m$. However, the South's bargaining power is limited by the fact that the patent-holder sells fewer units at any given price when there is imitation with $\gamma > 0$, so *the patent-holder requires a higher minimum price to enter in the absence of patent protection* (i.e. $p_I^{\min}(\varphi, \gamma) > p_E^{\min}(\varphi)$ for $\gamma > 0$).

To derive the range of (φ, γ) over which the South will choose to offer patent protection in the case where it has all of the bargaining power, we compare the South's payoffs under the respective bargaining subgames. For $\varphi \in [\varphi_I, \varphi_E)$, the patent-holder does not enter in the absence of patent protection. Over this range of fixed costs, the South must choose between implementing patent protection to induce entry at price $p_E^{\min}(\varphi)$ or allowing imitation to make (only) the low-quality imitated product available to consumers at zero price. Thus, for $\varphi \in [\varphi_I, \varphi_E)$, patent protection is preferred by the South iff

$$s_E(p_E^{\min}(\varphi)) \geq s_N(\gamma) \Leftrightarrow \int_{p_E^{\min}(\varphi)/q}^{1} (q\theta - p^B(\varphi))d\theta \geq \int_0^1 \gamma q\theta d\theta$$

which is the same as

$$p_E^{\min}(\varphi) \leq q(1 - \sqrt{\gamma}) \tag{17}$$

Using (15), the South is indifferent between patent protection at $p_E^{\min}(\varphi)$ and no patent protection for fixed costs satisfying

$$\varphi \leq \varphi^B(\gamma) \equiv q(\sqrt{\gamma} - \gamma)(1 + \Omega) \tag{18}$$

where $\varphi^B(\gamma) \geq \varphi_E^m$ iff $\gamma \geq \gamma^S$. Since $p_E^{\min}(\varphi) < p^m$, for all $\varphi \in [\varphi_I, \varphi_E)$, *price negotiations expand the range of γ for which the South prefers patent protection when the South has all of the bargaining power.*[23]

Providing patent protection also becomes more attractive for the South for $\varphi \in [0, \varphi_I]$ when it has all of the bargaining power. As noted above, $p_I^{\min}(\varphi, \gamma) > p_E^{\min}(\varphi)$ for $\gamma > 0$ because the patent-holder's average cost is higher without patent protection due to the fact that it loses sales to imitating firms. The trade-off for the South is that it benefits from the variety effect of having both the high-quality patented product and the low-quality imitated product if it does not provide patent protection, but it must pay a higher price for the patented product. It is shown in the Appendix that the latter effect dominates for all $\varphi < \varphi_I$, so the South prefers offering patent protection over this interval. This result stands in sharp contrast to the case where the patent-holder has all of the bargaining power, because in that case the competition from imitators reduces the patent-holder's markup ($p_I^m < p^m$). In that case, the South strictly prefers to not offer patent protection: not only does it yield the high-quality product at a lower price it also provides consumers access to the low-quality product at zero price.

We can now state our main result for the case where the South has all the bargaining power:

Proposition 7: *Suppose that the South can make a take-it-or-leave-it price offer for the patented product and compulsory licensing is not an option. Then, the South provides patent protection if (i) $\gamma \leq \gamma^S$ and $\varphi < \varphi_E$ or (ii) $\gamma > \gamma^S$ and $\varphi < \varphi^B(\gamma)$ where $\frac{d\varphi^B(\gamma)}{d\gamma} < 0$. Furthermore, the market outcome where the patent-holder competes with the imitative industry does not arise in equilibrium.*

To isolate the effect price negotiations have on the South's incentive for patent protection, it is useful to compare the case where all the bargaining power lies with patent-holder (as is true in our core model) to one where it lies with the South. Proposition 1 describes the South's equilibrium policy in the former case while Proposition 7 does so for the latter case. A comparison of Propositions 1 and 7 illustrates that the South's ability to drive the patent-holder to its minimum acceptable entry price *significantly expands the parameter region over which it chooses to provide patent protection.* When the patent-holder unilaterally sets the price, the South's decision regarding patent protection is determined solely by the quality gap parameter γ whereas when the South controls the price, both the quality gap γ and the fixed cost of entry φ matter. In particular, the South offers patent protection over the second region specified in Proposition 7 (i.e.

[23] Note that the result that price negotiations expand the range of γ for which the South prefers patent protection holds for any degree of power for the South that yields a price below the monopoly price.

$\gamma > \gamma^S$ and $\varphi < \varphi^B(\gamma)$) because it can get the patent-holder to sell at its minimum acceptable price. When all of the bargaining power resides with the South, price negotiations drive the patent-holder's net profits down to zero both with and without patent protection. Thus, while the patent-holder is indifferent to patent protection, the South has greater tolerance for it because the minimum price needed to induce entry is *higher* in its absence: i.e. $p_I^{\min}(\varphi, \gamma) > p_E^{\min}(\varphi)$.

Figure 6 illustrates how price negotiations affect Southern incentives for patent protection by comparing the two polar cases where all the bargaining power lies with the South.

[Figure 6 here]

In Figure 6, the South has all the bargaining power and it offers patent protection over regions **A**, **B**, and **C1**. This contrasts with the case where the patent-holder has all of the bargaining power, which results in patent protection being provided by the South only over region **B**.

5.2 CL, bargaining, and patent protection

We now extend the bargaining game to the case in which the South has the option of issuing a compulsory license if no agreement is reached after the first period. The option of CL alters the South's disagreement point from a payoff of 0 to present value of consumer surplus under CL, which equals $(s_N(\gamma) - R)(1 + \Omega)$. For the patent-holder, the fact that the South would issue a compulsory license in the absence of an agreement raises its disagreement payoff from zero to the present value of royalty payments it would obtain under CL, which equals ΩR. We show that the change in the disagreement points due to the option of CL affects the bargaining problem in two ways: it narrows the range of fixed costs for which an agreement can be reached and it alters the price that is negotiated in the event that the patent-holder enters.

We first consider the effects of CL on the subgame in which the South provides patent protection. The existence of a royalty payment for the patent-holder under CL means that the patent-holder will enter only if it earns a return of at least $\varphi + \Omega R$ from sales in the South. From (15), the minimum price the patent-holder is willing to accept when it has patent protection is $p_E^{\min}(\varphi + \Omega R)$. Since $p_E^{\min}(\varphi + \Omega R)$ is increasing in R, *the possibility of CL raises the minimum price that the South must pay to induce entry.* The existence of CL may also affect the maximum price that the South is willing to pay under patent protection. The price that makes the South indifferent between entry and CL solves the following equation:

$$(1+\Omega)s_E(p) = \Omega\left[s_N(\gamma) - R\right] \Leftrightarrow \int_{p/q}^{1} (q\theta - p)d\theta = \frac{\Omega}{1+\Omega}\left[\int_{0}^{1} \gamma q\theta d\theta - R\right]$$

which yields

$$p_E^{\max}(\gamma, R) = q\left[1 - \left(\frac{(\gamma q - 2R)\,\Omega}{q(1+\Omega)}\right)^{1/2}\right] \tag{19}$$

Observe that $p_E^{\max}(\gamma, R)$ is decreasing in γ and increasing in R, because CL is more attractive to the South the greater is the quality of the imitated product and the lower is the royalty rate under CL. The possibility of CL reduces the maximum price the South is willing to pay only when $p_E^{\max}(\gamma, R) < p^m$, which is satisfied only if the imitative capacity of the South is such that it prefers CL to entry at the monopoly price. This occurs if $\gamma \geq \gamma_{CL}$ as defined in (14). The ability of the South to deny entry by the patent-holder was not present in the case without price bargaining, because it was assumed that entry by the patent-holder preempted the South's right to issue a compulsory license.

When CL is an available option, the patent-holder and the South negotiate over prices that lie in the interval $[p_E^{\min}(\varphi + \Omega R), \min\{p_E^{\max}(\gamma, R), p^m\}]$. An agreement will be reached for all levels of fixed costs for which this interval is non-empty, which requires $p_E^{\min}(\varphi + \Omega R) \leq \min\{p_E^{\max}(\gamma, R), p^m\}$. For $\gamma < \gamma_{CL}$, CL is not a credible threat for the South and an agreement will be reached for $\varphi \leq \varphi_E(R)$. For $\gamma \geq \gamma_{CL}$, this interval is non-empty for $\varphi \leq \varphi_{CL}^B(\gamma, R)$, where $\varphi_{CL}^B(\gamma, R)$ is the solution to $p_E^{\min}(\varphi + \Omega R) = p_E^{\max}(\gamma, R)$. Since $p_E^{\max}(\gamma, R) < p^m$ for $\gamma > \gamma_{CL}$, $\varphi_{CL}^B(\gamma, R) < \varphi_E(R)$. The effect of CL on the range of values for which the patent-holder would enter with price bargaining is illustrated in Figure 7.

When CL is not an option, the patent-holder enters for $\varphi \leq \varphi_E$ and does not sell the product otherwise. When a CL is an option, the patent-holder enters in the first period for $\varphi < \min[\varphi_E(R), \varphi_{CL}^B(\gamma, R)]$ and waits for CL to issued in the next period otherwise. This results in a switch from entry to CL for $\varphi \in [\min[\varphi_E(R), \varphi_{CL}^B(\gamma, R)], \varphi_E]$, which is shown by regions **B, C,** and **D** in Figure 7. In region **A**, the option to use CL causes a switch from the product not being sold in the South to Southern consumers having access to it via the issuance of a compulsory license. The option to use CL expands consumer access to the product in the South, but it also reduces the range of fixed costs for which the patent-holder is willing to enter. Note that the interval over which entry occurs depends on the imitative ability of the South and the required royalty payment, but is independent of the relative bargaining power of the two parties.

Comparing Figure 7 with Figure 5, it can be seen that CL replaces entry for a larger range of parameter values when the patent-holder and the South negotiate over the entry price than when there is no negotiation. For fixed costs in region **D** in Figure 7, the option to issue a compulsory license results in a switch from entry to CL when price is negotiated between the two parties. In contrast, the patent-holder enters with or without CL in region **D** when price negotiations are absent. The South's ability to imitate in region **D** is sufficiently high that it prefers to deny entry at the patent-holder's preferred price and obtain the product under CL when it is able to negotiate with the patent-holder.

[Figure 7 here]

A second important effect of CL is to influence the price that is negotiated between the two parties. If the patent-holder has all of the bargaining power, it sells at the maximum price in the range of feasible prices. Referring to Figure 7, the patent-holder makes a take or leave it offer of p^m to the left of the vertical line line at γ_{CL} for $\varphi \leq \varphi_E(R)$. For $\gamma > \gamma_{CL}$, the patent-holder makes an offer of $p_E^{\max} < p^m$ for $\varphi \leq \varphi_{CL}^B(\gamma, R)$. The ability of the South to deny entry by the patent-holder benefits the South by reducing the price from p^m to $p_E^{\max}$ when CL is a credible threat. On the other hand, when the South has all of the bargaining power it makes a take or leave it offer at the lowest price in the range of feasible prices for $\varphi < \min\{\varphi_E(R), \varphi_{CL}^B(\gamma, R)\}$. The price at which the South obtains the product increases from $p_E(\varphi)$ to $p_E(\varphi + \Omega R)$ due to the option of CL, because the South must compensate the patent-holder for the royalty it would receive under a compulsory license. An important insight that emerges is that *the credible threat of CL benefits the party with less bargaining power.*

Combining the effect of CL on the region over which the patent-holder enters and the impact on the negotiated price under entry, we obtain the following result (proven in the Appendix) regarding the impact of the threat of CL on both parties:

Proposition 8: *Suppose that the South offers patent protection.*

*(i) If the patent-holder has all of the bargaining power, the threat of CL benefits the South in regions **A,C,D**, and **F** in Figure 7 whereas it harms the South in region **B**. The patent-holder benefits from the possibility of CL in regions **A**, **B**, and **C** whereas it loses in regions **D** and **F**. Neither party is affected in region **E**.*

*(ii) If the South has all of the bargaining power, the threat of CL benefits the patent-holder in all regions in Figure 7. The South also gains in region **A** and over portions of regions **C** and **D** for which $p_E^{\max}(\gamma, R) < p_E^{\min}(\varphi)$.*

Proposition 8 illustrates a couple of key points about the effect of allowing CL in the presence of price negotiations. The first point is that the South's ability to deny entry by the patent-holder under price negotiation is a benefit for the South. This can be seen by comparing the result of Proposition $8(i)$ with the effect of allowing CL in the absence of price negotiations. The South gains from the option of CL for parameter values in region **D** when price is negotiated but loses when it is not. For parameter values in **D** the imitative ability of the South is sufficiently high that it prefers CL to entry by the patent-holder at the monopoly price, so it can deny entry and choose CL when there are price negotiations between the two parties.

An important insight contained in Proposition 8 is that the ability to impose CL primarily benefits the party whose bargaining power is weaker. The option of CL raises the disagreement payoff of each party when it is a credible threat, so the party making a take-it-or-leave-it offer must make an offer that is sufficiently attractive to compensate for the other party's higher disagreement payoff. This effect benefits the South in regions **D** and **F** when the patent-holder has all of the bargaining power and CL is a credible threat. For the patent-holder, the existence of a positive royalty payment under CL provides a benefit that must be compensated for all parameter values for which it would be willing to enter at the monopoly price. Finally, Proposition 8 highlights the role of the South's imitative ability in determining the effects of CL since the threat of CL is credible only when $\gamma > \gamma_{CL}$.

We have shown how the option of CL affects price negotiations when the South provides patent protection. In the case where the South does not grant patent protection, on the other hand, the option of CL is not a credible threat for the South and therefore does not influence the negotiations. In the absence of patent protection, the South can obtain the product at quality γq from local imitators without delay and without having to pay a royalty, so the option of CL is dominated by imitation. Thus, the payoff frontier to the bargaining problem is unaffected by the option of CL when the South does not offer patent protection. Similarly, the South's payoff to not offering patent protection is unaffected by the option of CL.

We are now in a position to consider how the availability of CL affects the South's incentive to provide patent protection when the two parties negotiate over price. Since the payoff under the bargaining subgame without patent protection is unaffected by CL, whether patent protection becomes more or less attractive due to the option of CL depends only on the change in payoff to the South under patent protection. Consider first the case in which the South has all of the bargaining power. The only regions identified in Proposition 8 (ii) in which the South gains from the option of using CL are regions in which CL actually arises in equilibrium. However, immediate imitation without a royalty payment results in a higher payoff to the South than does CL, so the South will choose not to offer patent protection in these regions. In regions of the parameter space where the option of CL harms the South in the bargaining game, the option of CL reduces its incentive for patent protection.

A similar conclusion arises in the case where the patent-holder has all of the bargaining power. In the region of the parameter space where the option of CL influences the price bargain between the patent-holder and the South, it results in an entry price that makes the South indifferent between entry and CL. The South would prefer not to have patent protection in these cases because imitation dominates CL (since it avoids royalties and occurs without delay). Thus, the basic message of Proposition 3 – i.e. the option to use CL weakens the South's incentive for patent protection – continues to hold regardless of which party has the ability to make a take-it-or leave-it price offer.

6 Conclusion

TRIPS flexibilities such as compulsory licensing are intended to provide member countries of the WTO with a safety valve when domestic considerations make it imperative to opt out of TRIPS obligations. While CL predates TRIPS, developing countries had little use for it when they were free to deny patent protection to foreign firms. During the pre-TRIPS era, imitation and reverse-engineering allowed developing countries with adequate technological capability to obtain cheap access to pharmaceuticals that were patented in the rest of the world. Even those developing countries that lacked the ability to produce pharmaceuticals domestically were able to import them from countries such as India and China. But with the ratification of TRIPS, developing countries have come under increasing pressure to offer and enforce patent protection at a level that is on par with the Western world. As a result, during the post-TRIPS era CL has the potential to become an important policy tool using which developing countries can provide local consumers access to patented pharmaceuticals at reasonable prices provided its use is not met with serious resistance from developed countries.

We construct a stylized model in which a developing country (South) chooses its patent protection policy taking into account the effect of its policy on the incentive of a patent-holder to sell in its market. As per TRIPS rules, we assume that the South has the option to issue a compulsory license to a local firm only if the patent-holder chooses not to work its patent locally. Our analysis provides several interesting insights. First, we find that the South has an incentive to offer patent protection if and only if it is necessary for inducing the patent-holder to serve its market and the quality of the imitated local product is sufficiently low. Second, from the Southern perspective, TRIPS consistent CL is a poor substitute for imitation: not only does it involve a waiting period (during which the patent-holder is given an opportunity to work its patent), it also requires royalties to be paid to the patent-holder. Third, from the perspective of joint welfare, the desirability of CL hinges very much on whether or not the South has the freedom to deny patent protection. When the South has such policy freedom, CL is essentially counter-productive: not only does it not arise in equilibrium, but the option to use it results in a Pareto inferior outcome. On the other hand, when the South has no choice but to offer patent protection (as is basically true today for all members of the WTO), CL plays a much more useful role: not only does it arise in equilibrium, it can even generate a Pareto improving outcome. This result argues in favor of Article 31 of TRIPS under which CL is sanctioned by the WTO.

We also extend the basic model to the case where the patent-holder and the South bargain over the price. We show that patent protection becomes more likely when the South can negotiate a price below the optimal monopoly price. This effect arises in two ways. First, if the patent-holder would not enter in the absence of patent protection, the ability to obtain the higher quality product at a lower price makes entry more attractive to the South than relying on the low quality imitated product. Second, when the South makes a take-it-or-leave-it offer to the patent-holder, it has an incentive to offer patent protection even if the patent-holder is willing to enter without it. This is due to the fact that the price needed to induce entry is higher under imitation because competition from imitators reduces the patent-holder's sales in the South. This adverse effect of imitation on the price required to induce entry dominates the benefit of making the low quality product available to local consumers. Finally, we also show that the ability to issue a compulsory license undermines the South's incentive to offer patent protection when price is negotiated, just as it does in the absence of price negotiations.

7 Appendix

Here we show that for $\varphi \leq \varphi_I$ the South chooses to offer patent protection when it has the ability to make a take-it-or leave it price offer to the patent-holder.

Let $\varphi \leq \varphi_I$. The South offers patent protection iff

$$s_E(p_E^{\min}(\varphi)) \geq s_I(p_I^{\min}(\varphi, \gamma))$$

which is the same as

$$\int_{p_E^{\min}(\varphi)/q}^{1} [q\theta - p_E^{\min}(\varphi)]d\theta \geq \int_{0}^{\theta_I^{\min}} \gamma q\theta d\theta + \int_{\theta_I^{\min}}^{1} [q\theta - p_I^{\min}(\varphi, \gamma)]d\theta$$

where $\theta_I^{\min} = p_I^{\min}(\varphi,\gamma)/q(1-\gamma)$. Substituting for $\theta_I^{\min}$, $p_E^{\min}(\varphi)$, and $p_I^{\min}(\varphi,\gamma)$ allows us to rewrite the above inequality as

$$G(\gamma) \geq 0 \text{ where } G(\gamma) = \left[q\left(q - \frac{4\phi}{1+\Omega}\right)\right]^{1/2} - q\gamma - \left[q(1-\gamma)\left(q(1-\gamma) - \frac{4\phi}{1+\Omega}\right)\right]^{1/2} \geq 0$$

Straightforward differentiation shows that for all $\varphi < \varphi_I$, we have $G'(\gamma) > 0$ and $G(\gamma)|_{\gamma=0} = 0$ so that it must be that $G(\gamma) \geq 0$ for all γ when $\varphi < \varphi_I$.

Proof of Proposition 8:

In region **A** we have $\varphi > \varphi_E$, so entry would not have occurred without CL and both players receive 0. When the option of CL exists, the South obtains the product under CL and both parties receive a positive payoff. Both parties gain from CL.

In regions **E** and **F**, $\varphi < \min\{\varphi_E(R), \varphi_B^{CL}(\gamma, R)\} < \varphi_E$, so entry occurs with or without the threat of CL. If the patent-holder has all of the bargaining power, it enters at a price of p^m if there is no option of CL. The threat of CL is not credible in **E**, since $\gamma < \gamma_{CL}$, so it has no effect on the payoffs. For region **F** with $\gamma > \gamma_{CL}$, CL is a credible threat and the patent-holder enters at a price $p_E^{\max} < p^m$. This benefits the South and harms the patent-holder. If the South has all of the bargaining power, the patent-holder enters at a price of $p_E^{\min}(\varphi)$ when the option of CL does not exist and a price of $p_E^{\min}(\varphi + \Omega R)$ when it does. The South is harmed by the increase in price caused by the option of CL whereas the patent-holder benefits.

It remains to consider regions **B**, **C,** and **D,** where the threat of CL results in a switch from entry to the issuance of a compulsory license. Let p^B denote the price determined by the bargain if the patent-holder enters when there is no threat of CL. The South gains from a switch from entry to a compulsory license if $(1+\Omega)s_E(p^B) > \Omega s_N(\gamma)$, which is equivalent to

$$p^B > p_E^{\max}(\gamma, R)$$

The patent-holder gains from a switch from entry to CL if $v_E(p^B) < \varphi + \Omega R$, which is equivalent to

$$p^B < p_E^{\min}(\varphi + \Omega R)$$

In the case where the patent-holder has all of the bargaining power, the bargained price under entry equals the monopoly price ($p^B = p^m$) and the South benefits from the threat of CL if $p_E^{\max}(\gamma, R) < p^m$. This condition is satisfied iff $\gamma > \gamma_{CL}$, so the South benefits in regions **C** and **D** whereas it loses in region **B**. In regions **B** and **C**, the patent-holder benefits from the switch from entry to CL because $v_E(p^m) < \varphi + \Omega R$**.**

In the case where the South has all of the bargaining power, in the absence of the threat of CL we have $p^B = p_E^{\min}(\varphi) < p_E^{\min}(\varphi + \Omega R)$. Since the patent-holder is driven to zero profits under bargaining, the patent-holder must gain from the switch to CL for all $R > 0$. For the South, welfare is increased by the switch for all parameter values such that $p_E^{\min}(\varphi) > p_E^{\max}(\gamma, R)$. In Region **B** where $\gamma < \gamma_{CL}$ and $\varphi \leq \varphi_E$, the South cannot gain because $p_E^{\max}(\gamma, R) \geq p^m \geq p_E^{\min}(\varphi)$. The South gains for the set of $\{\gamma, \varphi\}$ in regions **C** and **D** such that $p_E^{\min}(\varphi) > p_E^{\max}(\gamma, R)$, is a non-empty set if $p_E^{\min}(\varphi) > p_E^{\max}(1, R)$.

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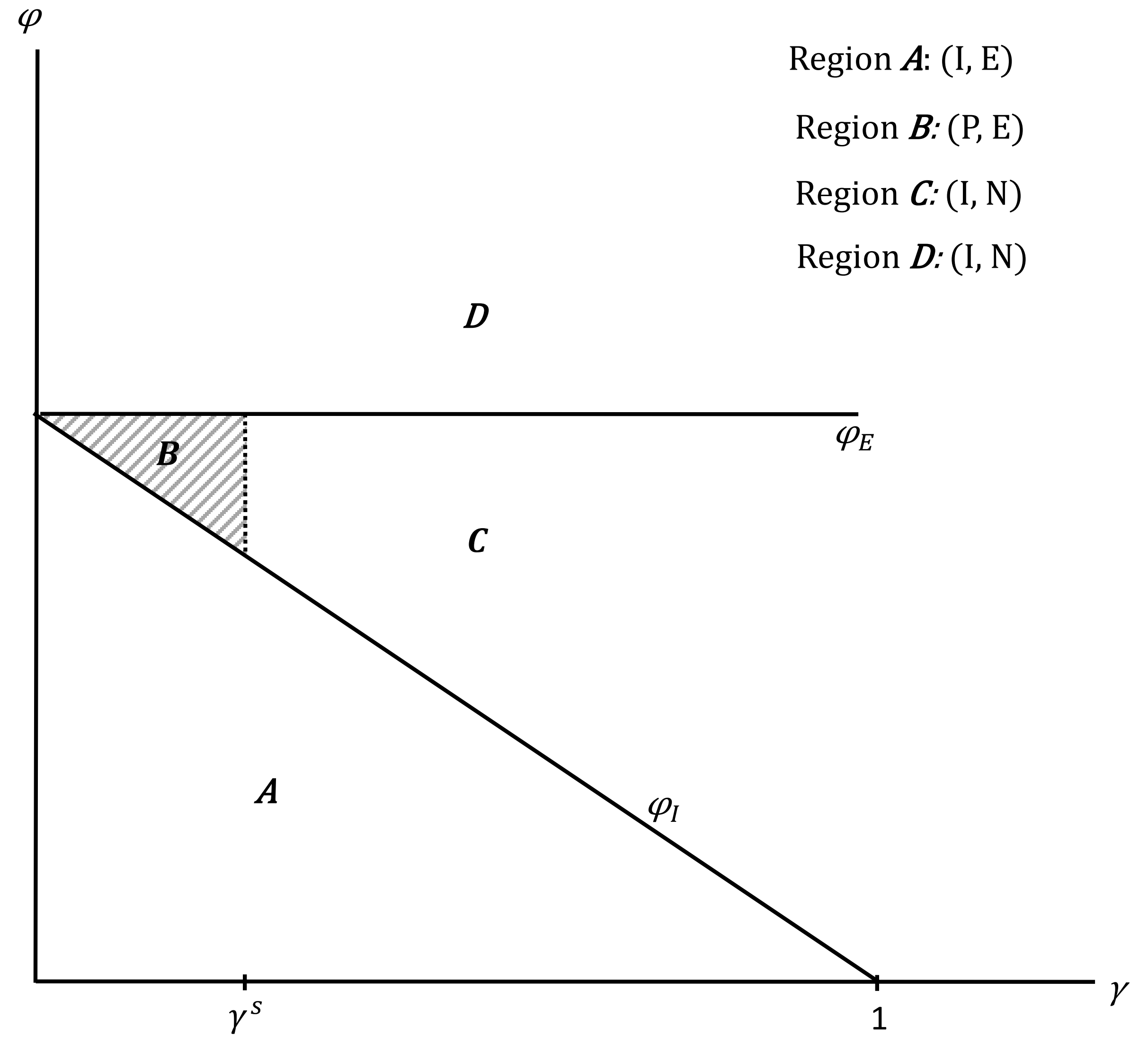

Figure 1: Equilibrium w/o CL

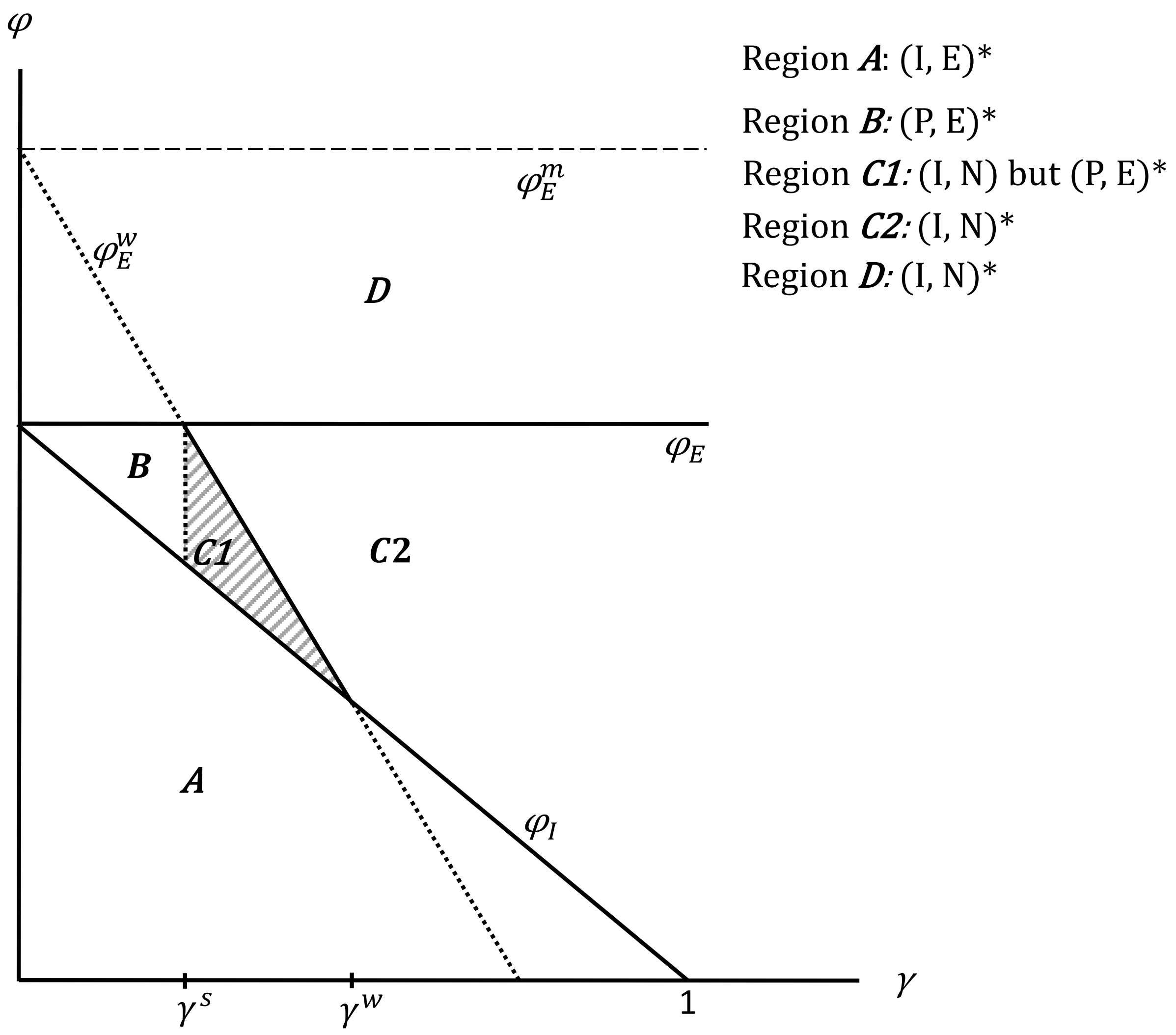

Figure 2: Efficiency of equilibrium

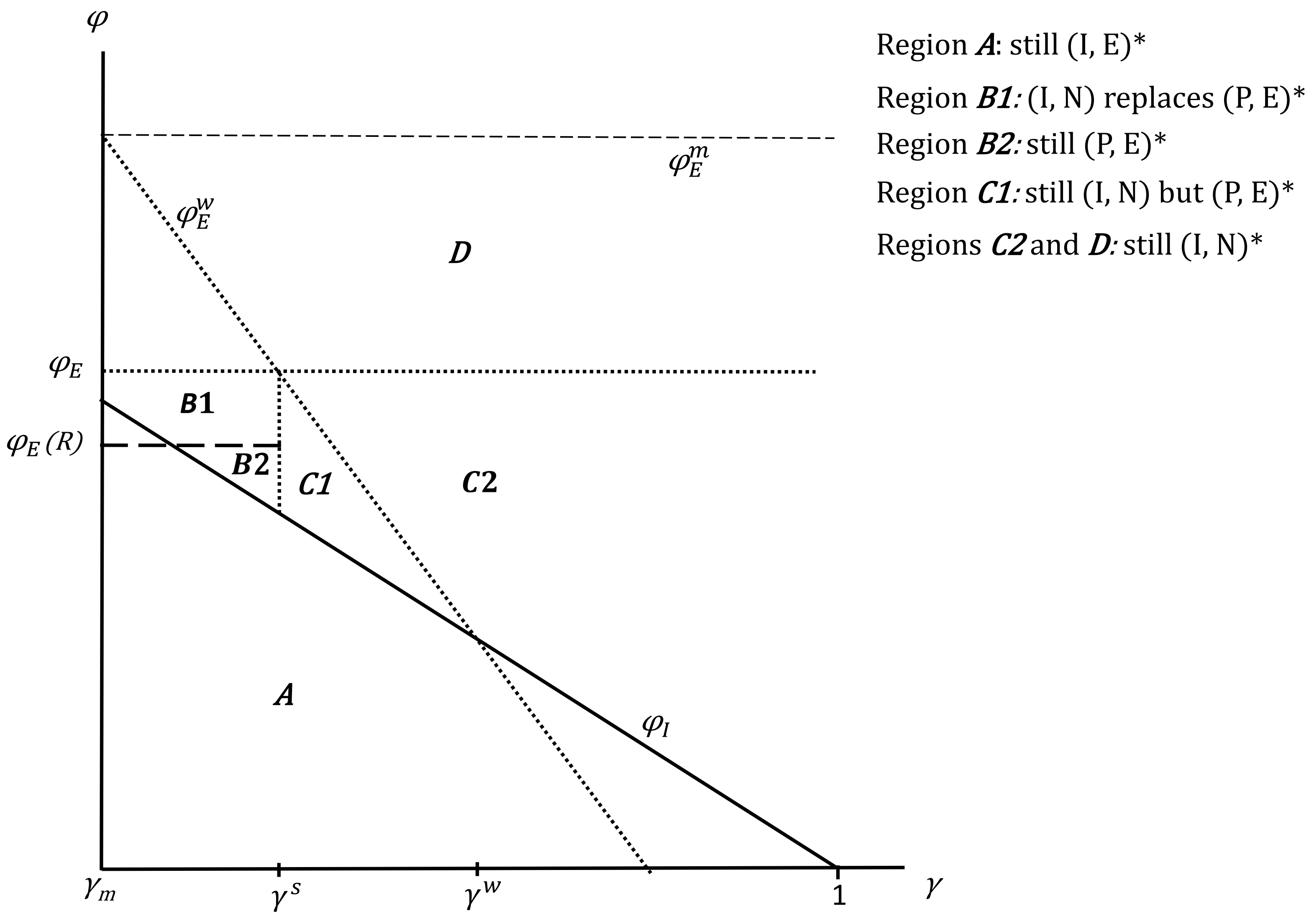

Figure 3: How the possibility of CL changes equilibrium

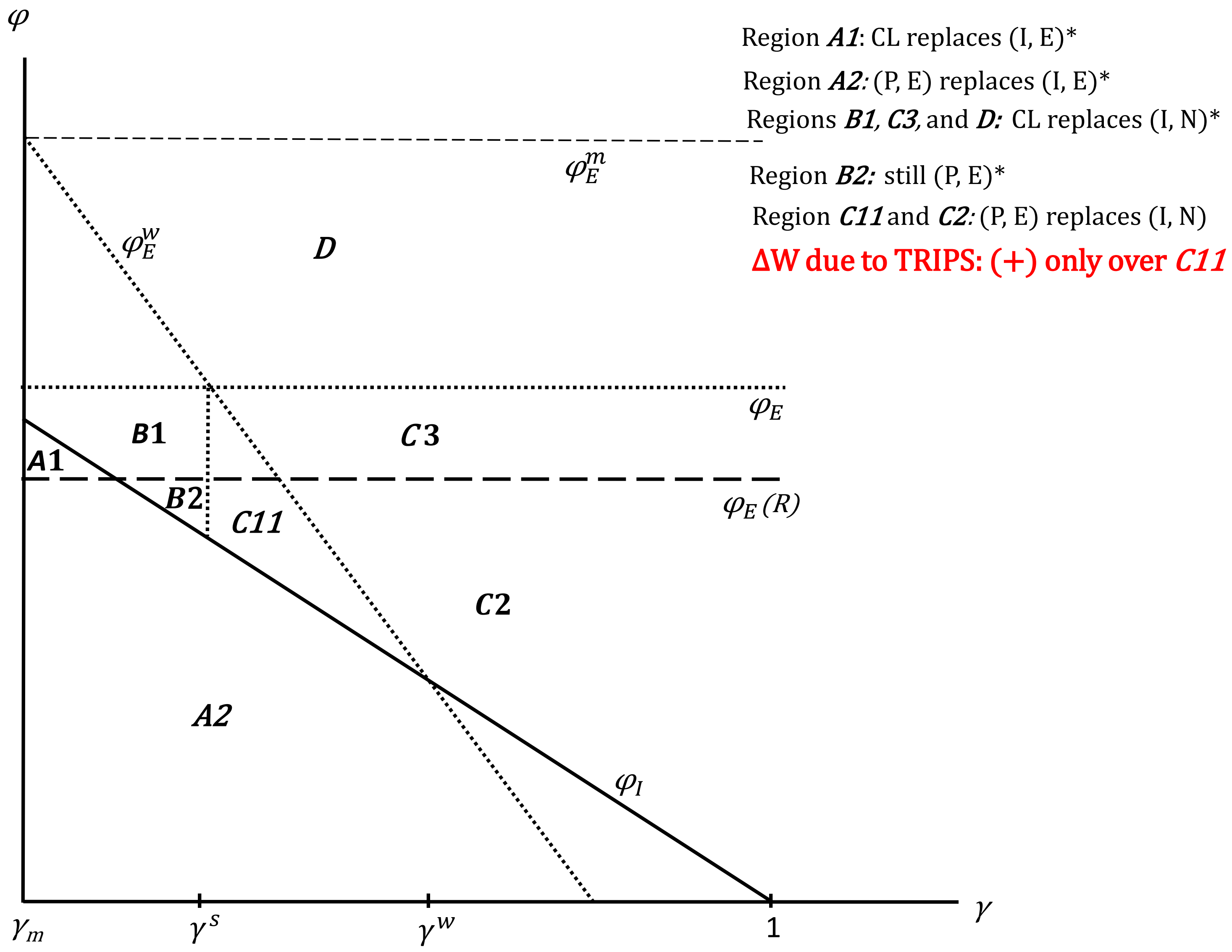

Figure 4: How TRIPS affects equilibrium and welfare

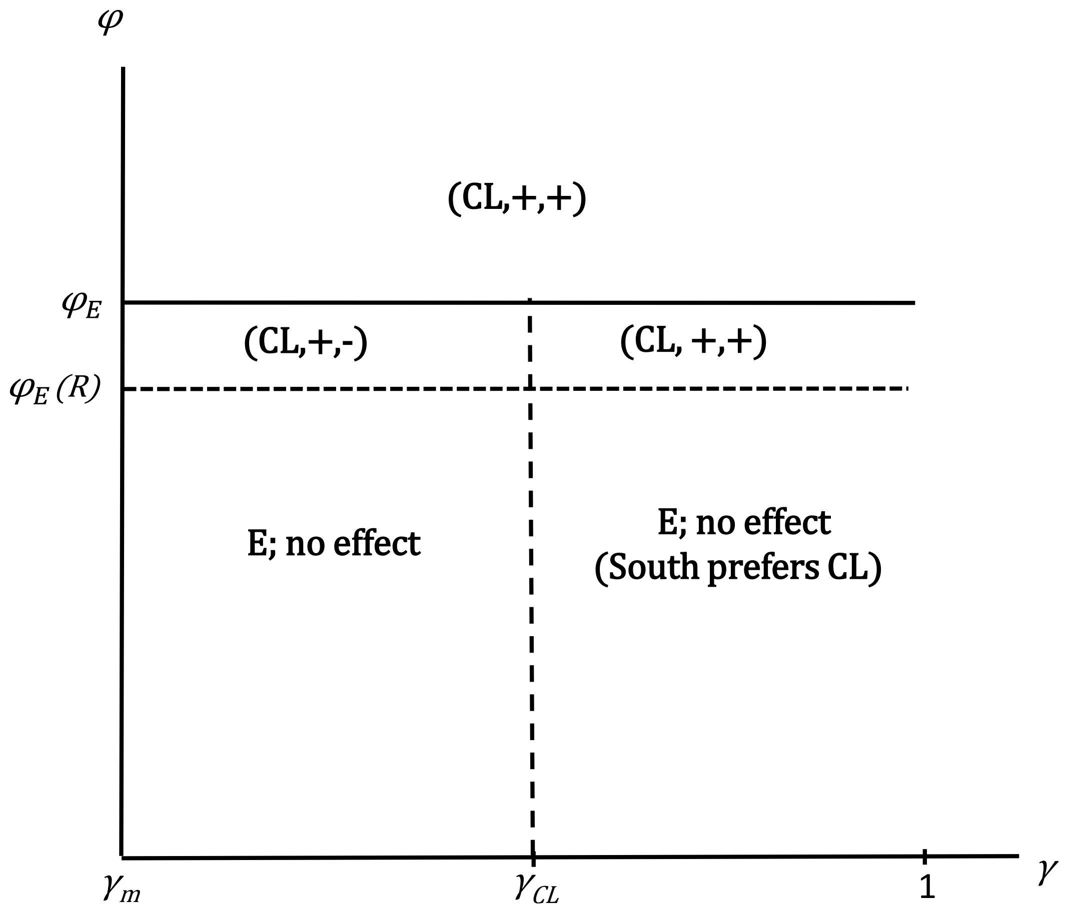

Figure 5: How CL affects both parties (South listed second)

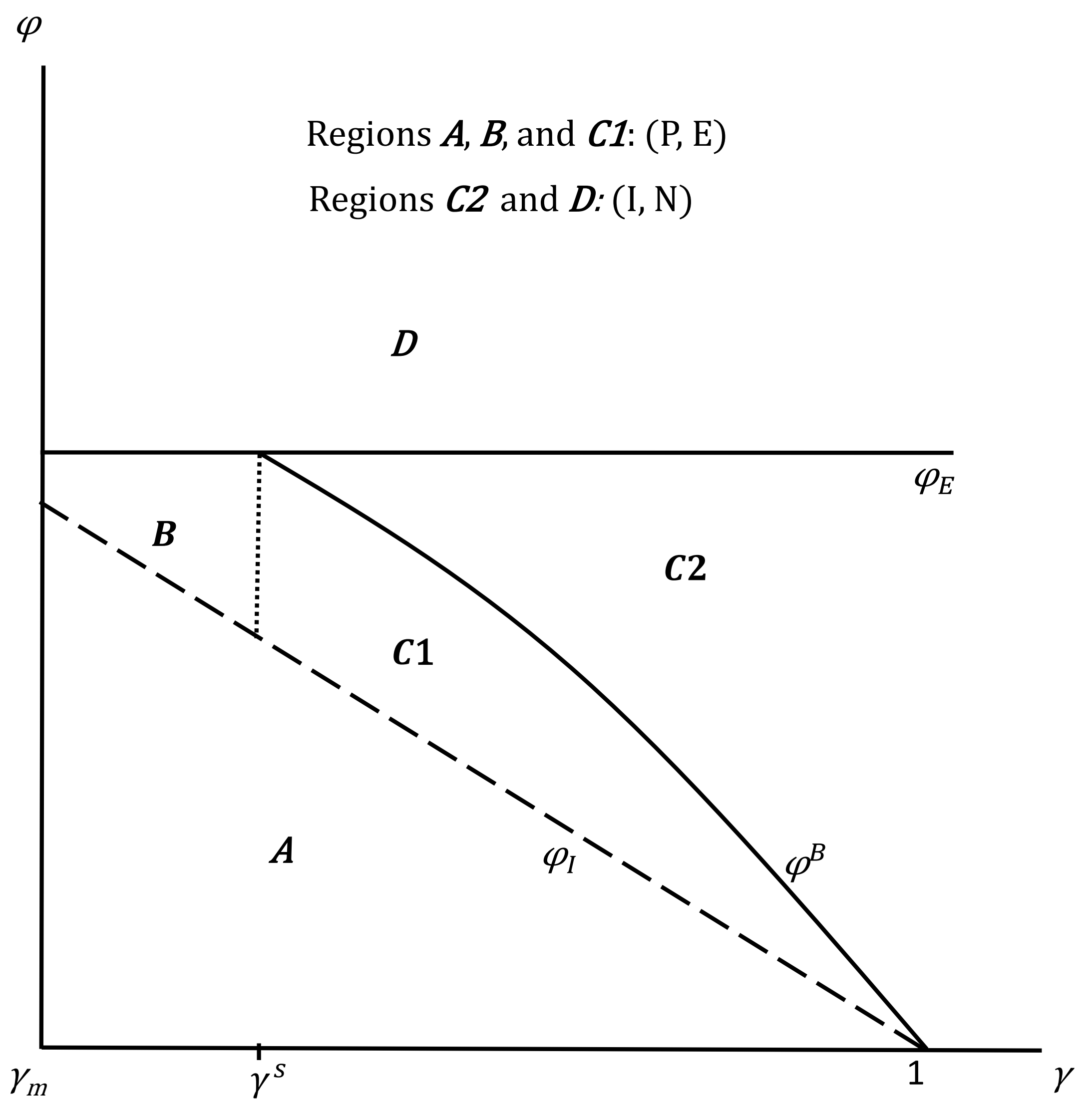

Figure 6: Equilibrium with price bargaining and w/o CL

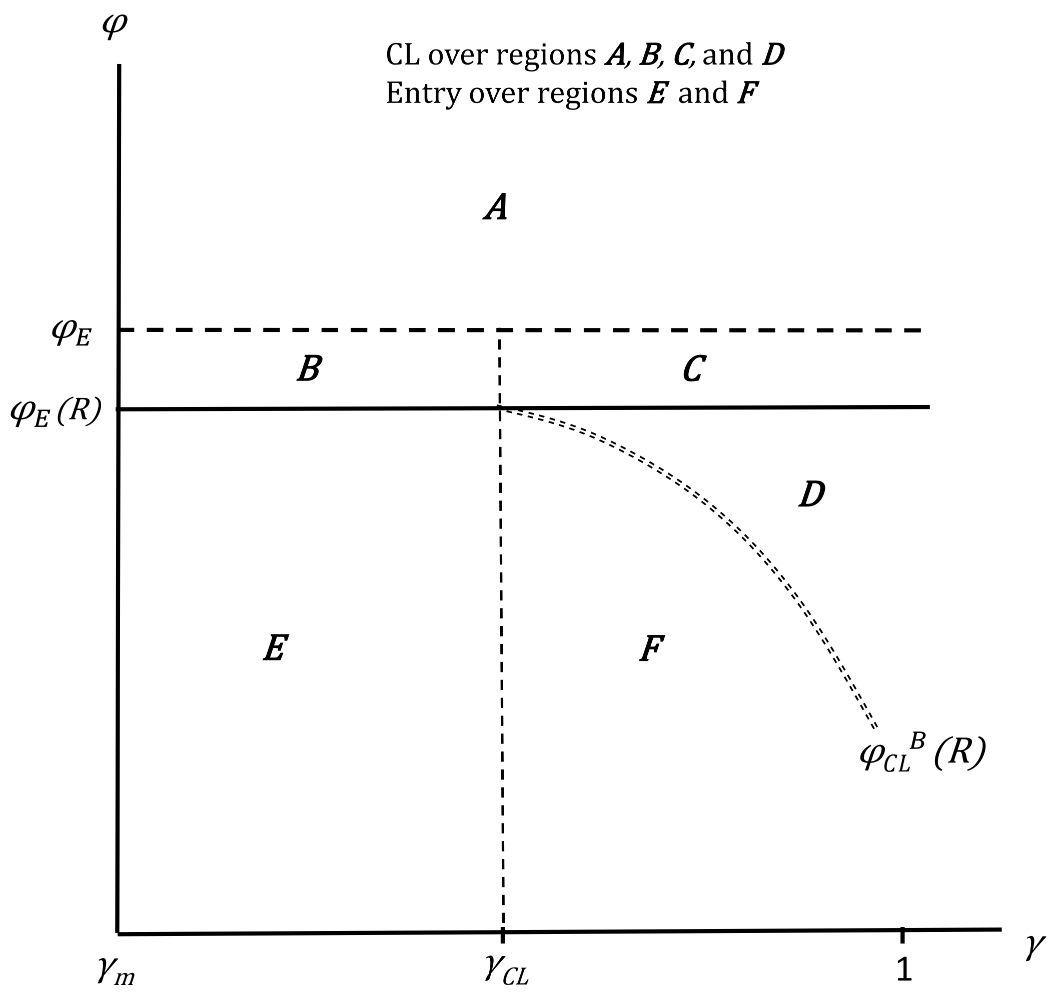

Figure 7: Effects of CL with price negotiations