To what extent should less developed countries enforce Intellectual Property?

Gilles Saint-Paul
GREMAQ-IDEI, Université de Toulouse I

Introduction

Many advocates recommend that LDCs should not enforce intellectual property rights. Their arguments have many facets. First, LDCs are "poor", and it would be unfair for them to pay high prices for patented goods. Second, historically, countries like the US have not enforced IP, and seemingly have benefited from it. Third, some argue that LDCs government should promote non-IP options such as open source software, as an adequate strategy for development. This paper discusses a number of issues in the context of that debate. It starts by discussing the consequences of IP enforcement in LDCs for global innovation and welfare in poorer countries. It then considers the costs and benefits of IP enforcement for a small, open, LDC, abstracting from global issues. Finally, it discusses the potential merits of an industrial policy based on open source software. The analysis suggests that the view that it is best for LDCs to free-ride on the global IP regime is overblown. Not only there seems to be a substantial cost in terms of lower innovation worldwide; but there are reasons to believe that even a small country free-riding on its own would do itself more harm than good, discouraging FDI, exports and licensing in IP-sensitive products. The paper proposes that an equally fair policy, but better in terms of global innovation and growth, would be strict enforcement of IPRs in LDCs, in exchange for a reduction in trade barriers in the North against exports from LDCs.

Why do we want LDCs to enforce intellectual property of firms based in developed countries? From the point of view of these firms, that is obvious: they make more money

if their patents and copyrights are enforced there. From a legal point of view, that is debatable: As IPRs are rights granted by governments, an individual government may well deny them. However, it is equally legitimate for other governments to require that a government enforces IPRs as part of a trade treaty.

From an economists's point of view, the most relevant consideration is whether the welfare of consumers is enhanced or harmed.

The free lunch argument

The argument in favor of intellectual property goes as follows. Inventing a new product or industrial device is a costly investment. The average price of a new medicine, for example, is $800m. If the invention can be freely copied, competitors of the inventor will be able to use it at no cost. Competition will drive the price of the invented good to its marginal production cost, and the inventor will not recoup the costs of his invention. Consequently, nobody will invest in R & D and the level of innovation will be suboptimal.

By granting intellectual property rights, the government grants a temporary monopoly on innovation. Innovators are then rewarded by the monopoly profits they can reap, or by the royalties they can charge competitors if they decide to license their innovation. Therefore, from the point of view of the global economy, Intellectual property favors innovation.

Consider now the case of a less developed country which is small relative to the world economy. Assume that no innovative activity takes place in the country. Then the country's market is small relative to the world market. Consequently, whether it enforces IPRs or not only has a minute impact on the expected profitability of an invention. Thus, from its individual point of view, enforcing property rights brings no benefits as it only has a small impact on the rate of innovation worldwide. As long as it can adopt the new technologies and new products invented abroad, it will benefit from the worldwide rate of innovation on which it has little impact. On the other hand, not enforcing IPRs guarantees that the country's markets will be competitive, so that goods will be sold at the lowest possible price. This clearly benefits the country's consumers.

Even if the individual country has an R & D sector, it may still have little incentive to set a high level of IP protection. After all, if it is small, what matters is the extent to which it can patent its own innovations abroad; the monopoly rents that innovators can reap in the home market make little difference. On the other hand, if the LDCs is large (as India, China, Brazil, Pakistan or Indonesia), then having a local R & D sector can make it worthwhile to have an IP protection system.

Global consequences

The problem is that many countries have the same incentives to free-ride on innovation abroad. Therefore, even though not enforcing IPRs does not make a big difference from the viewpoint of an individual LDC, that many of them will fail to enforce them simultaneously leads to a substantial reduction in the global market size for any innovation. That in turns reduces the number of goods being invented at any date, and therefore the economy's growth rate.

This generates a number of questions: what is the cost (in terms of foregone growth for the world economy) of this behavior? Do LDCs lose on net or are the costs concentrated in the Northern countries? If so, what is the appropriate global IPR system so that both North and South benefit from greater innovation?

While aggregate-level studies have trouble finding an effect of market size on innovation, some micro-level studies find surprisingly large effects. Acemoglu and Linn (2004), for example, find that a 1 % increase in market size increases the flow of new products in the pharmaceutical industry by 4 to 7 %. These estimates may actually be considered as implausibly high. But they nevertheless suggest that the effect is quite substantial.

What does that imply for the effects of IPR enforcement in LDC on global GDP growth? The message is that the effect could be quite damaging. In the software industry, for example, piracy rates in LDCs are 50-70 %, versus 20-30 % in the developed world. Furthermore, LDCs (as defined by non-OECD countries) account for about half of world GDP. So, if the enforcement level in LDCs converged to OECD levels, world piracy rates

would drop from 42.5 % to 25 %. That represents a 30 % increase in market size. Assuming effects that are of the same order of magnitude, but lower, than the estimates quoted above, this suggests the flow of new software could double. Therefore, IPR enforcement could have a very substantial impact on innovation flows and on the range of diverse products that are available to consumers.

How are these welfare gains distributed between LDCs and developed countries? In principle, developed countries that own the bulk of intellectual property should benefit. LDCs may either benefit or lose. Their consumers will have to pay more for patented products; on the other hand they will have access to a broader range of more sophisticated products. Whether they gain or lose depends on whether the latter effect dominates the former. The lower the increase in price brought about by patent enforcement, the more consumers value diversity and sophistication, the more LDC consumers are likely to benefit from IPR enforcement. One should also note that the gains need not be uniformly distributed among consumers of a same country. Poor people for example, are likely to benefit less from novelty and diversity than rich people, and to be more sensitive on the actual cost of a good. However, if an individual country gains as a whole, it is always possible for it to put in place a redistributive scheme to compensate the poorer consumers for the increased prices. Furthermore, the poorer consumers always have access to a (growing) set of generic products whose patents have expired, so that they need not be too affected by an increase in the price of some patented products. In countries that own intellectual property, the same gains and losses to consumers are present. But to these one should add the gains to the firms that own patents, i.e. the difference between the extra profits made out of higher prices and the extra costs of innovation. This term is always positive – otherwise there would not be an increase in the rate of innovation – so that if consumers in rich countries have the same preferences as consumers in poor countries, the total gains per capita in rich countries are larger than the gains per capita in poor countries.

It is not easy to find studies that estimate the net gains from IP enforcement. A paper by McCalman (2000), for example, estimates the distributional effects of the TRIPS

agreement by subtracting the net present value of a patent granted from the net present value of a patent obtained. He concludes that most LDCs lose, that the most important beneficiary is by far the United States, and that some developed countries such as Canada lose. But that approach only captures the effect of the agreement on international flows of corporate profits, and ignores gains to consumers from greater innovation. By construction, it implies that a non-innovating country would necessarily lose. To get an estimate of the total net gain, one must have an idea of (i) the increase in prices triggered by stronger IP enforcement, and (ii) the value to consumers of the new products and processes being invented. Modern economic theory suggests, however, that a very simple formula may be applied. It tells us that consumers in a non-innovating country gain provided:

$$d \ln p < (d \ln n)/(\sigma-1),$$[1]

where d ln p is the relative increase in the price level, d ln n the relative increase in the number of goods, and σ refers to the elasticity of substitution between different goods, which captures the degree to which consumers are happy with consuming one good rather than another. The greater that number, the less valuable are new products to consumers, because it does not matter much if one goes on consuming old goods instead of consuming new ones. Therefore, an increase in innovation is less valued, the greater σ. While it is not obvious to put numbers in that formula, an upper bound for the price increase triggered by IP enforcement is the monopoly markup[2], and theory tells us that it is intimately related to the elasticity of substitution σ: the more a new good is valuable to consumers, the lower σ, and the higher the price that a monopoly producing that good can

[1] That simplified formula actually looks at steady-state effects, ignoring lags between the increase in prices and the increase in innovation; to take these lags into account, one would have to introduce discounting, which would greatly complicate the formula. It would also be less likely to hold. On the other hand, strong R & D spillovers could create effects of IP on the *growth rate*, rather than the *level*, of the number of varieties, as in Grossman and Helpman (1992), in which case the formula should be altered in a way which makes the inequality more likely to hold. I believe the simplified formula is a convenient and illuminating short-cut.

[2] It is equal to $\sigma/(\sigma-1)$. It is the increase in price that would prevail in the extreme case where under non enforcement, one has perfect competition and prices are equal to marginal cost, while under enforcement, perfect monopoly would prevail and prices would be equal to the markup times marginal cost—and marginal cost is assumed unchanged as a result of this shift.

charge. Using that upper bound, one can compute, for any value of the elasticity of substitution, the minimum proportional increase in the number of goods above which consumers in LDCs are compensated for the increase in price. The results from such a computation are reported in Table 1 (the numbers in the second column are actually an upper bound, since one has taken an upper bound for the proportional increase in prices). If one takes our estimate of a doubling of the number of goods as a benchmark, then the Table tells us that it is worth enforcing IPs for consumers in LDCs as long as the markup is above 2. Paradoxically, the larger the markup, the lower the increase in the number of goods needed for IP enforcement to be valuable. Again, that is because a high markup signals that new goods are quite valuable to consumers (relative to their production costs). From a political perspective, it is for the industries where markups are high that one is likely to advocate relaxing IP rights in LDCs out of "fairness" concerns. Yet the analysis suggests that it is precisely in these industries that enforcement is most likely to be better for consumers.

Markup	Minimum increase in the number of varieties (%)
11	27
6	43
3.5	65
2	100
1.5	144

Table 1 – Required proportional increase in the number of varieties, for consumers in LDCs to benefit from IP enforcement.

To overcome the losses created by the incentives to free-ride on other's intellectual property, international coordination on patent systems is desirable. The free-rider problem implies that an individual country is better-off if all countries enforce IPRs than if most countries don't, even though from its own perspective it would prefer not to enforce them at home. As a result, it may be willing to join a global agreement on IP enforcement, committing itself to abide by the rules of the agreement, provided others

doo. Economists have emphasized that coordination does not mean harmonization, and that the optimal level of IPRs in LDCs may be lower than in the North, even though it is higher than in the absence of coordination. Grossman and Lai (2001), show that one may maintain global incentives for innovation constant at their optimal level, while shifting the deadweight loss from monopoly pricing away from consumers in the South, at the expense of consumers in the North. One can do so by increasing patent length in the North while reducing patent length in the South. I believe this result is somewhat fragile: if there are opportunities to export goods whose patent has expired in the South to the North, it is efficient for a patent to expire simultaneously worldwide. Otherwise, one needs to put in place a complex system to prevent exports of goods whose patents have not expired in the North from the South. Such a system would have to cope with incentives for smuggling and is in contradictions with the WTO principles. Furthermore, as discussed below, there are reasons to believe that not enforcing IPRs might not be that a good idea after all, even from the strict individual viewpoint of a small, non innovating LDC.

More fundamentally, the essence of the problem is distributive. If a given WTO member loses from enforcing property rights, it needs to be compensated in some way. Having a lower IPR level is unlikely to be the best way to compensate it. One may consider direct transfers, increased foreign aid, or simply the gains from trade associated with a reduction in the North's tariffs. Such a reduction could indeed come as a counterpart offered by the North for enhanced IP protection in the South.

Indeed, there are similarities between tariffs and enforcement of IPRs (See Goh and Olivier (2003)). A higher tariff imposed by a large enough trading bloc artificially depresses the price of its imports, thus benefiting its consumers by allowing them to indirectly exert monopsony power. Similarly, not enforcing IPRs reduces the price of goods whose blueprints are covered by such IPRs. Reducing tariffs reduces price distortions. Increasing IPRs increases price distortions. Trading one against the other allows one to keep the overall level of price distortions unchanged while shifting them in a way favorable to innovation. From the point of view of LDCs, they trade a higher price for their exports against a higher price for their imports, and a higher pace of innovation worldwide.

Not such a free lunch after all?

The preceding discussion has assumed that the only cost to reduced IP protection in a given LDC is a somewhat lower, and uniform, rate of innovation in the global economy. These costs are diffuse, and the only thing that matters for innovation is the global market size of new products. Thus, if Zimbabwe does not enforce patents for treatment of malaria but at the same time Poland starts enforcing them, the total rate of invention of such treatments may not go down.

As this example makes clear, these arguments ignore that LDCs have specific needs. If some potential inventions specifically benefit them – and one can think of many examples in health or biotechnology – then lack of enforcement of intellectual property from LDCs may shift innovations away from what they need, in favor of what the North needs, and thus harm them much more than the simplified analysis in the previous section suggests. Such mechanisms may operate at two levels.

First, LDCs may simply have different *tastes* from Northern countries; by tastes one includes not only specific consumption habits but genuine needs as in the case of disease treatment. The lower the level of IP in the South, the more innovation will favor the products consumed by the North. Diwan and Rodrik (1991) have analyzed this problem and find that the optimal level of patent enforcement implies equal levels in North and South, provided the world 'social planner' gives equal weights to individuals in the North and in the South. If, because of altruism, there is greater weight on the South, then patent protection should be lower in the South, but by an amount which is smaller, the more specific the needs of the South are. Furthermore, as argued above, lower IPRs is probably an inappropriate instrument to redistribute in favor of the South. Thus, the existence of specific needs is a powerful argument for a high level of IP enforcement in LDCs, even if the countries at hand do not have an innovative sector. The point is illustrated by the lack of research to find cures for tropical diseases, and the risk that AIDS research would be

reduced following governmental moves to renege on IP enforcement for AIDS drugs in a number of countries. It is also true that low income reduces the incentives for innovators to find a cure for a disease. However, in the case of say malaria, low income is compensated by the potentially large number of consumers that such a drug would have. Therefore, the low level of research to cure malaria must have to do with the LDC governments' lack of ability to commit to enforce IPRs. That ability has been further undermined by the recent AIDS episodes. Paradoxically, the more an invention is vital to a region, the greater the expected political pressure to renege on IPRs if such an invention were introduced, and the lower the economic incentives to work on it.

Second, countries differ in their factor endowments and relative productivity levels, which determine their *comparative advantage.* They tend to specialize in the goods for which they have a comparative advantage. One way for innovators to protect themselves is to focus on goods for which countries that do not enforce IP *do not* have a comparative advantage. For example, there is more incentive to improve a device for making airplanes than T-shirts, or to invent a new airplane design than a new T-shirt design. That innovation is biased toward the goods for which the North has a comparative advantage means that the North will grow faster than the South. Low enforcement of IPRs may therefore imply a widening gap between developed and less developed countries. Saint-Paul (2004) studies these issues, using a theoretical model, and indeed finds such an effect. He shows that while the South is less likely to lose from piracy than the North, it may lose too. Furthermore, as in Table 1, it is more likely to lose, the greater the markup. These arguments imply that the dynamic losses from lower innovation to a non-enforcing LDC are actually larger than suggested by a model that ignores the LDC's specific needs and comparative advantage.

These mechanisms tend to make it more costly for LDCs as a whole to free-ride on the North's intellectual property rights. However, they are still associated with a free rider problem: these adverse effects would simply not deter an individual, small LDC from having low enforcement of IPRs. LDCs are harmed by the fact that they all have a low enforcement level, but an individual LDC still benefits from its own low enforcement

level, everything else equal. However, there are also effects that tend to make low enforcement of IPRs not such a good idea, even from an individual country's perspective.

First, one may challenge the static gains from not enforcing IPRs. The risk of being imitated may have a strong impact on firms in developed countries to export to LDCs. Smith (1999) shows that the level of IPR enforcement has a significant negative effect on US exports to a country, provided the threat of imitation (which depends on the nature of the product and the level of human capital in the importer country) in that country is high. These results suggest that the threat of imitation brought about by weak IP enforcement substantially reduces the gains from trade, because firms in the North will simply be reluctant to export their patented goods to the LDCs. That effect tends to harm the country with weak enforcement.

Second, and for similar reasons, there exists empirical evidence that low IPR enforcement deters foreign direct investment from the North. Thus, Lee and Mansfield (1996) find a statistically significant negative correlation (controlling for other variables) between the level of US foreign direct investment (FDI) in a given country and the proportion of respondents to a business survey who consider that "Intellectual property protection is too weak to permit them to transfer their newest of most effective technology to wholly owned subsidiaries". They also find evidence that IPR protection affects the *composition* as well as the *level* of FDI. In particular, weaker IPR protection significantly biases FDI away from facilities to manufacture intermediate or final products or R & D facilities, and in favor of sales, distribution, and rudimentary production and assembly facilities. Similarly, and perhaps less surprisingly, Yang and Maskus (1998), finds that weaker patent laws reduce the incentive for US firms to license their technology in a given country. This type of result is entirely confirmed by a recent paper by Smarzynska (2002), who focuses on Central European and former Soviet countries. Using firm-level data, she finds that the level of IPR protection has a substantial impact on the composition of FDI. First, lower IP protection moves FDI away from IP sensitive

industries.[3] Second, it leads foreign firms to set up establishments specialized in distribution, rather than local production, of their products. Clearly, production is more 'high-tech' and vulnerable to imitation and reverse engineering than distribution. That phenomenon is just another aspect of the flight of FDI away from IP-sensitive activities.

If one assumes that trade and FDI in high-tech products are an important vector of technology transfer, and thus of technological catch-up between LDCs and developed countries, then that generates a trade-off for the typical LDC. Low enforcement makes it easier to copy a technology, *given* the number of technologies that are available for copying, i.e. given the number of technologies that the country is in contact with, through trade and FDI. On the other hand, lower IP protection reduces the number of technologies that can potentially be copied, as foreign firms are more reluctant to export and invest in technologically sensitive products. Thus, low IPR enforcement acts as a tax on foreign firms, whose returns are technology transfers. A higher tax rate increases technology transfers given the tax base, but reduces the tax base of technologies with which one is in contact.

The evidence on FDI is interesting, but altogether it does not imply that the costs of low IP enforcement are larger than their benefits. Typically, foreign direct investment is a small fraction of capital flows. Altering its level and composition need not have a large effect on the country's performance. Furthermore, it is not totally clear that FDI has positive productivity spillovers for domestic firms: the literature on spillovers from FDI is inconclusive; surely, there are losses for domestic labor and domestic consumers, but of course they have to be balanced against gains in the form of lower prices of patent goods. However, the effects just discussed also seem to have a real quantitative significance for a country's GDP per capita. Gould and Gruben (1996), using cross-country growth regressions, find a positive effect of IPR enforcement on a country's GDP per capita. Furthermore, the effect is stronger, the more open the country is to international trade. That is exactly the contrary of what one should expect on the basis of

[3] As defined by Mansfield (1995); these are sectors with a high R & D content, where imitation is relatively easy. They include cosmetics, for example, but not automobiles, where R & D is important but imitation is difficult.

the free lunch argument, which would imply that the more closed the country, the lower the market share of its firms in a foreign non-enforcing country, and the lower the scope for imitating foreign products, thus the larger the effect on GDP of national patent policies. The evidence therefore suggests that rather than hampering technology transfer, intellectual property rights in a given country actually favors it, so that its GDP goes up. That is consistent with the fact that IP enforcement tilts the composition of FDI in favor of manufacturing plants as opposed to distribution outlets, if one assumes that manufacturing plants yield positive technological spillovers for the recipient country. That does not imply, still, that the country's consumers benefit on net. From the increase in GDP should be subtracted the royalties (and monopoly profits) paid to the rest of the world, which would not exist absent IPR enforcement.

Other arguments

The preceding discussion suggests that the value for an LDC of having a low enforcement of IPRs for the sole purpose of imitating innovations made abroad may not be that large after all. However, there are a number of other considerations that should be taken into account.

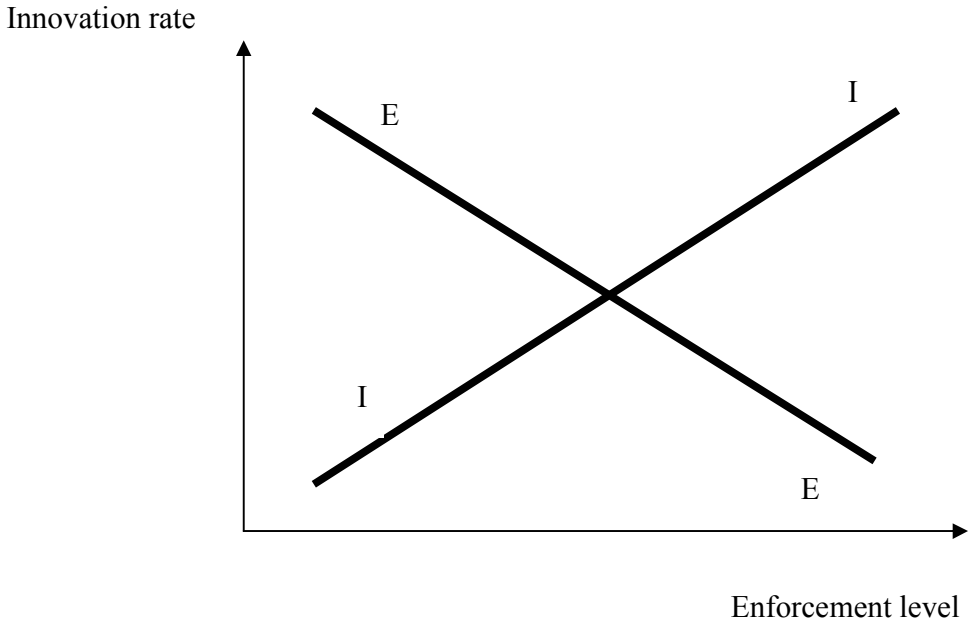
First, enforcing a system of intellectual property is a complex task requiring considerable expertise in many fields. The less developed a country, the more likely it lacks the required human capital to enforce IPRs. Consequently, from a strictly pragmatic view, the optimal level of IPR enforcement in an LDC is probably below that of a developed country. That problem may be considerably alleviated, however, if a country joins a supranational organization such as the EU. It may then benefit from superior IP enforcement granted by an EU-wide agency; this allows it to access the superior legal infrastructure and expertise level of more advanced countries. It is also likely that substantial economies of scale are involved in having an EU-wide IPR law: the cost for applicants to be protected in the whole zone would be much lower and possibilities of conflicts between national laws would be eliminated. To take a crude example, if a patent expires in Italy before it expires in France, the single-market rules implies that one may well export goods that use the invention from Italy to France, in effect eliminating any

effective protection in France. In other words, there are substantial *network externalities* in patent laws, which make an EU-wide policy all the more valuable. Of course, the gains from an EU-wide policy have to be balanced against the costs due to different preferences about IPRs. But the conclusion of the above discussion is that there does not seem to be a compelling reason why preferences should be different, and in particular why poorer countries should have less protection.

Second, the country could envisage a *moratorium* on IP enforcement, to give itself a fresh start by adopting a number of technologies, and then only start to enforce IPRs. This could be beneficial if these technology were of crucial importance for the country to develop, or if having them could generate a number of favorable dynamic effects. For example, a country could start its own software industry by using foreign patents that it would not enforce. That would generate a critical level of know-how in that industry, which would make it viable to compete internationally. Once that objective is reached, the country could enforce IPRs just like the other countries, and its software industry would in fact benefit from it. One can also argue that even if the country is unable or unwilling to have a software industry of its own, software is so critical to productivity growth in many sectors, that the benefits of free-riding on a number of key patents exceed their costs in that particular case; the growth supplement from using software in the country's major industries exceed the growth lost due to lower IPR enforcement.

There are a number of key problems with that approach. The first one is that other countries may well retaliate against such measures. The second is that the policy is likely to be beneficial only if market participants understand that it is a one-off policy. However, a government that follows such a policy signals that it is likely to renege on IPRs again in the future, and indeed whenever convenient, so that other countries and foreign investors will believe that IP enforcement will permanently be low in the country. That lack of credibility of a moratorium on IP can be reinforced if an industrial lobby (for example an imitation industry) arises in favor of maintaining a low IP protection regime.

Third, since patents are limited in time, the costs of enforcing IPRs depend on the worldwide rate of technical change. Under rapid technical change, patented goods and processes are much more valuable than those that have fallen in the public domain. When technical change slows down, using "generic" goods whose patent has expired would do just as well as breaking IPRs. Consequently, the lower the worldwide rate of innovation, the greater the value to an individual country of enforcing patents. If individual countries recognize that, then an equilibrium arises where the degree of IP enforcement and the rate of innovation are consistent with each other. Greater enforcement increases the pace of technical change, through the innovators greater incentives to do research; represented by the II locus in the graph below. The II locus summarizes the innovators' optimal behavior. Conversely, however, greater technical change reduces enforcement, through the governments' optimal enforcement policies. That is represented by the EE locus, which summarizes the individual governments' enforcement behavior.



The graph may be useful to think about a number of issues: an increase in the profitability of R and D in the North – due, for example, to an increase in the supply of highly educated workers – shifts II upward triggering a spurt in technical change but also reduced enforcement. A reduction in enforcement costs, say due to better international

cooperation, perhaps in the context of supranational institutions like the WTO and the EC, shifts EE up, thus generating greater enforcement and more innovation. An increase in patent length increases the individual countries' incentives to free-ride, holding the rate of innovation constant. That is because generic goods are now less valuable relative to patented goods, as they are an older technology. As a result the EE curve shifts down. However, at the same time, longer patents make innovation more valuable, shifting II up. Enforcement unambiguously falls, but innovation may either be larger or smaller.

On industrial policy and IP enforcement, with a special focus on Open Source Software

A fairly different line of discussion concerns a country's ability to develop its own high tech industry, and how its IP strategy interferes with that development. This discussion has been especially vivid in the context of the debate on Open Source Software (OSS), where a number of OSS advocates have argued that OSS could be a good strategy for a developing or middle-income country to foster its own software industry. That would in turn generate incentives for bright individuals to remain at home, which would eventually enhance entrepreneurship in high value added sectors, thus contributing positively to development, and perhaps, to the extent that these sectors are associated with "good jobs at good wages", reducing income inequality.

That kind of argument rests on a number of hypotheses, most of which are quite debatable.

To begin with, there is no presumption that it is necessarily desirable for a country to have its own software industry, or for that matter its own "high-tech" industry. If markets work well, such an industry will develop, if needed, without government intervention. If it does not, it suggests that the country's pattern of comparative advantage does not make it competitive in that industry. Government intervention geared at generating a local high-tech industry might be successful, but it would actually reduce welfare.

So the question is more interesting if markets do not work well. One way that it may be so is if entrepreneurs and investors fail to take into account the dynamic externalities

generated by particular activities. For example, as a by-product of high-tech activity, a number of innovations may be made, in a process of learning by doing. These innovations in turn would increase the country's competitiveness and growth potential. That argument is quite close to the nascent industry argument; if one first has to produce in order to learn the most efficient way of producing, and if firms are short-sighted and do not take that learning process into account, then nascent industries have to be encouraged and/or protected even though they may not be competitive initially. In that view, an industry's productivity in a given country depends on the past *cumulative* output of that industry. By subsidizing an industry that is not competitive, the government boosts its output, raising its future productivity, which may make it competitive later. Below, we shall refer to these learning mechanisms as *dynamic learning externalities,* borrowing from the economics literature. The word *externality* refers to the idea that private decision makers fail to fully take these effects into account.

Another important example, stressed long ago by Bulow and Summers (1986), is that of labor market imperfections. If jobs in certain industries pay more than a competitive wage, which may be true for a number of reasons (incentives, ability of workers to grab specific capital, etc), then the market will undersupply such jobs. Industrial policy of various sorts may then be welfare enhancing if it favors the industries that pay high wages. That concept may recoup that of high-tech industries, although not necessarily.
Therefore, under market imperfections, one may find good theoretical arguments for industrial policy.

It does not follow, though, that such policies are justified.
First, identifying the proper nascent industries for which protection is valuable is a challenging task.
Second, the attempt to make an uncompetitive industry competitive by subsidizing it in the hope that it will learn faster is undermined by other countries' similar attempts. If my competitors are more productive, and implement the same subsidies as I do, they will learn at the same pace as me, and I will never be more productive than them. Once again, we have a coordination problem: if all countries simultaneously support the most

dynamic sectors, the attempts to gain an edge in those sectors are defeated. The worldwide supply of the corresponding goods is excessive relative to its optimum, although the outcome is not necessarily worse than under world-wide laissez-faire, as there is some value to subsidizing the sector because of the learning externality.

Third, there is a terms-of-trade effect: if a country becomes more productive, the relative price of its exports fall, which makes it less valuable to invest in industrial policy to boost productivity. One can think of industries where productivity growth is low, that can yet be quite valuable because their relative price appreciates through time. For example, France seems to have a comparative advantage in industries intensive in medium-skilled labor, such as tourism, high fashion, or wine; the scope for productivity improvements in such industries is much lower than in the computer industry. However, their relative price has gone up while that of computers has gone down, so it is not clear that one would have preferred France to specialize in computers. Indeed, the French subsidized computer national champion Bull has never emerged from making losses, and is a constant drag on the taxpayer's resources.

Fourth, it is well known that in practice, subsidies in the real world are better explained by the power of lobbies (as in the case of agriculture) than by any intention by the policymaker to correct for market imperfections.

Favoring high-tech industries may also be undesirable from the point of view of income distribution. A large empirical literature has suggested that new information technologies are intensive in human capital but not in unskilled labor, so that they tend to raise the relative demand for skilled labor, which has contributed to the rise in earnings inequality in the United States over the last three decades[4]. In contrast, as demonstrated in a recent paper by Beaudry and Green (2003), Germany has not focused so much on new information technologies, instead remaining specialized in older, capital intensive industries that are less conducive to inequality. The cost of the policy is that Germany (and the rest of Europe) has not benefited from the burst in economic growth that the US

[4] Similarly, the Indian software industry, which is briefly discussed below, has been claimed to increase inequality. Nevertheless, one should be more cautious at complaining about inegalitarian effects in an LDC. To the extent that the development process involves a "modern sector" gradually taking over a "traditional sector", rising inequality at the start of that process is inevitable and not to be worried about.

experienced in the late nineties. But the other side is that Germany has escaped the worrying increase in inequality and stagnation of real wages for many workers that the US has known.

Where does that leave us? At this point, it is not clear at all that a government should actively intervene to promote its "high-tech" industries. And an LDC should have even less interest in doing so than a developed country. The knowledge base is lacking and highly skilled workers are in short supply. Specializing in labor-intensive goods and selling them to rich countries seems a much better strategy: the gains from trade are quite large and clearly documented, in contrast to the uncertain gains from hazardous industrial policies. From an inequality perspective, the skill-biased aspect of information technologies are bad news for an LDC, especially given that inequality is more likely to lead to violence and redistributive conflicts in these countries. It is well known that such conflicts have adverse effects on the country's growth performance.

Nevertheless, there are some specific high-tech industries for which the skill-bias argument should be qualified. One of them is software. It is well known that in India, in the late 1990s, a software industry developed, which accounts for a sizable fraction of both exports and GDP growth (See Arora and Athreye (2001)). The Indian example suggests that there are some high-tech industries in which an LDC can specialize, which runs counter to the presumption that it is inefficient for it to do so given the scarcity of the required factors of production. Indeed, while India has a critical mass of highly skilled workers, relative to its population these workers are still a very scarce factor. In 1995, the stock of scientists and engineers in India was 140,000, i.e. roughly the same figure as in France and the UK, countries 20 times less populated. So why is it that so many Indian engineers are working in the textile industry [don't you mean software?], rather than supplying their human capital to labor-intensive industries, where its productivity could be very large, given the masses of workers employed in these industries? A likely explanation is that the effect of the relative scarcity of human capital is offset by another factor, namely that it is much easier to catch up with the North's technological level in a 'light' industry as software, than in a 'heavy' industry like

textiles. Using the best software and the best computers only requires buying them and installing them. Furthermore, it is an industry which does not require complicated organizations, as people can work in small teams on specific projects[5]. Setting up a textile factory with the same sophisticated machines and organization as the world state-of-the-art may be more complicated. So it may be profitable for India to produce textile using old-fashioned, labor intensive techniques, because raw labor is abundant, and *at the same time* to employ scientists and engineers in the software industry, where they can quickly converge to the world productivity level. The argument is reinforced if one observes that the factor which is even scarcer than human capital is physical capital: buildings, machinery, and equipment, which harms India's competitiveness in heavy industry and capital-intensive technologies, but not so much in sectors such as software. Finally, in an LDC, property rights on physical goods often are less well enforced than in developed countries, which reduces the incentive to invest in structures and machinery because of the fear of hold-up by governments or organized crime. That problem is much lighter for software, given its intangible nature.

To summarize: the rapidly falling cost of hardware and the infinite portability of software, as well as the associated modularity of work organization, makes it possible for a country poorly endowed in human capital to develop such an industry. Its potential to rapidly reach the world state-of-the-art productivity level may offset its handicap in factor endowment.

The Indian software industry has developed in the absence of any explicit government intervention to create it. Nor has the government designed intellectual property rights with the objective of promoting the software industry. But it suggests that having a high tech industry is not out of reach for an LDC, at least for some specific industries. Inevitably, this brings the question: should the government support these industries, and how? In the context of the IP regime, how does it affect the viability of the industry?

[5] Arora and Athreye (2001) report that the median size of the most important export project for firms in the Indian software industry is 150 man-months.

I have argued above that even if the industry generates dynamic learning externalities, one should be quite cautious about encouraging it. Nevertheless one has to make a decision about which intellectual property regime to apply, and that decision has an impact on the dynamics of the software industry.

Should an LDC promote open-source software, as has been suggested? A straightforward pro argument is that it would not have to pay for the software it uses, which could boost its own software industry. Another straightforward con argument is that if its firms produce OSS software, it is not clear how they could make money and thus survive. A standard answer is: by selling services that are complementary to the software. Surely, that also applies to the other suppliers of the OSS software, so it is not clear that the LDC would provide a cheap alternative. For example, the city of Munich has implemented an OSS strategy for its services, which has cost it more than the cheapest proprietary software alternative. In equilibrium, we expect only two types of OSS software to survive: that produced by academics, and that produced by firms who make enough money by selling complementary services. The former can be treated the same way as "general knowledge": it is fine to use it, but the economy does not generate terribly high incentives to produce it and improve it. The latter is likely to be, on balance, as expensive as proprietary software, as firms have to recoup their labor costs, although subtle effects could arise due relative costs differences between the inputs required to produce proprietary software and those required to produce the services that are complementary to OSS.

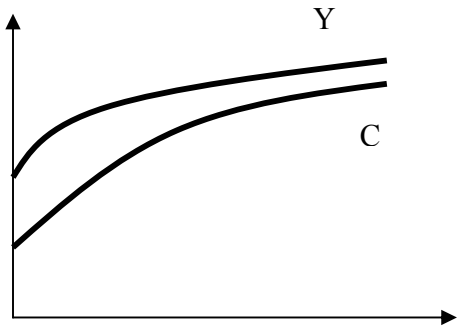
More fundamentally, what makes Open Source a dubious development strategy for an LDC is that even ignoring profitability problems, innovations that are the by-product of the software industry's activity can be used freely by other countries. Consider a nascent software industry in an LDC. Assume that to survive, that industry must become more productive relative to foreign competitors. Assume that productivity can be achieved by moving along a learning curve, as engineers constantly improve their software and introduce new programs. There is some evidence that such a process is going on in India. Arora and Athreye (2001) report that "Indian firms are increasing their productivity by

improving their software development processes, by moving up the value chain, and developing proprietary development tools". If these improvements and innovations are Open Source, then they can be adopted freely by other countries. So the other countries' industries will become more productive as well. That will slow down the process of catching up, and possibly jeopardize the viability of the industry in the long-run.

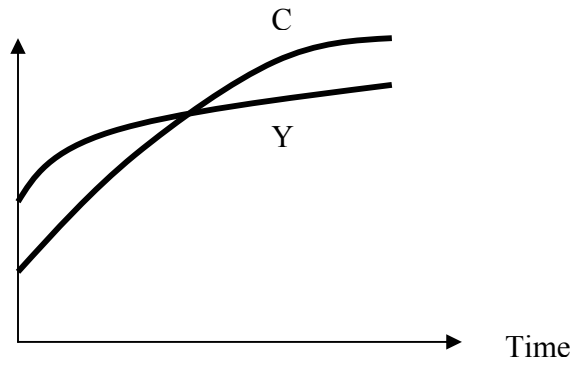
The argument may have some relevance, as one may argue that the Indian software industry, for example, may eventually be in trouble. As labor costs rise and other industries gradually catch up with world state-of-the-art technology, India's comparative advantage in producing software will go down. The effect of scarce human capital will become larger than the effect of technological catch-up, because other industries will have caught up—their productivity gains will allow them to outbid the software industry for its scientists and engineers, and as the software industry's productivity level is already at the world frontier, it has no scope for overbidding. In other words, as the country develops and becomes less backwards technologically (but also in terms of rule of law and other public infrastructure), the software industry for which these shortcomings are less important eventually loses its edge, and the comparative advantage logic which dictates that India should specialize in goods intensive in unskilled labor rather than skilled labor eventually prevails. That process may already be taking place: wages in the Indian software industry have been growing by more than 20% a year. It need not be inevitable: it may be offset by an increase in the stock of human capital. But the bottom line is that, given these conflicting effects, IP policy can make a difference as to whether an LDC's software industry will survive or not.

This discussion is illustrated by the following pictures: the Y curve describes how the productivity of India's software industry evolves over time. It rises because of the learning process. The C curve describes the minimum productivity level that the Indian software industry must have to be competitive, i.e. for its unit cost not to exceed the world price of software. It goes up with time as the world price of software goes down. As drawn, it goes up faster than actual productivity in the Indian software industry, reflecting the above argument that technological catch-up in other sectors will drive up

Indian labor costs relative to its productivity in software. Nevertheless, it is drawn in such a way that the Indian software industry remains viable forever.



Suppose now that the Indian government imposes a regulation forcing the Indian industry to be open-source. The rest of the world will then be able to freely use its innovation in software. That is good news for the world at large: it raises global productivity growth in software, allowing the world price of software to fall more rapidly. But it is bad news for India: as the world price of software falls more rapidly, the C curve rises more quickly, which potentially leads to the destruction of the Indian software industry:



Thus, despite our skepticism that dynamic learning externalities justify an active industrial policy favoring nascent high-tech sectors, these externalities suggest that it can be critical to appropriately grant intellectual property rights to the innovations they generate.

Conclusion

At face value, there are reasonably strong arguments for an LDC to by-pass intellectual property protection: lack of a domestic research sector, cheaper products, the U.S. historical experience, etc. This paper has made the case that in practice, these arguments may not be so strong: free-riding may deprive LDCs of the innovations they specifically need, deter foreign direct investment and exports in IP-sensitive sectors, and eventually harm the growth process. A cooperative approach, by which LDCs agree to enforce intellectual property at a specified level, in exchange for reductions in trade barriers in the North, seems a better strategy for global development and a fair sharing of the benefits of globalization.

References

Acemoglu, D. and Linn, (2004) “Market size and innovation: Theory and evidence from the pharmaceutical industry”, MIT working paper.

Arora, A. and Athreye (2001), “The software industry and India’s economic development”, WIDER DP # 2001/20

Beaudry, Paul and David Green, "Wages and employment in the US and Germany: What explains the difference ?", *American Economic Review* v93, n3 (June 2003): 573-602

Bulow, J. and Summers, L., “A Theory of Dual Labor Markets with Application to Industrial Policy, and Keynesian Unemployment,” *Journal of Labor economics*, 1986, 376-414.

DIWAN, I. AND D. RODRIK, 1991, "*Patents, appropriate technology, and North-South trade*", Journal of International Economics, Vol. 30, pp. 27-47.

Goh, A. and J. Olivier (2002), “ Free Trade and Protection of Intellectual Property Rights: Can We Have One Without the Other?”, mimeo, HEC.

Gould, D. and W. Gruben (1996), “The role of intellectual property rights in economic growth”, *Journal of Development Economics,* 48, 323-350

Grossman, G. and E. Helpman (1992), *Innovation and growth in the global economy*. MIT Press.

Grossman, Gene M. and Edwin Lai, (2001), “International Protection of Intellectual Property,” Princeton University, manuscript.

Lee, J-Y, and E. Mansfield (1996), "Intellectual Property rights protection and US foreign direct investment", *Review of Economics and Statistics,* 78, 181-186

Mansfield, Edwin. (1995) "Intellectual property protection, foreign direct investment and technology transfer," IFC Discussion Paper No. 27.

McCalman, P. (2000), "Reaping what you sow: An empirical analysis of international patent harmonization", mimeo, University of California-Santa Cruz

Saint-Paul, G. (2004), "Welfare effects of Intellectual Property in a Norh-South model of endogenous growth with comparative advantage", mimeo, Toulouse university, forthcoming.

Smarczynska, B. (2002), "The Composition of Foreign Direct Investment and Protection of Intellectual Property Rights: Evidence from Transition Economies", World Bank Working Paper.

Smith, P. (1999), "Are weak patent rights a barrier to US exports?", *Journal of International Economics*, 48, 151-177

Yang, G. and K. Maskus (1998), "Intellectual Property rights and licensing: an econometric investigation", mimeo