Do European computer–related patents increase welfare?

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Abstract

When the home country introduces a patent law after the winner of the patent race is known the country's welfare may rise only if the domestic firm wins. If the home country decides before the patent race ends, the welfare may be increased when the probability that the domestic firm wins is sufficiently large. In both cases, the conditions on the product market determine the welfare gain and one may at least doubt whether those conditions are satisfied.
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1 Motivation

While the first reading of the 'Proposal for a Directive of the European Parliament and of the Council on the patentability of computer–implemented inventions' (European Commission, 2002) took place, it has frequently been argued that European firms would suffer a competitive disadvantage as compared to their US rivals when the Directive is not implemented. The paper aims at shedding some light into the matter. Given that software patents can be obtained in the US since the early 80s, the paper examines whether or not domestic firms suffer a competitive disadvantage, under which circumstances they support a patent law and whether introducing the law would increase the home country's welfare.

2 The framework

There are two countries j, $j = A, B$. Whereas the foreign country (A) has introduced a patent law, the domestic country (B) has to decide on the issue. In each country there is one firm i, $i = 1, 2$. Firm 1 (2) is owned by individuals living in A (B). Both firms engage in a patent race. It is assumed that both firms develop the product, e.g. a new software package or a new computer chip but they infringe on each other. Hence, only the winner of the race obtains a patent in all countries offering protection. The latter is granted the exclusive rights for T years. In a monopolised market, the loser can sell his product only after the patent expired. However, if the home country does not introduce the patent law the loser can offer his product at the domestic market.

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Let π_{ij}^m denote firm i's monopoly flow profit in market j. Likewise, let π_{iB}^d stand for firm i's profit in the domestic market when the firms share the market, i.e. B does not have a patent law. It is reasonable to assume $\pi_{ij}^m > \pi_{iB}^d$.

The consumers' surplus shall be a function $S(n)$, where $n = 1,2$ is the number of firms in the market. Without a threat of entry, a monopolist charges a higher price or offers a lower quantity as compared to a duopolist so that $S(2) \geq S(1)$. The instantaneous welfare of a country comprises the consumers' and the firms' surplus consisting in the domestic firms' profits accrued from both markets.

Given this setup, the following cases can be distinguished:

(I) only country A has patent protection and firm 1 wins the race,
(II) both countries have patent protection and firm 1 wins,
(III) only country A has patent protection and firm 2 wins, and
(IV) both countries have patent protection and firm 2 wins.

Consider case I. Here, firm 1 is the monopoly in market A for T years and both firms sell their products in the domestic markets. The discounted present value of the flow profits Π_i as well as the discounted present value of the home country's welfare W are derived with[1]

$$\Pi_1^I = \frac{1}{r}[\pi_{1A}^m - \beta(\pi_{1A}^m - \pi_{1A}^d) + \pi_{1B}^d], \quad \Pi_2^I = \frac{1}{r}[\beta\pi_{2A}^d + \pi_{2B}^d],$$
$$W^I = \frac{1}{r}S(2) + \Pi_2^I. \tag{1}$$

where $\beta = e^{-rT}$ and the superscript marks the case.

In case II, firm 1 holds the monopoly position in both countries for T years. The domestic firm can only offer its product after the patent has expired. The present value of the flow profits and the welfare are given by

$$\Pi_1^{II} = \frac{1}{r}[\pi_{1A}^m + \pi_{1B}^m - \beta(\pi_{1A}^m + \pi_{1B}^m - \pi_{1A}^d - \pi_{1B}^d)], \quad \Pi_2^{II} = \frac{1}{r}\beta[\pi_{2A}^d + \pi_{2B}^d],$$
$$W^{II} = \frac{1}{r}[S(1) + \beta\{S(2) - S(1)\}] + \Pi_2^{II}. \tag{2}$$

Case III describes the situation where firm 2 monopolises the foreign market for T years, but the foreign firm 1 offers its product in the domestic market. The present values of the profits and the social welfare are determined with

$$\Pi_1^{III} = \frac{1}{r}[\beta\pi_{1A}^d + \pi_{1B}^d], \quad \Pi_2^{III} = \frac{1}{r}[\pi_{2A}^m + \pi_{2B}^d - \beta(\pi_{2A}^m - \pi_{2A}^d)],$$
$$W^{III} = \frac{1}{r}S(2) + \Pi_2^{III}. \tag{3}$$

Finally, in case IV, firm 2 becomes the monopoly in A and B. Then, the present value of profits and welfare ensue with

$$\Pi_1^{IV} = \frac{1}{r}\beta[\pi_{1A}^d + \pi_{1B}^d], \quad \Pi_2^{IV} = \frac{1}{r}[\pi_{2A}^m + \pi_{2B}^m - \beta(\pi_{2A}^m + \pi_{2B}^m - \pi_{2A}^d - \pi_{2B}^d)],$$
$$W^{IV} = \frac{1}{r}[S(1) + \beta\{S(2) - S(1)\}] + \Pi_2^{IV}. \tag{4}$$

[1] Given the foreign firm wins the patent race, its discounted present value is determined by $\Pi_1^I = \int_t^T e^{-rt}\pi_{1A}^m dt + \int_T^\infty e^{-rt}\pi_{1A}^d dt + \int_0^\infty e^{-rt}\pi_{1B}^m dt$. Solving the integrals yields the form given in equation (1). In a similar way, the other equations are obtained.

3 Welfare analysis

Whether firms and the home country benefit from the introduction of a patent law can be determined by comparing cases I and II on the one hand on the other hand cases III and IV. Given the foreign firm 1 succeeds in innovating first, we find

$$\Pi_1^{II} - \Pi_1^{I} = \frac{1-\beta}{r}[\pi_{1B}^{m} - \pi_{1B}^{d}] > 0, \quad \Pi_2^{II} - \Pi_2^{I} = -\frac{1-\beta}{r}\pi_{2B}^{d} < 0,$$
$$W^{II} - W^{I} = -\frac{1-\beta}{r}[S(2) - S(1) + \pi_{2B}^{d}] < 0. \tag{5}$$

The equations present the difference in the present value of profits (welfare) with and without discovery protection. Whereas the foreign firm gains from a patent law, the domestic firm and the home country as a whole lose. If the home country does not grant intellectual property rights, the domestic market becomes a shelter for the loser, i.e. the domestic firm, during the T years. After the patent has expired both firms are on equal footing again. Then, by passing the patent law, the home country destroys the domestic firm's refuge. Accordingly, the domestic firm finds a patent disadvantageous. Over and above the reduction in the firms' surplus, patent protection monopolises the product market so that the consumers' surplus shrinks as well. Consequently, a patent law unambiguously reduces welfare. In contrast, the foreign firm earns the higher monopoly profit as compared to the duopoly one if the loser's shelter is destroyed by the change in law. In addition, it can be argued that introducing the patent law entails a competitive disadvantage vis à vis for the domestic firm.

In case the domestic firm 2 wins the patent race, the corresponding differences read

$$\Pi_1^{IV} - \Pi_1^{III} = -\frac{1-\beta}{r}\pi_{1B}^{d} < 0, \quad \Pi_2^{IV} - \Pi_2^{III} = \frac{1-\beta}{r}[\pi_{2B}^{m} - \pi_{2B}^{d}] > 0,$$
$$W^{IV} - W^{III} = \frac{1-\beta}{r}[\pi_{2B}^{m} - \pi_{2B}^{d} - \{S(2) - S(1)\}]. \tag{6}$$

Now, the home country grants the foreign firm a shelter when the patent law is not passed. By analogous reasons to the above stated, the foreign firm loses and suffers a competitive disadvantage vis à vis the domestic firm if the home country does not protect discoveries. However, the reverse conclusion that the domestic firm gains a competitive advantage over the foreign firm is not entirely correct. By winning the patent race the domestic firm has already a competitive advantage over the foreign rival and this advantage is merely increased by the introduction of the patent law.

However, the last equation reveals that the home country's welfare is not necessarily increasing after the legal system has been changed. The firms' surplus is rising, but the consumers' surplus is shrinking due to the introduction of the patent law. Hence, only if the increase in the firms' surplus outweighs the decrease in the consumers' surplus, i.e. if $\pi_{2B}^{m} - \pi_{2B}^{d} > S(2) - S(1)$, the home country will pass the patent law.

The preceding analysis postulated that the home country can decide on the patent law after the winner of the race has been revealed. More often than not, some patent races have been decided, some races begun but are not yet finished, whereas the majority of races have not even started when the home country takes its choice. To assess the ex–ante desirability of a patent law, let the home country assign a certain probability p to the event that the domestic firm 2 wins the race so that the foreign firm's probability of innovating

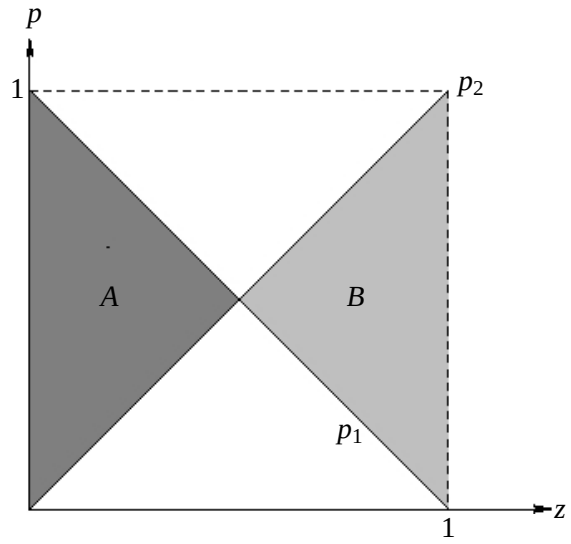

Figure 1: well

first is $1-p$. Then, the ex–ante changes in the present value of the profits $\Delta\Pi_i$ and the welfare ΔW are given by[2]

$$\Delta\Pi_1 = \frac{1-\beta}{r}[(1-p)\pi_{1B}^m - \pi_{1B}^d], \quad \Delta\Pi_2 = \frac{1-\beta}{r}[p\pi_{2B}^m - \pi_{2B}^d],$$
$$\Delta W = \frac{1-\beta}{r}[p\pi_{2B}^m - \pi_{2B}^d - \{S(2)-S(1)\}]. \tag{7}$$

These changes in the present values measure the ex–ante desirability of a patent protection in country B for the firms and the home country. Suppose that the foreign and the domestic firms' profits are identical, i.e. $\pi_B^m = \pi_{1B}^m = \pi_{2B}^m$ and $\pi_B^d = \pi_{1B}^d = \pi_{2B}^d$. Let z denote the relative duopoly profit, i.e. $z \equiv \pi_B^d/\pi_B^m$, $z \in [0,1]$. In addition, let $p_1(z)$, $p_2(z)$ and $p_s(z)$ be defined as follows: $p_1(z) \equiv 1-z$, $p_2(z) \equiv z$ and $p_s(z) \equiv z + [S(2)-S(1)]/\pi_B^m$. For every relative duopoly profit z, the function p_i determines the probability p for which the firms and the home country are ex–ante indifferent between changing and not changing the legal system. The functions p_i are drawn in figure 1.

According to (7), the domestic firm ex–ante supports the patent law if the probability of winning the race is sufficiently large, i.e. $p \geq p_2$. The foreign firm takes the opposite position, i.e. it prefers the patent law as long as $p \leq p_1$. Area A marks situations in which the foreign and the domestic firm benefit from a patent law, whereas in situations illustrated by area B, neither firm gains from patent protection. The reasons for the results can easily be revealed by considering the extreme cases of $z = 0$ and $z = 1$. In the former one, the relative duopoly profit is zero, as e.g. in a price setting duopoly producing a homogeneous good. If a firm loses a patent race it receives zero profit even though the home country does not protect discoveries. However, when the home country changes the legal system, the expected profits are strictly positive as long as the probability of winning the patent race is strictly positive. The latter applies to the foreign as well as the domestic firm given $p \in (0,1)$.

[2] Let Π_i^p and Π_i^n denote the ex–ante present value in a situation with and without a patent law. Then, the functions are defined as $\Pi_i^p = (1-p)\Pi_i^{II} + p\Pi_i^{IV}$ and $\Pi_i^n = (1-p)\Pi_i^I + p\Pi_i^{III}$. Then, $\Delta\Pi_i$ is given by $\Delta\Pi_i = \Pi_i^p - \Pi_i^n$. The function ΔW is similarly derived.

On the other hand, if $z = 1$, the duopoly and the monopoly profit are identical. This situation may arise if products are independent, but both need a component developed by the winner of the race. Given the home country does not introduce the patent law, both firms realise the monopoly profit with certainty. In contrast, if discoveries are protected, the expected profit for both firms is lower as long as they do not win with certainty. Hence, neither firm wishes a patent law.

Finally, the introduction of patent protection will increase the home country's welfare if the probability that the domestic firm wins the race is sufficiently large, i.e. if $p \geq p_s (> p_2)$. Yet, p_s may exceed one so that the home country will never benefit from the patent law. From the definition of p_s, it can be concluded that this situation becomes the more likely the larger the relative duopoly profit z is. However, depending on the precise relationship between the increase in the consumers' surplus and the monopoly profit, the home country may decide against the patent law even though $z = 0$. This situation appears in a Bertrand oligopoly of a homogeneous product. Then, $S(2) - S(1)$ always exceed the monopoly profit π_B^m.

4 Conclusion

If the home country decides on the introduction of patent protection after the winner of the race has be revealed the desirability of protection depends on the losers origin. While changing the legal system is advantageous neither for the home country nor for the domestic firm when the latter loses the race, positions may differ if the domestic firm wins. Then, the domestic firm always supports the law, whereas the home country only passes the law if the difference between the monopoly and the duopoly profit exceeds the loss in the consumers' surplus. Depending on the nature of product market competition, this may never be the case. Concerning the competitive disadvantage argument, it has been demonstrated that establishing property rights in the home country (1) increases the competitive disadvantage for the domestic firm in case it loses the race and (2) increases the competitive advantage in case it wins the race.

Given the home country has to decide on patent protection before the winner of the patent race is revealed, firms gain by the law if the probability of winning itself is sufficiently large. The home country's welfare tends as well to increase if the probability of the domestic firm winning the race is sufficiently high. Again, depending on the precise conditions on the product market the home country may never find it worthwhile passing the law.

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