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International Doctorate in Economic Analysis

Innovation, Imitation and Trade Agreements:

Firms Decisions in International Environments

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“The idea of a better-ordered world is one in which medical discoveries will be free of patents and there will be no profiteering from live and death.”

Indira Gandhi. World Health Assembly, 1982

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I. Introduction

This dissertation consists of three chapters that can be read independently. Nevertheless, there is a common factor that connects these chapters, namely the access of economic agents (firms, countries and consumers) to innovative products.

The first chapter is an empirical paper that deals with the knowledge sources that firms use for their innovative activities. In particular, it investigates the factors that influence firms to adopt an inward looking approach to innovation, in which they rely on knowledge sources within the firm, versus an external looking approach in which they rely on sources outside the firm. The analysis is based on responses from up to 527 surveyed firms on the importance of internal and external knowledge sources to the development of its most economically important innovation. The factors include appropriation conditions, technology characteristics, the firm's internal innovative capabilities, and firm boundary characteristics such as whether or not it is part of a larger firm and its size. 53.8% of firms find internal knowledge sources of greatest importance, 15.1% prefer external sources, and 31.1% found them of equal importance. Two different regression models explored the effect of several factors on the relative importance of these three categories of knowledge sources. Firms active in the high technology telecom equipment sector are more likely than the reference category of the food sector to find internal sources of greater value than external sources. Firm size and R&D intensity have no effect on preferences, while independent firms are less likely to prefer internal knowledge sources.

The second chapter investigates the welfare implications for developing countries of meeting the requirements established by the Trade Related aspects of Intellectual Property rights (TRIPs) agreement. Within this context, we restrict our attention to the pharmaceutical industry. The intellectual property component of the Uruguay round GATT treaty requires that developing countries grant intellectual property protection to pharmaceutical innovations as a condition of membership to the WTO. The local supply of pharmaceutical drugs in these countries depends on both the decision to meet the TRIPs requirements and the level of development of the local industry. The external supply, by means of multinational firms, will depend on the threat of imitation by these economies. This threat of imitation, in turn, is a combination of the strength of imitative abilities and patent rights. As suggested by the case of India, trade provisions may be used by countries to countervail their threat of imitation in order to ensure the supply of drugs by foreign multinationals. In a static framework, we consider two countries that differ in their strength of their IPRs, namely an imitating country and a non-imitating country. Both countries decide about their trade policy, which affects the demand supplied by a multinational firm producing a good of quality higher than that of the local industry. We show that trade policy is used to offset the multinational's monopoly power, which is higher in the non-imitating country. In addition, it is shown that although the multinational prefers to serve a country with low threat of imitation, this does not necessarily guarantee a higher welfare level as compared to a country with a high threat of imitation.

In the third chapter we investigate the implications of permitting parallel imports of pharmaceuticals produced by a monopoly, from one country to another. We use a model where countries differ in the patients' level of co-payment for buying pharmaceuticals, and patients differ in the utility obtained from the consumption of pharmaceutical drugs. We show that there is room for parallel imports only if the differences in terms of co-payment and distribution of the population between the two countries are large enough. The presence of a parallel importer makes the prices charged by the monopoly converge. As a consequence, consumers in the exporting country are worse off, while the utility of consumers in the importing country increases. Moreover, public expenses of pharmaceuticals decrease in both countries. The effects on the total welfare are discussed for two particular cases: On the one hand, when the countries differ in their health system only, parallel imports are shown to be welfare decreasing; on the other hand, when the countries differ in the health needs of their patients only, parallel imports are shown to enhance the total welfare.

II. The Relative Value of Internal and External Information Sources to Innovation

1. Introduction

Innovation researchers over the past decade have increasingly stressed the importance of external knowledge sources to the ability of firms to innovate. These include user-producer networks (Lundvall, 1992), collaborative research with other firms or universities (Hagedoorn et al, 2000) links with universities (Mansfield, 1991; Pavitt, 1991), and contracted-out research (Howells, 1999). Several researchers have argued that innovative activities will increasingly depend on external knowledge sources (Gibbons, 1994; Georghiou, 1998). Antonelli (1999) suggests that "the systematic use of technological cooperation" is becoming "the dominant form" of producing new knowledge. One of the main justifications for the increasing importance of cooperation is the belief that modern technology is growing in complexity and consequently beyond the abilities of a single firm (Kash and Rycroft, 1994). Under these conditions, firms must collaborate in order to develop competitive new products and processes.

The evidence in support of the importance of external sources is drawn both from case studies and from surveys, such as the first and second Community Innovation Surveys in Europe. Surveys consistently show that firms attach a high importance to information obtained from their customers and suppliers, from attending trade fairs and conferences, and from reading journals[1]. The survey results also point to two distinct types of external knowledge sources that firms find of value. The first group consists of external sources based on personal contacts, such as customers, suppliers, or cooperative research agreements. These types of external knowledge sources require collaboration or cooperation between innovating organisations. The second group includes sources that can be accessed relatively inexpensively and which do not require personal contacts, such as reading journals, searching patent databases, or attending trade fairs.

However, existing empirical research on the role of external information sources has been of little value in addressing the relative importance of external and internal knowledge sources. The reason is that most innovation surveys suffer from a major drawback that reduces their value for investigating the role of external knowledge sources – there are very few questions on internal sources of knowledge, such as the firm's production engineering department, head office, related plants, sales and marketing staff, or R&D unit. For instance, the second CIS questionnaire asks about ten external information sources and only two sources within the firm or its group. The result is that most of the respondent's answers concern external sources, which, not surprisingly, influences the types of analyses that are conducted and the topic of papers that are made available. The structure of innovation questionnaires results in a consistent bias in favour of external knowledge sources for innovation[2].

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[1] See the collected research reports for the first CIS in Arundel and Garrelfs (1997) and De Bresson (1998), Baldwin and Da Pont (1996) on Canada, Francois and Favre (1998) for the second CIS for France and Levin *et al* (1987) for the Yale survey in the United States.

[2] An exception is a series of innovation surveys by Statistics Canada on biotechnology and on the use of Advanced Manufacturing Technologies, which ask an equal number of questions about internal and external

An alternative method to assess the importance to firms of external knowledge sources is to use data on the location of R&D expenditures. These can include both expenditures to learn about research conducted outside the firm and contracted-out research. A 1997 survey of American R&D laboratories reports that firms spend less than 5% of their R&D learning about university research (Adams, 2001). Howells (1999) reports that contract R&D in the UK by business was equal to 10% of total business expenditures on R&D. These are comparatively low percentages of R&D spending, which contrasts with the subjective importance given to external knowledge sources in survey research. The explanation is probably due to the fact that many sources of valuable knowledge are neither mediated by market relationships, such as contract R&D, nor expensive to acquire. For example, a valuable idea for an innovation can be obtained at almost no cost from a publication (Senker, 1995) or at a minor cost from attending a trade fair. Faulkner et al (1995) report that the TRA|CE study in the UK found that half of the contribution of public research organisations to innovation was due to firms reading the literature.

Several factors will place an upper limit on the ability of firms to access external knowledge through cooperation or collaboration. As Langlois and Foss (1999) note, the sticky nature of knowledge, the need to coordinate different production activities and the fact that the production of knowledge requires many different people, compels firms to maintain a minimal level of competences in house. As firms develop internal innovative capabilities, they also increase their 'absorptive capacity' for external knowledge sources (Cohen and Levinthal, 1989). Several studies, using either theoretical or empirical approaches, find that the importance of external knowledge sources to innovation may be mediated by the internal capabilities of the firm[3].

These different perspectives on the value of external knowledge sources leads to a question that can be tested empirically – how important to firms are external knowledge sources compared to their own internal capabilities? We are particularly interested in external knowledge sources that require personal contacts. The answer to this question is of relevance to a wide range of policies that are designed to encourage firms to source knowledge externally. These include R&D subsidies, particularly in Europe, that require collaboration between firms or between firms and public research institutes, policies to encourage links between firms and public research institutes, and programmes to improve access to external sources that do not require personal contacts, such as patent databases or scientific publications.

knowledge sources. The former includes production engineering departments, the head office, related plants, sales and marketing staff, etc.

[3] Cassiman et al (2001) characterize the interactions between knowledge flows and the firm's investment decisions, in a model in which firms may affect the impact of knowledge flows from and to the firm throught their technology investments. The complementarity between internal and external knowledge sources is also present in Veugelers and Cassiman (1999) and in Veugelers (1997), who finds a positive effect of cooperation on internal R&D in firms with an staffed R&D department. The acquisition of an absorptive capacity that allows the firm to benefit from knowledge spillovers has been introduced in the context of research joint ventures by Kamien and Zang (2000).

This study uses the results of the KNOW survey of European firms with less than 1000 employees to investigate the relative importance of internal versus external knowledge sources for innovation. The analysis is limited to a set of questions on the firm's most economically important innovation, following a similar technique used by Baldwin and Da Pont (1996). This technique partly address Coombs et als (2001) criticism that research on the role of different knowledge sources on innovation needs to focus on the innovation, rather than on the firm. We cannot entirely focus on the innovation, since our data is limited to information on the innovative firm's perspective.

The rest of the paper is organized as follows. The next section explains the methodology. Section 3 is devoted to the descriptive results. Section 4 describes the regression results and some concluding remarks are provided in the last section of the paper.

2. Methodology

The KNOW survey was conducted in the Spring of 2000 in seven EU countries: the UK, Denmark, the Netherlands, France, Germany, Italy, and Greece. The choice of countries to include in the survey depended on the origin of the participants in the KNOW project, funded by the Framework Programme of the European Commission. Although the survey does not cover all EU countries due to funding limitations, the four largest EU economies were included plus two of the smaller, developed economies and one of the less developed economies.

The survey was limited to five sectors: food and beverages (NACE 15), chemicals excluding pharmaceutical (NACE 24 minus NACE 24.2), telecom equipment (NACE 32), telecom services (NACE 64.2), and computer services (NACE 72). These specific sectors were chosen to provide a range of low, medium and high technology manufacturing and to include two innovative service sectors.

In each country, a random sample of firms from two size classes (10 – 249 employees and 250 – 999 employees) within each of the five sectors was drawn from a national business registry. A standard survey protocol based on a telephone CATI technique was used in all countries with the exception of the UK, where a postal survey was used. Table 1 gives the number of firms surveyed, the number of responses, the response rates, and the number of useable responses. The response rates by country vary from 9.6% in the UK to 76.5% in Denmark, with an average of 25.3% if the UK is included and 33.2% if the UK is excluded. The number of useable responses is less than the total number of responses because the analyses exclude non-innovative firms, firms that did not fit the sampling criteria for size and sector, and firms that did not answer the questions on their most economically important innovation[4].

[4] For size, a maximum cut-off of 1,250 employees was used to allow for natural employment growth between the time that the data in the business registries were collected and the survey date.

Table 1. Survey results by country

	Firms Surveyed	Responses	Response rate	Useable responses
UK	1003	96	9.6%	44
Denmark	170	130	76.5%	78
Netherlands	331	151	45.6%	114
France	613	76	12.4%	65
Germany	470	101	21.5%	51
Italy	278	92	33.1%	75
Greece	260	110	42.3%	100
Total	*3017*	*764*	*25.3%*	*527*
Total excluding UK	*2014*	*668*	*33.2%*	

The response rates in Table 1 are based on all surveyed firms, although only 5.6% of the respondent firms did not innovate. If we assume that the target population only includes innovative firms, the estimated response rates increase substantially, since non-innovative firms can then be excluded from the population. For the Netherlands, limiting the target population to innovative firms only in each of the five sampled sectors increases the response rate from 45.6% to an estimated 72.7%[5].

The KNOW survey includes two question groups of relevance to the value of external versus internal knowledge sources. The first question asks the respondent to estimate the percentage of their product and process innovations, introduced within the previous three years, that were developed 1) "mainly in-house", 2) "in collaboration with external partners", and 3) by buying in, which includes "purchase, licensing, or contracting out development work". In-house development is restricted to the site of the firm, division, or subsidiary, while "external partners" includes other divisions of the same firm in a different location. This question provides a background measure of the firm's preference for innovating in-house or through external sources. The option for in-house development can also be interpreted as a measure of the firm's internal capabilities.

The second set of questions focus on the firm's most economically important innovation that it introduced in the previous three years. The key question is: "Overall, how important to the successful completion of this innovation were internal knowledge sources compared to external sources?" Three options were provided: Internal most important, external most important, and both of equal importance. External sources are defined to include sources within other divisions or units of the same firm, while internal sources must be located at the

[5] The percentage of Dutch firms in the five sectors surveyed by KNOW that innovate is available from Eurostat (1999) and is 62.7% after weighting for the distribution of the samples drawn from each sector for the KNOW survey.

same physical site. This should increase the role of external sources compared to a definition based only on sources outside the firm.

Information was also obtained on other characteristics of the firm and its innovation strategies that could influence the relative importance of internal versus external knowledge sources. These include the type of innovation (product/service, process, combined product and process), the ownership status of the firm (division, national subsidiary, or independent), whether or not the innovation had been patented, the receipt of government subsidies to develop the innovation, the number of employees, sector of activity, the firm's R&D status, and the division of R&D expenditures by location (in-house, other divisions or subsidiaries of the same firm, independent organisations). In addition, the Dutch survey obtained ordinal data on the development cost of the most important innovation.

3. Descriptive Results

375 firms in the sample (71.2%) have less than 249 employees, while 152 (28.8%) firms are mid-sized, with between 250 and 1,250 employees. The mid-size firms account for 78.3% of total employment among the sample. Almost all the respondent firms, 96%, perform R&D: 71% on a continuous basis and 25% on an occasional basis.

3.1. Percent of all innovations developed in house

Table 2 gives the average percentage, by sector, of all of each firm's product innovations that were developed in-house, via collaboration, or through buying-in. The majority of each firm's innovations, 70% on average, are developed in-house, with 16% developed through collaboration and 14% through buying-in. There are no significant differences by firm size in how firms innovate and only minor differences by sector, with one exception. Telecom service firms develop significantly fewer product innovations in-house than the average. Fewer process innovations (results not shown) are developed in-house (59%), with most of the difference, compared to product innovations, due to a higher rate of buying-in (23%) and a small increase in collaboration (18%).

These results for all innovations provide a first fix on the relative importance of in-house versus external knowledge sources. Most innovations are developed predominantly through in-house activities. The results also show that almost half of externally acquired product innovations (and more than half of process innovations) are bought in. Collaboration, which by definition requires sourcing knowledge from outside the firm, accounts for a comparatively small share of innovations. However, collaboration is only one form of sourcing external knowledge. Some of the innovations developed mainly in-house could have depended on vital pieces of knowledge from external sources. Furthermore, these results are for all of each firm's innovations, with no adjustment for their economic importance to the firm. For both these reasons, most of our analyses of the role of external knowledge use the series of questions on the most economically important innovation that the firm introduced in the previous three years.

Table 2. Percent of all product innovations (introduced in the previous three years) developed:

	In-house	Collaboration	Buying-in
Food	68%	17%	15%
Chemicals	76%	12%	11%
Telecom equip	67%	17%	16%
Telecom services	50%	26%	25%
Computer services	73%	17%	10%
Total	70%	16%	14%

Rows sum to 100%

3.2. Most economically important innovation

Several characteristics of the firms' most economically important innovation are given in Table 3, plus information on the use of information sources in its development. Product or service innovations predominate, with only 14.1% of small and 22% of mid-size firms introducing a process innovation alone. For the product innovations only, the product innovation accounted for 16.1% of the total sales of all small firms and 15.2% of the total sales of the mid-size firms, indicating hardly any difference by firm size.

Table 3. Characteristics of the most economically important innovation

	Small (< 250 emps)	Mid-size (250 – 1,250)
Type of innovation		
Product/service	54.9%	44.7%
Combined product & process	31%	33.3%
Process	14.1%	22%
	100.0%	100.0%
Sales share from product, service, product/process innovations	16.1%	15.2%
Received a development subsidy	19.8%	18.1%
Patented (by firm or another organisation)	20.7%	37.4%
New scientists/engineers brought in to develop innovation[2]	48.2%	53.3%
External sources contributed to original idea[1]	79.4%	78.5%
External sources contributed to completion[1]	70.1%	77%

1: Excludes sources from other units of the same firm, but includes competitors, suppliers, customers, PRIs, and consultants.
2: Excludes staff from other units of the same firm, but includes new staff from suppliers, customers, PRIs, and consultants…

The most important innovation has been patented for almost twice as many mid-size as small firms. These differences are not entirely due to sectoral effects, since the most important innovation is significantly less likely to be patented by small firms in the chemical and telecom equipment sectors compared to mid-size firms in these two sectors. However, the rates are not significantly different (although favouring mid-size firms) in food and beverages, telecom services, and computer services.

Almost equal percentages of small and mid-size firms received government subsidies to develop the innovation. Slightly more mid-size firms brought in new scientists or engineers to work on the innovation. Over 70% of firms noted that external information sources (excluding other units of the same firm) contributed to both the original idea behind the innovation and to its completion. The external sources listed in the questionnaire include competitors, suppliers, customers, PRIs, and consultants. The use of many of these external sources will depend on direct person-to-person contact and therefore raise the possibility of leaking information, in contrast to the use of sources such as reading the literature or accessing patent databases.

3.3. Use of external knowledge sources

The KNOW survey asked firms about the contribution of external knowledge sources to the development of the idea and the completion of their most important innovation. Table 4 provides the percentage of firms that used each of those sources.

Table 4. Use of external knowledge sources for the development of the most important innovation.

	Food and beverages	Chemicals	Telecom equipment	Telecom services	Computer services	*Total*
Idea						
Competitors	34.1	47.1	31.5	32.6	34.4	36.6
Suppliers	37.3	30.8	34.1	21.7	41.5	34.9
Customers	50.4	50.4	56	52.2	63.4	54.8
Univ./PRIs	12	12.4	9.9	8.7	14.7	12.1
Consultants	16.1	9.9	6.7	15.6	24.6	15.1
Completion						
Competitors	10.6	13.3	6.5	8.7	8.5	9.8
Suppliers	48	37.7	40.7	50	46.9	44.2
Customers	37.3	45.5	34.1	34.8	42	39.7
Univ./PRIs	10.7	20.8	12.1	13.6	11.5	13.8
Consultants	21	16.7	12	23.9	22.3	18.9

Some differences arise in the type of source used for the development of the idea and the completion of the innovation. In the case of the development of the idea, customers is the most cited type of source, with 54.8% of all firms, while in the case of completion 44.2% of firms obtained some contribution from suppliers, followed by customers (39.7%). By sector, the most relevant differences occur in the type of sources used for the completion of the most important innovation. The highest percentage corresponds to suppliers in all sectors except chemicals, in which 45.5% of firms obtained contribution from their customers. It is in the services sectors (telecom and computer services) were consultants most contributed to the completion of the innovation, although this percentage is also high in the food sector (21%).

Table 5 provides information on the most important knowledge source. As one would expect, the same differences noted above by sector arise also when firms are asked to report the type of source whose contribution was the most important. However, for a large percentage of firms none of these external sources was the most important, meaning that for those firms the largest contribution came from their own internal sources. A high percentage of firms in the telecom services sector (35.6%) did not cite any of the external sources as the most important for the development of the idea for their most important innovation. In the case of the completion of this innovation, the highest percentage of firms not citing any of the external sources corresponds to the telecom equipment sector (36.3%). By firm size (results not reported), the percentage of small firms finding customers as their most important external source is significantly higher than that of mid-size firms (40.2 against 29.2). Also, mid-size firms attach more importance to suppliers and consultants than small firms.

Table 5. Most important knowledge source for the development of the most important innovation.

	Food and beverages	**Chemicals**	**Telecom equipment**	**Telecom services**	**Computer services**	*Total*
Idea						
Competitors	9.8	22	9.9	11.1	7.8	12.4
Suppliers	15.4	13	15.4	8.9	20.3	15.5
Customers	36.6	32.5	41.8	28.9	41.4	37.1
Univ./PRIs	3.3	4.9	5.5	2.2	2.3	3.7
Consultants	7.3	5.7	1.1	8.9	5.5	5.5
Other	2.4	4.1	5.5	4.4	7.8	4.9
None of the above	25.2	17.9	20.9	35.6	14.8	21
Total	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*
Completion						
Competitors	1.6	4.1	1.1	-	-	1.6
Suppliers	29.8	22.8	28.6	27.3	28.5	27.3
Customers	26.6	28.5	22	20.5	24.6	25.2
Univ./PRIs	2.4	8.1	2.2	11.4	3.8	4.9
Consultants	9.7	5.7	4.4	15.9	11.5	8.8
Other	3.2	5.7	5.5	2.3	7.7	5.3
None of the above	26.6	25.2	36.3	22.7	23.8	27
Total	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*

3.4. Relative importance of internal versus external knowledge sources

Table 6 provides descriptive results for the effect of four factors on the percentage of firms that found internal, external, or both equally to be their most important knowledge source for developing this innovation. The four factors are appropriation conditions, the type of technology, the firm's research capabilities, and the firm's boundaries.

Appropriation

The two variables for appropriation conditions are whether or not the innovation was patented and if secrecy was the most important appropriation method used by the firm. The results for both, secrecy and whether or not the innovation was patented differ very little from the average.

Technology

There are two variables for differences in the type of technology: whether it is a process innovation alone or contains a product component (this includes combined product/process innovations) and the firm's sector of activity. We would expect external sources to be the most widely used in high technology sectors such as telecom equipment, while internal sources could suffice for low technology sectors such as food and beverages, although external sources could be used in the latter for process innovations. The results for the telecom sector conflict with expectations, with 64% of telecom equipment firms finding internal knowledge sources to be of greatest value, which is significantly more than the average of 53.8%, while the results for the food and beverage sector are close to the average.
The lowest reliance on external sources occurs in the computer services sector, where only 10.6% find external sources to be more important than the alternatives. The cause is due to an above average percentage (40%) of these firms that find both internal and external sources to be of equal value. This could be due to the frequency of customisation in this sector, in which software is developed to meet the customer's requirements. In support of this possibility, significantly more computer service firms than all other firms combined state that customers contributed to the idea (63.4% versus 51.9%) of their most important innovation.

There is very little difference between product and process innovators in the preference for internal knowledge sources, but a higher percentage of process innovators prefer external sources (20.7% versus 14.3%), probably reflecting the role of equipment suppliers, while more product innovators find both sources of equal value (32.1% versus 28.0%).

Innovative capabilities

There are very little differences by both the R&D status of the firm, and R&D intensity, but some differences arise by whether or not the firm brought in or hired 'new scientists or engineers to work on this innovation' from either their suppliers or customers, PRIS, or consultants. The question specifically refers to both hiring and 'bringing in', since firms can obtain external expertise on a temporary basis without going through a formal hiring process. A higher percentage of firms that did not bring in new scientists and engineers find their internal sources to be of greatest importance (60.9% versus 47.3%) while firms that bring in new expertise are more likely to find both internal and external sources of equal importance.

Table 6. Factors influencing the most important knowledge source

		N	Internal	External	Equal	
	All firms	*517*	*53.8%*	*15.1%*	*31.1%*	*100%*
By appropriation						
Innovation patented		128	52.3%	16.4%	31.3%	100%
Not patented		376	55.1%	14.6%	30.3%	100%
Firm relies most on secrecy		149	56.4%	13.4%	30.2%	100%
By technology measures						
Food and beverages		123	52%	18.7%	29.3%	100%
Chemicals		125	53.6%	15.2%	31.2%	100%
Telecom equipment		92	64.1%	12%	23.9%	100%
Telecom services		45	51.1%	24.4%	24.5%	100%
Computer services		132	49.2%	10.6%	40.2%	100%
Product innovation		427	53.6%	14.3%	32.1%	100%
Process innovation		82	51.2%	20.7%	28.1%	100%
By firm capabilities						
Continuous R&D performer		357	53.8%	14.3%	31.9%	100%
Occasional and never		147	52.4%	17.7%	29.9%	100%
R&D personnel share	< 5%	203	54.7%	16.3%	29%	100%
	5% - 20%	165	53.3%	14.6%	32.1%	100%
	> 20%	147	53.1%	14.3%	32.6%	100%
Bringing in new scientists/engineers Yes		256	47.3%	16%	36.7%	100%
	No	258	60.9%	14.3%	24.8%	100%
By firm boundaries						
Independent		286	50.7%	14.3%	35%	100%
Part of a group		226	57.1%	16.4%	26.5%	100%
< 250 employees		367	54.5%	15%	30.5%	100%
250 + employees		150	52%	15.3%	32.7%	100%
Received subsidy	Yes	95	43.2%	18.9%	37.9%	100%
	No	397	56.2%	15.1%	28.7%	100%

Note: The total number of firms is less than the total in Table 1 (527) due to missing values.

Firm boundaries

57.1% of firms that are part of a group cite internal sources, compared to 50.7% of firms that are independent. As expected, firms that receive subsidies to develop their most economically important innovation are considerably less likely to cite internal sources than firms that did not receive a subsidy (43% versus 56.2%).

Bringing-in new staff

Bringing in new scientists and engineers on either a temporary or permanent basis is one of the most important methods that firms can use to develop their own internal capabilities. For this reason, this activity deserves a closer look at the specific sources of new staff. The questionnaire asks if these staff were obtained from suppliers, customers, PRIs, or consultants. We would expect sourcing from suppliers to be temporary and more prevalent for the introduction of process technology, while sourcing from PRIs could be more frequent among high technology sectors.

Both expectations are met. The source of new staff varies by sector, as shown in Table 7, and by the type of the firm's most economically important innovation. Food and beverage firms are less likely than other firms to bring in any additional staff. This is particularly pronounced for customers, PRIs, and consultants, while they are similar to the average for suppliers. The low overall rate in this sector of bringing in new staff could be due to low technical complexity and little need for additional expertise.

Telecom equipment firms have the lowest rate of bringing in staff from suppliers, but an above average rate of drawing staff from PRIs. The two service sectors have the highest overall rates of bringing in new staff, although telecom service firms rely more on suppliers, In contrast, computer service firms rely more on PRIs.

Table 7. Percent of firms bringing in new scientists or engineers from four sources to work on their most economically important innovation

	Suppliers	Customers	PRIs	Consultants	Any of these
Food and beverages	23%	5.6%	15.1%	14.3%	47.6%
Chemicals	20.2%	11.3%	23.4%	11.3%	39.5%
Telecom equipment	18.3%	14%	23.7%	14%	46.2%
Telecom services	36.2%	8.5%	12.8%	23.4%	42.6%
Computer services	25.2%	16%	35.9%	26%	30.5%
Total	*23.2%*	*11.3%*	*23.6%*	*17.3%*	*40.7%*

Note: Excludes scientists brought in from other units of the same firm.

Development cost for the most economically important innovation

The Dutch version of the KNOW questionnaire included a categorical question on the development costs for the innovation. Four categories were provided: less than 0.05 million Euros, 0.05 to 0.5 million Euros, 0.5 to 5 million Euros, and over 5 million Euros[6]. Data on development costs are available for 105 firms, but only 14 firms spent less than 0.05 million and 12 spent more than 5 million. For this reason, the categories are combined into two groups: less than 0.5 million Euros and over 0.5 million Euros.

[6] The Euro costs are approximate and use an exchange rate of 1 NLG = 0.5 Euros, whereas the real exchange rate is 1 NLG = 0.455 Euros.

As shown in Table 8, the percentage of firms that find internal knowledge sources to be more important than external sources declines with the development costs from 54% of firms that spent less than 0.5 million Euros to develop the innovation, to 33.3% of firms that spent over 5 million Euros. The difference is picked up by both the ‘equal’ group, which increases from 27% of firms that spent less than 0.5 million Euros to 38.1% of firms that spent over 5 million, and the external group, which increases from 19% of firms that spent less than 0.5 million Euros to 28.6% of firms that spent more than this amount.

Table 8. Distribution of the most important source of knowledge by the development cost of the most economically important innovation

Cost (Euros)	N	Internal	External	Equal	
< 0.5 million	63	54%	19%	27%	100%
> 0.5 million	42	33.3%	28.6%	38.1%	100%
Total	*105*	*45.7%*	*22.9%*	*31.4%*	*100%*

Notes: Limited to Dutch firms.

The development cost also has a strong impact on whether or not the firms brings in new scientists and engineers. For development costs below 0.5 million Euros, 31.3% of firms bring in new staff, compared to 61.9% of firms that spent more than this amount[7].

4. Regression Results

The regressions explore the factors that influence the probability that a firm finds internal sources, external sources, or both equally to be the most important knowledge source for the development of the innovation[8].

4.1. Model specification

There are three options for the model specification, depending on the status of the ‘equal’ option. First, if the equal option lies in between the internal and external options in an ordered sequence, an ordered logit model is the best specification. Second, there could be no ordered relationship at all, with each of the three options being completely different choices. Under this condition, the best model is a multinomial logit. Third, the equal option could be indistinguishable from either the internal or external option. In this case, a simple binomial logit model would be the best. Preliminary analysis showed that the multinomial and binomial logit were the best model specifications. Both models were applied to the KNOW data and a similar vector of independent variables was used.

4.2. Independent variables

The factors that influence the importance of knowledge sources for the firm’s most economically important innovation will depend on general conditions within the firm and

[7] Chi-square=9.7**.

[8] We also explored the effect of different knowledge sources on the economic value of product-based innovations to the firm, using the percentage of the firm’s sales from the innovation. Only the coefficients for the firm’s sector were significant.

several firm characteristics, plus factors that apply specifically to this particular innovation. The former group includes the innovative capabilities of the firm, firm boundary conditions such as its size and ownership status, its sector of activity, and its general strategies for sourcing external information. The latter group includes appropriation conditions for this particular innovation, the type of innovation, the types of external knowledge sources that the firm uses to develop it, and whether or not it received a government subsidy.

Two variables are used as a proxy for the innovative capabilities of the firm. The first variable is the percentage of all product innovations that the firm developed in-house. We use product rather than process innovations because 84% of the most important innovations contain a product component. This provides a background measure of the rate of in-house innovation. A second measure of internal capabilities is the R&D intensity of the firm, measured as the share of all employees that are active in R&D[9]. The role of this variable is ambiguous: on one hand, it represents the firm's internal knowledge sources, but, on the other hand, it is also linked to the firm's absorptive capacity for external knowledge sources.

Small firms with less than 250 employees (SMALL = 1) could be less likely than mid-size firms (SMALL = 0) to seek external knowledge, since they have fewer staff that could develop the personal contacts required to access external knowledge[10]. Ownership status (independent or part of a larger firm) could also play an important role. The question on the relative importance of internal and external knowledge sources defines other divisions of the same firm as an external source. Therefore, independent firms (INDEPENDENT = 1) should be more likely than firms that are part of a larger firm (INDEPENDENT = 0) to rely on internal knowledge sources.

Internal expertise could suffice for the development of well-understood technologies, while complex technologies or technologies at the technological frontier could require firms to actively seek knowledge from external sources. Therefore, we expect the firm's sector of activity to influence the relative importance of internal versus external knowledge sources. Specifically, we expect firms in the high technology telecom equipment sector to place greater emphasis on external knowledge sources than firms in the low technology food sector. Each sector is entered into the regression as a dummy variable, with the food sector as the reference category. However, low technology firms could be more likely to outsource process innovations to specialised suppliers. To control for differences in knowledge sourcing by the type of innovation, the regression includes a dummy variable PRODUCT that equals 1 if the most economically important innovation is a product innovation. Process innovations are coded as zero.

[9] There is no correlation between the share of innovations developed in-house and the R&D employment share, indicating that these two variables measure different aspects of the firm's innovative capabilities.

[10] Small firms could also have a more limited range of internal capabilities, but this factor is captured by the variable for R&D employee share and the percent of innovations developed in-house. Therefore, the remaining effect of firm size is limited to the number of possible personal contacts.

In addition to using knowledge sources that require direct personal contacts, which raises the possibility of leaking strategic information, firms can use non-personal methods of sourcing external information. These include regularly reading the scientific and business literature to seek ideas for innovation (JOURNALS = 1) or similarly reverse engineering competitor's products (REVERSE = 1). These two variables apply to the firm's general innovation strategies and not specifically to its most economically important innovation. The first variable, JOURNALS, provides a measure of the general degree to which the firm searches for external knowledge sources of possible value to its innovative activities. We expect outwardly-looking firms to be less likely to depend on internal knowledge sources. Conversely, firms that frequently reverse engineer competitor's products should be less likely to need to rely on innovation via personal contacts with outside sources. For this reason, we expect REVERSE to increase the probability of depending on internal knowledge sources.
In addition to the variable PRODUCT, discussed above, the variables that specifically refer to the most important innovation cover whether or not it was patented, the use of specific knowledge sources, and whether or not the firm received a subsidy.

Strategic concerns over the release of information to competitors could influence the willingness of the firm to rely on external knowledge sources. Patents could play a role in reducing risk by conferring clear ownership rights and by reducing the probability of infringement. Firms could be more willing to rely on external knowledge sources when the most important innovation is patented, either by the firm itself (FIRMPAT) or by another firm (OTHPAT).

The dependent variable in the regression is derived from a question that refers to the overall importance of internal versus external knowledge sources to the successful completion of the innovation. For this reason, the use of each external knowledge source is limited to the most important source that contributed to the completion of this innovation. The questions on external sources for the original idea are not included. Each of the five external knowledge sources is entered into the regression as a dummy variable that equals 1 when it is the most important external knowledge source. The five variables are COMPETITORS, SUPPLIERS, CUSTOMERS, PUBLIC RESEARCH organizations and CONSULTANTS. The reference category for external knowledge sources consists of firms that use none of the external knowledge sources or which report that none of them were the most important to them.

The final variable in the regression is a dummy variable (SUBSIDY) that equals 1 when the firm received a government subsidy to develop this innovation and zero otherwise. In Europe, many innovation subsidies, such as the EU Framework Programme, require firms to collaborate with other firms or with public research organisations. Therefore, we expect firms that have received a subsidy to be less likely to rely on internal knowledge sources.

The last factor is the cost of developing the innovation. Innovation costs should increase with technical complexity and when the development work is not routine. In both cases, the firm will need to conduct a 'search' for possible solutions that could lead to areas outside of the firm's in-house expertise. The firm will either need to build up internal capabilities in these areas, partly by bringing in new expertise from external sources, or by collaborating with external partners that already have the necessary expertise. In both cases, the relative value of external versus internal knowledge sources should increase. The model for the Netherlands also includes a variable for the cost of the innovation (HIGHCOST) which equals 1 when the innovation cost is over 0.5 million Euros and zero otherwise.

4.3. Results

Multinomial logit results for all countries combined are given in Table 9 while the binary logit results are given in Table 10[11]. All of these regressions include dummy variables for country (Netherlands is the reference category), although the coefficients for the country dummies are not provided. The country dummies are included to adjust for national differences in the responses that are not captured by the other variables. Only binary logit results are given for the analysis for the Netherlands alone that includes a variable for the cost of the innovation (HIGHCOST) (Table 11).

As shown in Table 9, the multinomial results with 'internal' as the reference category show that firms that find external and internal knowledge sources to be of 'equal' importance and firms that prefer 'external' sources differ significantly from the reference category. However, when 'equal' is the reference category, there are eight statistically significant coefficients for the 'internal' group (excluding the constant), but only two for firms that prefer 'external' knowledge sources. These results indicate that there is little difference between the 'external' and 'equal' groups of firms. In contrast, both the 'equal' and the 'external' groups differ from the 'internal' group. Hence, we are only able to answer the question of which factors make a firm to consider internal sources more important or of equal importance as external sources.

Table 10 presents binary logit results for two models with internal and external sources being the most important as the dependent variable, respectively. The pseudo R-square and the Chi-square of both models suggest that the first one succeeds better in explaining the data. However, this may be due to the fact that there are only 67 cases in which external sources were the most important against 230 cases in which internal sources were the most important.

Whether or not the innovation was patented has no effect on the preference for internal knowledge sources. By technology characteristics, the dummy variable for an innovation with a PRODUCT component is not significant. The firm's R&D employment intensity also has no effect, but the percentage of products developed in-house significantly increases the probability that the firm will prefer internal knowledge sources.

The firm boundary variables have a greater effect on the preference for internal sources, with the exception of firm size (also not significant when entered as the log of the number of employees). Firms that received a subsidy to develop the innovation are significantly less

[11] Due to missing values in some of the explanatory variables, the number of observations in the regressions is smaller than 517.

likely to prefer internal knowledge sources, as are independent firms. The latter is a peculiar result, since external knowledge sources include other divisions or units of the same firm. Therefore, we expected firms that are part of a group to be less likely to cite internal sources, whereas the opposite occurs[12].

All the external sources used to complete the innovation, except PUBLIC RESEARCH, significantly reduce the preference for internal sources.

Only the variables concerning the use of external knowledge sources for the completion of the innovation have a significant and positive impact on the preference for external sources.
In the regressions by sector (results not reported), due to a small number of positive cases, a few variables could not be included. These include sourcing knowledge from competitors, public research for the food and telecom equipment sectors, and the use of journals by telecom equipment firms.

Appropriation, technology characteristics and R&D intensity have no effect in any of the sector models. The receipt of subsidies significantly reduces the preference for internal sources in both the food and chemical sectors, but has no effect in telecom equipment and computer services, probably because very few of the latter received a subsidy. Independent food firms were less likely to prefer internal sources, but this variable is not significant in the other three sectors. Small telecom equipment firms are less likely to prefer internal sources. With regard to the methods used by the firms to obtain ideas for innovation, reading scientific journals has a negative effect on the preference for internal sources in the chemicals sector, but the effect is not significant for two other sectors, although the coefficient is in the right direction. The use of suppliers decreases the preference for internal knowledge sources in all the sectors except for the computer services sector. The negative effect of consultants on the preference for internal sources is limited to computer service firms.

[12] This result is robust and also occurs in separate regressions for manufacturing and service firms.

Table 9. Multinomial regression results

	Internal as reference category		Equal as reference category	
Variables	**Equal**	**External**	**Internal**	**External**
Constant	-2.11**(0.698)	-0.63(0.79)	2.11**(0.698)	1.48*(0.872)
General variables (not linked to the most important innovation)				
Innovative capabilities				
In-house product share	-0.016***(0.004)	-0.02***(0.005)	0.016***(0.004)	-0.0045(0.005)
R&D employee share	0.007(0.007)	0.005(0.006)	-0.0074(0.005)	-0.0023(0.006)
Firm boundaries				
SMALL	-0.29(0.321)	-0.304(0.391)	0.29(0.321)	-0.01(0.392)
INDEPENDENT	0.59*(0.311)	0.45(0.381)	-0.59*(0.311)	-0.15(0.397)
Outward-looking approach to external knowledge sources				
JOURNALS	0.73**(0.359)	0.066(0.416)	-0.73**(0.359)	-0.66(0.45)
REVERSE	0.12(0.301)	-0.18(0.367)	-0.12(0.301)	-0.3(0.382)
Sector				
Chemicals	0.23(.379)	0.21(0.449)	-0.23(0.379)	-0.02(0.466)
Telecom equipment	-0.71(0.436)	-0.41(0.507)	0.71(0.436)	0.3(0.528)
Telecom services	0.17(0.576)	0.57(0.628)	-0.17(0.576)	0.39(0.638)
Computer services	0.55(0.376)	-0.35(0.49)	-0.55(0.376)	-0.89*(0.497)
Variables limited to the most important innovation				
Appropriation conditions				
FIRMPAT	-0.15(0.371)	-0.66(0.514)	0.15(0.371)	-0.51(0.528)
OTHPAT	0.38(0.452)	0.78(0.524)	-0.38(0.452)	0.4(0.492)
Technology characteristics				
PRODUCT	-0.17(0.368)	-0.34(0.419)	0.17(0.368)	-0.16(0.425)
SUBSIDY	0.93**(0.369)	0.18(0.454)	-0.93**(0.369)	-0.75(0.453)
BRINGING IN	0.22(0.272)	0.23(0.341)	-0.22(0.272)	0.01(0.352)
Most important external knowledge source for completing the innovation				
COMPETITORS	3.15**(1.189)	1.98(1.597)	-3.15**(1.189)	-1.17(1.317)
SUPPLIERS	1.72***(0.375)	2.04***(0.476)	-1.72***(0.375)	0.31(0.517)
CUSTOMERS	1.76***(0.389)	1.88***(0.501)	-1.76***(0.389)	0.11(0.542)
PUBLIC RESEARCH	0.15(0.728)	1.79***(0.807)	-0.15(0.728)	1.65*(0.926)
CONSULTANTS	1.29**(0.518)	1.8***(0.641)	-1.29***(0.518)	0.5(0.676)
Number of cases	430			

* *p<0.1, ** p<0.05, *** p<0.001* Standard Errors in brackets

Pseudo R square= 0.346; Model Chi square=152.115 ***: % correctly predicted=64.4%: Model with only intercept: 53.8%

Note: Only two reference categories are given because the third (external) is redundant. In this case, the coefficients for ‘internal’ compared to the reference category external are identical to the ‘external’ compared to the reference category internal. Similarly, the coefficients for ‘equal’ in reference to external are identical to ‘external’ in reference to equal.

Table 10. Binary Logit results

Variables	Binary logit (reference to external/equal)	Binary logit (reference to internal/equal)
Constant	0.93(0.596)	-0.65(0.742)
General variables (not linked to the most important innovation)		
% products developed in house	0.02***(0.004)	-0.01**(0.004)
Share R&D employees	-0.007(0.005)	0.002(0.006)
Firm boundaries		
SMALL	0.28(0.292)	-0.18(0.356)
INDEPENDENT	-0.56**(0.279)	0.19(0.356)
Outward-looking approach to external knowledge sources		
JOURNALS	-0.51(0.312)	-0.23(0.39)
REVERSE	-0.04(0.269)	-0.23(0.342)
Sector		
Chemicals	-0.22(0.338)	0.15(0.416)
Telecom equipment	0.61(0.387)	-0.1(0.464)
Telecom services	-0.33(0.507)	0.45(0.565)
Computer services	-0.32(0.341)	-0.59(0.455)
Variables limited to the most important innovation		
Appropriation conditions		
FIRMPAT	0.27(0.339)	-0.61(0.485)
OTHPAT	-0.51(0.416)	0.57(0.455)
Technology characteristics		
PRODUCT	0.24(0.328)	-0.28(0.379)
BRINGING IN	-0.21(0.246)	0.13(0.319)
SUBSIDY	-0.69**(0.334)	-0.26(0.412)
Most important external knowledge source for completing the innovation		
COMPETITORS	-2.87**(1.16)	0.35(1.303)
SUPPLIERS	-1.81***(0.331)	1.45***(0.449)
CUSTOMERS	-1.79***(0.345)	1.27**(0.471)
PUBLIC RESEARCH	-0.72(0.599)	1.91**(0.771)
CONSULTANTS	-1.46**(0.462)	1.43**(0.598)
Number of cases	430	430
Pseudo R-square	0.340	0.176
Model chi-square	126.250***	46.111**
% correctly classified	73.3	84.9

* $p<0.1$, ** $p<0.05$, *** $p<0.001$ Standard Errors in brackets

Table 11 provides results for the Netherlands, which include the dummy variable HIGHCOST that equals 1 when total development costs for the innovation exceeded 0.5 million Euros and 0 otherwise.

Table 11. Binary logit results for internal sources as the most important knowledge source. The Netherlands.

Constant	1.21(1.393)
General variables (not linked to the most important innovation)	
Innovative capabilities	
Percent product innovations developed in-house	0.016*(0.01)
Share R&D employees	-0.004(0.01)
Firm boundaries	
SMALL	2.14**(0.994)
INDEPENDENT	-0.82(0.793)
Sector	
Chemical sector	0.03(.83)
Telecom equipment	1.29(1.038)
Telecom services	-2.93*(1.587)
Computer services	-1.13(0.909)
Variables limited to the most important innovation	
Appropriation conditions	
FIRMPAT	0.48(0.793)
OTHPAT	1.51(1.012)
Technology characteristics	
PRODUCT	-0.87(0.966)
HIGHCOST	-0.73(0.65)
SUBSIDY	-2.69**(0.858)
External knowledge sources	
COMPETITORS	-3.41*(1.815)
SUPPLIERS	-2.53**(1.019)
CUSTOMERS	-2.34**(.829)
PUBLIC RESEARCH	-1.23(1.434)
CONSULTANTS	-0.69(2.076)
Number of cases	93
Pseudo R^2	0.481
Model chi-square	41.49***
% correctly classified	78.5

* p<0.1, ** p<0.05, *** p<0.001 Standard Errors in brackets

The percent of product innovations developed in house increases the preference for internal knowledge sources. Smaller firms are more likely to prefer internal sources, while independent firms are less likely to prefer internal sources. Contrary to what Table 8 above suggests, the cost of the most important innovation has no effect on the firms' preference for external knowledge sources.

5. Conclusions

The results of this survey show that small and mid-sized firms in five sectors developed 70% of their product innovations 'mostly in-house', with only 16% developed through collaboration with other firms and 14% obtained from buying the innovation from another firm. The low percentage of innovations that are developed through collaboration suggests that European firms in these five sectors are a long way off from the "systematic use of cooperation", as suggested by Antonelli (1999). Furthermore, the percentage of innovations that are bought-in is very similar to the percentage that are developed via collaboration. This shows that it is very important to be able to differentiate between the different methods that firms use to source innovations from external sources. Otherwise, we could mistakenly interpret buying-in for more complex collaborative activity between firms.

Although firms develop most of their innovations in-house, many of them could be of little importance to the firm. The results for the firm's most economically important innovation show a greater role for external knowledge sources, with 46% of firms reporting that external knowledge sources were either more important or equal to the importance of internal knowledge sources for its completion.

The regression results show that one of the most important factors in the preference for internal versus external knowledge sources is the firm's background rate of in-house innovation. Given this rate, the regressions evaluate the effect of other factors on the relative importance of internal and external knowledge sources. Surprisingly, several factors that have been cited in the literature as influencing the use of external knowledge sources have no effect. These include the firm's sector of activity, the firm's R&D intensity (measured by employee share) and whether or not the innovation was patented.

We expected firms in the telecom equipment sector to be less likely to develop innovations in-house due to the complex nature of telecommunications technology. The firm's R&D intensity could also be positively correlated with the importance of external knowledge sourcing, for similar reasons. However, the results suggest that telecom firms are more rather than less likely than other firms to rely on internal technology. A possible explanation is that firms active in low technology sectors rely on their suppliers for process innovations, thereby confounding the results, but this is an unlikely explanation, since the regression models include a variable to control for product or process innovations. An alternative explanation that cannot be addressed in this study is that technological complexity in the telecom sector only affects the knowledge sourcing strategies of large firms with over 1,000 employees.

R&D intensity has no effect on the relative importance of internal and external knowledge sources, which further suggests that technological complexity has little effect on the relative importance of internal and external knowledge sources. We must point out, however, that the question refers to relative values. Increasingly complex innovations could require increasingly high levels of internal expertise.

Patenting could increase the probability of using external knowledge sources by solving ownership disputes for intellectual property. But, whether or not the innovation was patented had no effect on the importance of internal versus external knowledge sources. This is possibly because appropriation issues and concerns over information leakage play only a minor role in the decision to obtain information from external sources.

Two factors significantly reduced the probability that the firm would rely on internal versus external knowledge sources. First, firms that receive innovation subsidies are considerably less likely to prefer internal sources. This result could simply reflect the requirement to collaborate in order to receive a European subsidy. Of greater concern, this suggests caution in interpreting survey estimates of the frequency with which firms collaborate, since these estimates will be influenced by policy. This will make it more difficult to determine if firms would willingly enter into collaboration in the absence of subsidies. Second, firms that regularly search the scientific and business literature for new ideas for innovation are less likely to rely on internal sources for their most important innovation. This effect is particularly strong among firms in the chemical sector. These firms could use the literature to identify potential partners for developing an idea into an innovation.

We have identified some of the determinants of the preference of firms for internal knowledge sources. However, this set of factors seems to be different from the one that makes firms attach a larger or equal importance to external sources for the development of their innovation. Furthermore, the fact that, in terms of our vector of independent variables, the equal group is indistinguishable from the external group suggests that further research needs to be done in this direction.

The use of external sources in the innovative activities of the firms is actively encouraged by European policy makers, who stress the importance of collaborating with other firms, or establishing links with PROs. However, almost half the firms in the KNOW survey give more importance to internal sources, revealing the significant role of in-house capabilities. A possible explanation could be that these internal capabilities are necessary for the efficient use of external sources, which is in accordance with the idea of an absorptive capacity allowing the firm to benefit from the knowledge spillovers.

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III. Developing Countries after the TRIPs Agreement: Patent and Trade Policies

1 Introduction

In 1995, the TRIPs (Trade Related aspects of Intellectual Property rights) negotiations ended with an agreement in which the developing countries were required to grant (by the year 2005) product patents for pharmaceutical innovations as a condition of membership in the World Trade Organization (WTO). At the time the Uruguay round of GATT was being debated, almost fifty developing countries were not granting patent protection for pharmaceutical innovations. This allowed imitation by their domestic firms of the pharmaceutical products introduced by the multinational companies from the developed world. During this negotiation the developed economies put a lot of pressure on countries with weak or non-existing patent rights to accept the TRIPs requirements, in order to decrease or eliminate the threat of imitation by these countries. However, the threat of imitation faced by the multinationals when selling its product in a developing country is not solely determined by the characteristics of the country's intellectual property rights (IPR) system. This threat of imitation, as pointed out by Smith (1999), is the "interaction of strength of imitative abilities and patent rights". Therefore, countries may be ranked according to the combination of these two parameters, which together determine their threat of imitation. It also follows that the TRIPs agreement will not have the same consequences for all the developing countries.

In this paper, we wish to explore several issues concerning the relation between the IPR system in developing countries and the decisions taken by multinationals from developed economies. We are also interested in studying the welfare implications for developing countries of meeting the requirements established by the TRIPs agreement. First, we study the effects of the strength of patent rights on the multinationals' decisions to export a pharmaceutical drug to a developing country. Second, we examine the interaction between the IPR protection policy and the trade policy in developing countries. Finally, we explore the welfare effects of adopting weak and strong patent protection policies, respectively, taking into account the countries' abilities to imitate.

With regard to the first issue, one expects that the multinational prefers to export to countries with strong patent rights. In this sense, the weak patent protection that characterized India during the period 1970-1995 had as a consequence the growth of its pharmaceutical industry and a decrease in the presence of multinationals[1]. Sticking to the case of India, the weakening of its trade policy that followed its commitment to the TRIPs agreement suggests that there might be a link between the IPR system and the trade policy in developing countries. The prohibition of imitation implied by the TRIPs agreement might lead 'ex-imitating' countries to adopt measures to ensure the supply of drugs by foreign multinationals. If these measures are used to countervail the country's threat of imitation, then foreign firms are expected to get better conditions in countries where the threat of imitation is stronger.

[1]This decrease in the presence of multinationals was also due to a package of measures, introduced by India in 1970, in order to encourage the domestic production of pharmaceuticals. These consisted of restrictions on the import of finished formulations, high tariff rates, ratio requirements and equity ceilings on foreign participation. India decided to drop this package after the TRIPs agreement.

It has been largely claimed by the Third World that the creation of a patent system in these countries would have serious consequences for their well-being. However, this depends on the conditions that each country was facing before the acceptance of the TRIPs agreement, basically the degree of development of their domestic industry. In countries like India, where the pharmaceutical industry experienced a notable growth as a result of its lax patent policy and high industry protection level, welfare losses are expected to be larger. On the contrary, in countries where the domestic pharmaceutical industry was less developed, the establishment of a patent system may open the access to high quality drugs of at least a part of their population, which implies a welfare increase.

Although a large part of the literature on this topic is mainly descriptive (Lanjouw (1998), Nogués (1990 and 1993), Rapp and Rozek (1990) and Schweitzer (1997)), some theoretic work has also dealt with these issues. Zigic (2000) shows that when the Northern and the Southern firms compete in the Northern market and there are different degrees of IPR violation by the South, the tariffs serve also as a mechanism to countervail the IPR violation of the Southern firms, so they are higher than in the simple duopoly case. The common belief that the South always benefits from relaxing IPR protection is proved not to always hold in Zigic (1998). Finally, Watal (2000) analyses the policy options for India to reduce the welfare losses that may follow the application of the requirements of the TRIPs agreement. Contrary to Zigic (2000) our focus is on the Southern market. Within our context, the Southern countries use the tariff to countervail the multinational's monopoly power.

In a static setting, two different countries are considered, namely, an *Imitating* country (hereinafter, country I) and a *Non-Imitating* country (hereinafter, country NI). The distinction between both types of countries lies in the strength of their IPRs, that is, the imitating country is characterized by granting weak patent rights whereas the non-imitating country grants strong patent rights. However, the threat of imitation in both countries is determined by its imitative capacity (the ability to imitate in the absence of IPR laws) together with the existing IPR system (see Smith (1999)). Both countries decide about their trade policy, which affects the demand supplied by a multinational firm producing a good of quality higher than that produced by the local industry. The quality of the good produced by the local firms will be higher in country I than in country NI, where imitation is not allowed. Considering different scenarios, we compare the trade policy in each type of country, in order to establish a link between the levels of industry and patent protection. In the setting where the multinational serves both markets, so that countries do not compete, the trade policy is harsher in the non-imitating country, thus serving as a way to countervail the monopoly power of the multinational. In this case, the imitating country obtains a higher level of welfare than the non-imitating country. In the setting where the multinational serves only one of the two countries, it always chooses the non-imitating country. However, this does not guarantee a higher level of welfare: if the imitative abilities of country I's industry are strong enough, the welfare attained by this country will be larger, even without the presence of the multinational.

The rest of the paper is organized as follows: the next section introduces the model, sections 3 and 4 study the cases of a two-plants and a one-plant multinational, respectively. Section 5 analyzes the case in which the countries choose their imitation regime. Finally, we conclude in section 6.

2 The Model

Consider the market for a pharmaceutical product in a developing country. In this market, a multinational firm, from now on called m, supplies a pharmaceutical drug of quality s_m. The same product, with quality s_l, is also produced by a competitive local industry, called l, and supplied at a price equal to marginal cost.

In order to study how the TRIPs agreement affects the behavior of the multinational and the local firms, we will consider two types of countries: country I, which allows the imitation of the multinational's product, and country NI, where imitation is not allowed. Here the level of imitation does not only depend on the degree of intellectual property right protection (Diwan and Rodrik (1991)), but also on the imitation capacity of the domestic industry. That is, the higher the ability to imitate by the local industry, the closer the local quality is to that of the multinational. We parametrize the level of imitation by $\rho \in (0,1)$.

If s_m represents the multinational's quality, then s_{li} is the quality of the local drug in country $i = NI, I$, with $s_{lI} = \rho_I s_m$, $s_{lNI} = \rho_{NI} s_m$ and $\rho_I > \rho_{NI}$. We assume that there is no trade between both countries.

The consumers' preferences for the drug are represented by a utility function $u(s,p) = \theta s - p$, where s is the quality of the drug, p is the price paid for the drug and $\theta \in [0,1]$ is a taste parameter which measures the consumers' preference for higher quality. It is assumed that the consumers' taste parameters are uniformly distributed in the interval $[0,1]$. The larger is θ, the stronger the consumer's preference for a high quality. Each drug may be identified with a quality-price pair (s,p). Given two drugs (s_m, p_m) and (s_l, p_l) with $s_m > s_l$ and $p_m > p_l$, the critical consumer (the one who is indifferent between both qualities) is given by

$$\tilde{\theta} = \frac{p_m - p_l}{s_m - s_l}$$

whenever $\tilde{\theta} \in (0,1)$, so consumers in the interval $[0, \tilde{\theta}]$ buy the low quality good and consumers in the interval $(\tilde{\theta}, 1]$ buy the high quality good.

Let $\Delta_i = s_m - s_{li}$ represent the quality differential. In country I this is given by $\Delta_I = (1-\rho_I)s_m$, while in country NI it is given by $\Delta_{NI} = (1-\rho_{NI})\, s_m$. Production costs are assumed to be zero, for both the multinational and the local industry. Given that the local industry is competitive, p_l is equal to zero, and demand functions are as follows:

$$\begin{aligned} q_{mi}(p_{mi}, p_{li}) &= \max\{1 - \frac{p_{mi}}{\Delta_i}, 0\} \text{ and} \\ q_{li}(p_{mi}, p_{li}) &= \min\{\frac{p_{mi}}{\Delta_i}, 1\}. \end{aligned}$$

The demand supplied by the multinational, q_{mi}, measures the capacity established in the country by the multinational, thus assessing its presence in the market of the developing country.

Each country's government chooses its trade policy. That is, they choose the value of a tariff $\lambda_i \geq 0$ which measures the degree of protection of the local industry. When the multinational produces q_{mi}, it only incurs in the tariffs imposed by country i, that is $\lambda_i q_{mi}$.

We consider two different situations:

a) Two plants-multinational. The multinational is assumed to have a large capacity, which allows it to sell its product in both countries. The timing is as follows. First, both governments simultaneously choose the degree of industry protection. Then, in each of the countries the multinational chooses its price. Finally, the consumers in both countries decide from whom to buy the drug.

b) One plant-multinational. The multinational is assumed to have a limited capacity, so it supplies its pharmaceutical drug only in one country, either NI or I. In this case the timing of the game is the following: first, both governments choose the level of industry protection. Second, the multinational decides in which country to sell its product. In this country, the multinational chooses its price. Finally, the consumers decide from whom to buy the drug.

3 The case of a two-plants multinational

In this section we investigate the equilibrium behavior in the case of a two-plants multinational. In particular, we compare the total welfare of the imitating and non-imitating country in this setting. We proceed by backward induction, so we first derive the equilibrium prices for the multinational and the local firm, and then we analyze the governments' decision.

3.1 Price stage

At the second stage of the game, the multinational, m, chooses its price. The objective function is given by

$$\underset{\{p_{mi}\}}{Max}\ (p_{mi} - \lambda_i) \max\{1 - \frac{p_{mi}}{\Delta_i}, 0\}.$$

One can check that neither $p_{mi} = \Delta_i$ (in which case $D_{mi}(p_{mi}) = 0$) nor $p_{mi} = 0$ (in which case $D_{mi}(p_{mi}) = 1$) are optimal strategies for the multinational firm, since in both cases its profits are equal to zero. Hence, its optimal strategy is to choose $p_{mi} \in (0, \Delta_i)$. Equilibrium prices and quantities if $\lambda_i < \Delta_i$ are the following

$$\begin{aligned} p^*_{mi}(\lambda_i) &= \frac{\Delta_i + \lambda_i}{2} \qquad p^*_{li} = 0 \\ q^*_{mi}(\lambda_i) &= \frac{\Delta_i - \lambda_i}{2\Delta_i} \qquad q^*_{li}(\lambda_i) = \frac{\Delta_i + \lambda_i}{2\Delta_i}. \end{aligned} \tag{1}$$

If $\lambda_i \geq \Delta_i$ the multinational will not find it optimal to produce and the local industry will serve the whole market. In this case, the multinational's optimal decision is to choose a price such that it serves no demand.

3.2 Governments

First, we compute consumer surplus and total welfare for all possible values of λ_i. We denote by the M and A subscripts the presence and the absence of the multinational in the country, respectively.

If $\lambda_i \geq \Delta_i$, then only the local product is supplied, so consumer surplus and total welfare in country i are given by

$$CS_{iA} = TW_{iA} = \int_0^1 \theta s_{li}\ d\theta = \frac{1}{2} s_{li}. \tag{2}$$

If $\lambda_i < \Delta_i$, then both products are supplied. Consumers on the left of the critical consumer $\widetilde{\theta}(p_{mi}, \lambda_i) = \frac{\Delta_i + \lambda_i}{2\Delta_i}$ buy the local product, and those on the right buy the multinational's good. Hence, consumer surplus in country i is given by

$$\begin{aligned} CS_{iM}(\lambda_i) &= \int_0^{\frac{\Delta_i+\lambda_i}{2\Delta_i}} \theta s_{li}\ \ d\theta + \int_{\frac{\Delta_i+\lambda_i}{2\Delta_i}}^1 \left(\theta s_m - \frac{\Delta_i + \lambda_i}{2}\right) d\theta = \\ &= \frac{s_m}{2} + \frac{-3\Delta_i^2 - 2\lambda_i \Delta_i + \lambda_i^2}{8\Delta_i}. \end{aligned}$$

Total welfare is obtained by adding government revenues $\left(\lambda_i \frac{\Delta_i - \lambda_i}{2\Delta_i}\right)$ to the above expression. That is,

$$TW_{iM}(\lambda_i) = \frac{s_m}{2} - \frac{3\Delta_i^2 - 2\lambda_i \Delta_i + 3\lambda_i^2}{8\Delta_i}. \tag{3}$$

Proposition 1 *The optimal level of industry protection in country i is given by*

$$\lambda_i^{2P} = \frac{\Delta_i}{3},$$

where $i = \{I, NI\}$.

Proof. Country i maximizes the function

$$TW_i(\lambda_i) = \begin{cases} TW_{iM}(\lambda_i) & \text{if} \quad \lambda_i < \Delta_i \\ TW_{iA} & \text{if} \quad \lambda_i \geq \Delta_i. \end{cases}$$

Maximizing $TW_{iM}(\lambda_i)$ gives $\lambda_i^{2P} = \frac{\Delta_i}{3}$, which satisfies $TW_{iM}(\lambda_i^{2P}) > TW_{iA}$. ¥

The above result states that the level of industry protection is negatively related to the country's imitative abilities. Hence, the government offsets the multinational's monopoly power, which is increasing in the quality differential, by means of its trade policy.

The optimal protection level λ_i^{2P} is such that the demands served by the multinational and the local firm do not depend on the quality differential Δ_i, since $q_{mi}(\Delta_i) = \frac{1}{3}$ and

$q_{li}(\Delta_i) = \frac{2}{3}$. Contrary to the usual result in this kind of models, the low quality good has a larger demand than the high quality good. The reason for this phenomenon lies in the presence of the tariff λ. Also, as the imitation capacity of local firms increases, competition becomes harsher and p_{mi}, as well as government revenues, decrease.

From Proposition 1 it immediately follows that the trade policy is harsher in the non-imitating country. The intuition behind this result is that the multinational's monopoly power is larger in the non-imitating country, due to the higher quality differential Δ_i. As we have seen, in this model the countries' trade policy is used to countervail the multinational's monopoly power. Similarly, one can show that

$$TW_{IM} > TW_{NIM}.$$

4 The case of a one-plant multinational

In this section, we consider the case of a multinational with limited capacity which sells its product in one of the two countries. We assume that governments compete in λ in order to attract the multinational to its market.

4.1 Reaction Functions

Lemma 2 *a) For any* $\lambda_I \in (0, \Delta_I)$, *there exists* $\overline{\lambda_{NI}}(\lambda_I) = \frac{\Delta_I \Delta_{NI} - (\Delta_I - \lambda_I)\sqrt{\Delta_I \Delta_{NI}}}{\Delta_I}$ *such that the multinational enters country NI (I) if* $\lambda_{NI} < (>) \overline{\lambda_{NI}}(\lambda_I)$ *and is indifferent between both countries if* $\lambda_{NI} = \overline{\lambda_{NI}}(\lambda_I)$. *In this case, we assume, by means of a tie-breaking rule, that it enters each one with probability* $\frac{1}{2}$.
b) If $\lambda_{NI} < \overline{\lambda_{NI}}(0)$, *then the multinational always enters country NI.*

Proof. Given λ_I and λ_{NI} such that the multinational sells in both markets (that is, $\lambda_{NI} < \Delta_{NI}, \lambda_I < \Delta_I$), we compare multinational's profits in each country:
$\Pi_{mNI}(\lambda_{NI}) - \Pi_{mI}(\lambda_I) = \frac{(\Delta_{NI} - \lambda_{NI})^2}{4\Delta_{NI}} - \frac{(\Delta_I - \lambda_I)^2}{4\Delta_I}$. This is positive for all $\lambda_{NI} < \overline{\lambda_{NI}}(\lambda_I)$, where $\overline{\lambda_{NI}}(\lambda_I) = \frac{\Delta_I \Delta_{NI} - (\Delta_I - \lambda_I)\sqrt{\Delta_I \Delta_{NI}}}{\Delta_I}$, and negative, otherwise. We can see that if λ_{NI} is lower than $\overline{\lambda_{NI}}(0) = \Delta_{NI} - \sqrt{\Delta_I \Delta_{NI}}$, then the multinational obtains higher profits in country NI than in country I, for any positive value of λ_I.¥

The non-imitating country has an advantage over the imitating country in attracting the multinational to its market, since for any protection level λ_{NI} smaller than $\overline{\lambda_{NI}}(0) = \Delta_{NI} - \sqrt{\Delta_I \Delta_{NI}}$ the multinational enters country NI, no matter the level of protection in country I. Moreover, this interval becomes larger if the imitation capacity of firms in country I increases[2].

[2] Δ_I is increasing in ρ and $\frac{\partial \overline{\lambda_{NI}}(0)}{\partial \Delta_I} = -\frac{\Delta_{NI}}{2\sqrt{\Delta_I \Delta_{NI}}}$.

Lemma 3 *The reaction function of country NI's government is as follows:*

a) If $\overline{\lambda_{NI}}(0) > \frac{\Delta_{NI}}{3}$*, then the optimal protection level is* $\lambda_{NI}(\lambda_I) = \lambda_{NI}^{2P}$ *for all* λ_I*.*

b) If $\overline{\lambda_{NI}}(0) \leq \frac{\Delta_{NI}}{3}$*, then the optimal protection level is given by the function*

$$\lambda_{NI}(\lambda_I) = \begin{cases} \overline{\lambda_{NI}}(\lambda_I) - \varepsilon & \text{if} \quad \lambda_I \leq \widetilde{\lambda_I} \\ \frac{\Delta_{NI}}{3} & \text{if} \quad \lambda_I > \widetilde{\lambda_I}, \end{cases}$$

where $\widetilde{\lambda_I} = \Delta_I - \frac{2}{3}\sqrt{\Delta_I \Delta_{NI}}$ *is such that* $\overline{\lambda_{NI}}(\widetilde{\lambda_I}) = \frac{\Delta_{NI}}{3}$*.*

Proof. Country NI's government maximizes the function

$$TW_{NI}(\lambda_{NI}) = \begin{cases} TW_{NIM}(\lambda_{NI}) & \text{if} \quad \lambda_{NI} < \overline{\lambda_{NI}}(\lambda_I) \\ \frac{1}{2}TW_{NIM}(\lambda_{NI}) + \frac{1}{2}TW_{NIA} & \text{if} \quad \lambda_{NI} = \overline{\lambda_{NI}}(\lambda_I) \\ TW_{NIA} & \text{if} \quad \lambda_{NI} > \overline{\lambda_{NI}}(\lambda_I). \end{cases}$$

If $\overline{\lambda_{NI}}(0) > \frac{\Delta_{NI}}{3}$, then the optimal level of protection is the same as in the two plants case, that is, λ_{NI}^{2P}. If $\overline{\lambda_{NI}}(0) \leq \frac{\Delta_{NI}}{3}$, then country NI will choose $\frac{\Delta_{NI}}{3}$ if and only if $\frac{\Delta_{NI}}{3} < \overline{\lambda_{NI}}(\lambda_I), i.e.$, if λ_I is larger than $\Delta_I - \frac{2}{3}\sqrt{\Delta_I \Delta_{NI}}$. For smaller values of λ_I and assuming that λ_I is divisible by a smallest unit ε, NI's best response is to charge $\overline{\lambda_{NI}}(\lambda_I) - \varepsilon$ in order to attract the multinational to its market, since one can show that $TW_{NIM}(\overline{\lambda_{NI}}(\lambda_I) - \varepsilon) > \frac{1}{2}TW_{NIM}(\overline{\lambda_{NI}}(\lambda_I)) + \frac{1}{2}TW_{NIA}$.¥

If $\overline{\lambda_{NI}}(0) > \lambda_{NI}^{2P}$, then the analysis in proposition 1 applies immediately. Indeed, the optimal level of protection in the two-plants case assures that the multinational sells in country NI. Therefore, in this case countries are actually not competing among themselves, so that the optimal λ_{NI} coincides with λ_{NI}^{2P}. On the contrary, when $\overline{\lambda_{NI}}(0) \leq \lambda_{NI}^{2P}$ countries compete. Indeed, if country NI chooses λ_{NI}^{2P}, it is not sure that the multinational sells in its market. λ_{NI}^{2P} will be country NI's best response only for those values of λ_I where $\overline{\lambda_{NI}}(\lambda_I)$ is larger than the optimal protection level in the two-plants case, λ_{NI}^{2P}. Otherwise, it is optimal to choose the maximum possible level of protection such that the multinational enters country NI, i.e., $\overline{\lambda_{NI}}(\lambda_I) - \varepsilon$.

Lemma 4 *The reaction function of country I's government is as follows:*

$$\lambda_I(\lambda_{NI}) = \begin{cases} \lambda_I \geq 0 & \text{if} \quad \lambda_{NI} < \overline{\lambda_{NI}}(0) \\ \overline{\lambda_I}(\lambda_{NI}) - \varepsilon & \text{if} \quad \lambda_{NI} \in \left[\overline{\lambda_{NI}}(0), \widetilde{\lambda_{NI}}\right] \\ \frac{\Delta_I}{3} & \text{if} \quad \lambda_{NI} > \widetilde{\lambda_{NI}}, \end{cases}$$

where $\widetilde{\lambda_{NI}} = \Delta_{NI} - \frac{2}{3}\sqrt{\Delta_I \Delta_{NI}}$ *is such that* $\overline{\lambda_I}(\widetilde{\lambda_{NI}}) = \frac{\Delta_I}{3}$*.*

Proof. Country I's government maximizes

$$TW^I(\lambda_I) = \begin{cases} TW_{IM}(\lambda_I) & \text{if} \quad \lambda_I < \overline{\lambda_I}(\lambda_N) \\ \frac{1}{2}TW_{IM}(\lambda_I) + \frac{1}{2}TW_{IA} & \text{if} \quad \lambda_I = \overline{\lambda_I}(\lambda_N) \\ TW_{IA} & \text{if} \quad \lambda_I > \overline{\lambda_I}(\lambda_N), \end{cases}$$

where $\overline{\lambda_I}(\lambda_N)$ is the inverse of $\overline{\lambda_{NI}}(\lambda_I)$. If $\lambda_{NI} < \overline{\lambda_{NI}}(0)$, then country I is indifferent among all λ, since the multinational always enters country NI. If $\lambda_{NI} \geq \overline{\lambda_{NI}}(0)$, then country I chooses $\lambda_I = \frac{\Delta_I}{3}$ if this is smaller than $\overline{\lambda_I}(\lambda_{NI})$, *i.e.*, if λ_{NI} is larger than $\Delta_{NI} - \frac{2}{3}\sqrt{\Delta_I \Delta_{NI}}$. For smaller values of λ_{NI} and assuming that λ_I is divisible by a smallest unit ε, I's best response is to charge $\overline{\lambda_I}(\lambda_{NI}) - \varepsilon$ in order to attract the multinational to its market, since one can show that $TW_{IM}(\overline{\lambda_I}(\lambda_{NI}) - \varepsilon) > \frac{1}{2} TW_{IM}(\overline{\lambda_I}(\lambda_{NI})) + \frac{1}{2} TW_{IA}$. ¥

Figure 1 below depicts country I's reaction function $\lambda_I(\lambda_{NI})$. In this picture, regions NI and I represent the sets of pairs $(\lambda_{NI}, \lambda_I)$ such that the multinational produces in country NI and I, respectively. By $\overline{\lambda_{NI}}(\lambda_I)$ we denote the line segment at which the multinational is indifferent between both countries. Region Z represents the area at which the multinational does not enter any country.

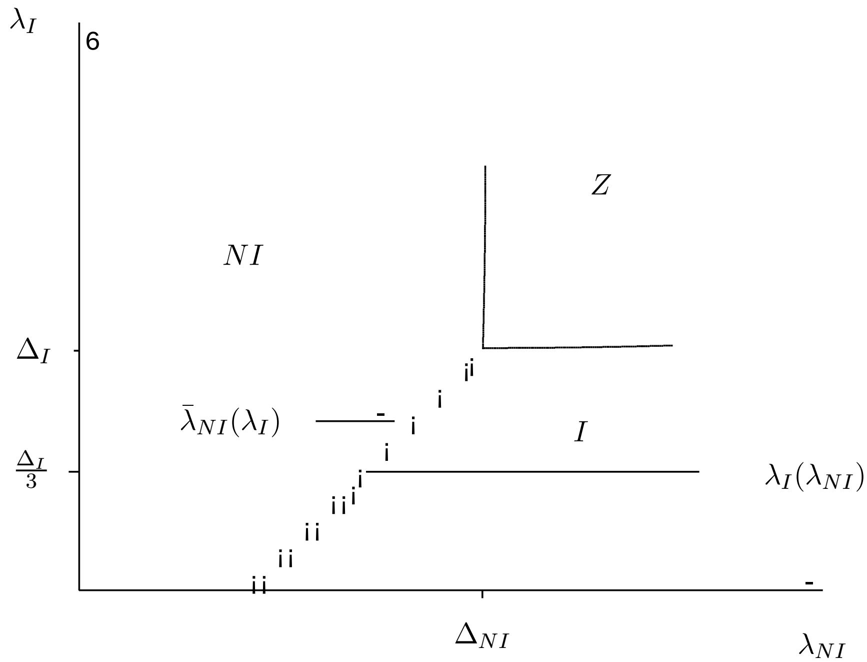

Figure 1
Country I's reaction function

4.2 Equilibria

There exist two types of equilibria:

- No-competition *(NC)* equilibrium occurs when $\overline{\lambda_{NI}}(0) > \lambda_{NI}^{2P}$. As already said, in this case, NI is actually not facing I's competition. Therefore, the equilibrium protection level coincides with the one in the two-plants case, that is, $\lambda_{NI}^{1P} = \lambda_{NI}^{2P}$. On the contrary, country I is indifferent among all possible values of λ_I, indeed, in any case the multinational will not sell in its market.

- Competition *(C)* equilibrium occurs when $\overline{\lambda_{NI}}(0) \leq \lambda_{NI}^{2P}$. Reaction functions are as in Figure 2. As we will see in the proof of the next proposition, in this case, countries are playing à la Bertrand in attracting the multinational. Further, country NI has a comparative advantage, since the competition faced by the multinational will be stronger if it enters country I than if it enters country NI. This generates an interval of protection levels λ_{NI} such that the multinational always enters this country, which increases with the imitation capacity in country I. Therefore, countries will undercut their level of protection so that NI chooses $\lambda_{NI}^{1P} = \overline{\lambda_{NI}}(0) - \varepsilon$, I chooses $\lambda_I^{1P} = 0$ and the multinational selects country NI.

Figure 2 below represents the equilibrium of type C, which we denote by E.

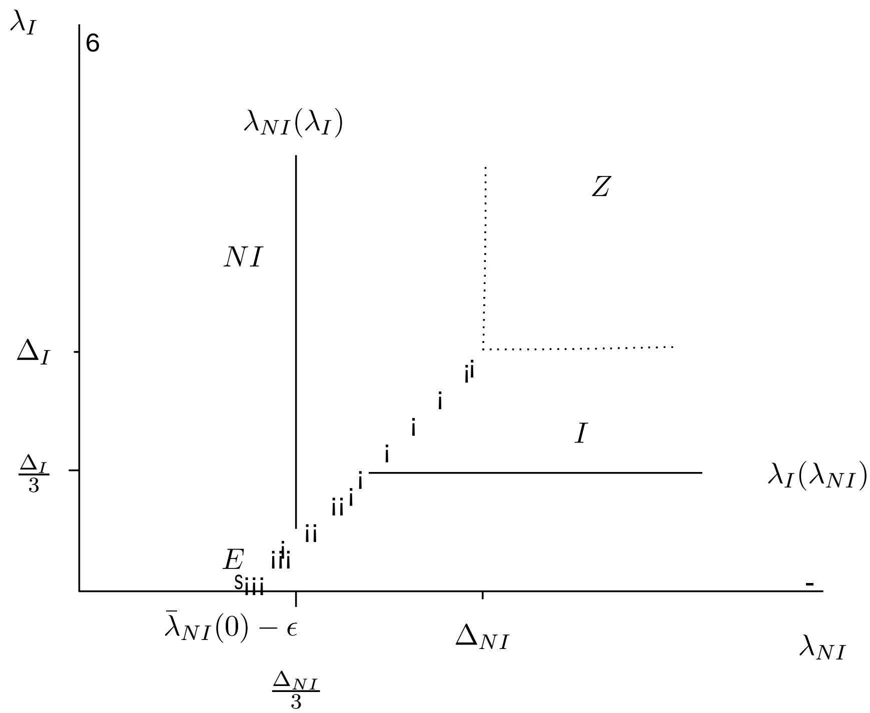

Figure 2
Equilibrium type C

The following table summarizes the equilibria depending on the value of the parameters. The larger the imitation capacity of firms in country I, ρ_I, the larger the comparative advantage of being a non-imitating country. Therefore, for high enough values of the imitation capacity ρ_I a NC equilibrium emerges. For lower values of ρ_I, an equilibrium of type C exists.

$\rho_I < \frac{5+4\rho_{NI}}{9}$ $(\frac{\Delta_{NI}}{3} > \overline{\lambda_{NI}}(0))$	Competition *(C)*	$\lambda_{NI}^{1P} = \overline{\lambda_{NI}}(0) - \varepsilon$
$\rho_I > \frac{5+4\rho_{NI}}{9}$ $(\frac{\Delta_{NI}}{3} < \overline{\lambda_{NI}}(0))$	No Competition *(NC)*	$\lambda_{NI}^{1P} = \lambda_{NI}^{2P} = \frac{\Delta_{NI}}{3}$

Proposition 5 *In equilibrium, the multinational always enters country NI, and the optimal levels of protection are the following:*
a) If $\rho_I < \frac{5+4\rho_{NI}}{9}$*, then a type NC equilibrium follows in which NI chooses* λ_{NI}^{2P} *and I chooses an arbitrary positive level of* λ_I*.*
b) If $\rho_I > \frac{5+4\rho_{NI}}{9}$*, then a type C equilibrium follows in which* NI *chooses* $\lambda_{NI} = \overline{\lambda_{NI}}(0) - \varepsilon$ *and I chooses* $\lambda_I^{1P} = 0$.

Proof. See the Appendix.

If the imitative abilities of firms in the country with weak IPR protection are high enough, then the multinational will always prefer to enter the non-imitating country, no matter the level of industry protection in the imitating country. If, on the contrary, country I's imitative abilities are low enough, then entering the non-imitating country is no longer a dominant strategy for the multinational, so countries compete among themselves to attract the multinational. However, having a strong IPR protection system provides the non-imitating country with a comparative advantage, which makes the multinational prefer this country even if country I sets a zero tariff.

In the following proposition, we compare the country's welfare levels for all possible pairs of protection levels.

Proposition 6 *In equilibrium, the total welfare levels are:*
a) In equilibrium type NC the imitating country always obtains higher welfare than the non-imitating country.
b) In equilibrium type C: If ρ_I *is smaller than* $\widetilde{\rho_I}(\rho_N) = 12\rho_N - 11 + (1-\rho_N)8\sqrt{2}$*, then the non-imitating country obtains a higher level of welfare than the imitating country, otherwise, the opposite occurs.*

Proof. See the Appendix.

Figure 3 summarizes Proposition 6.

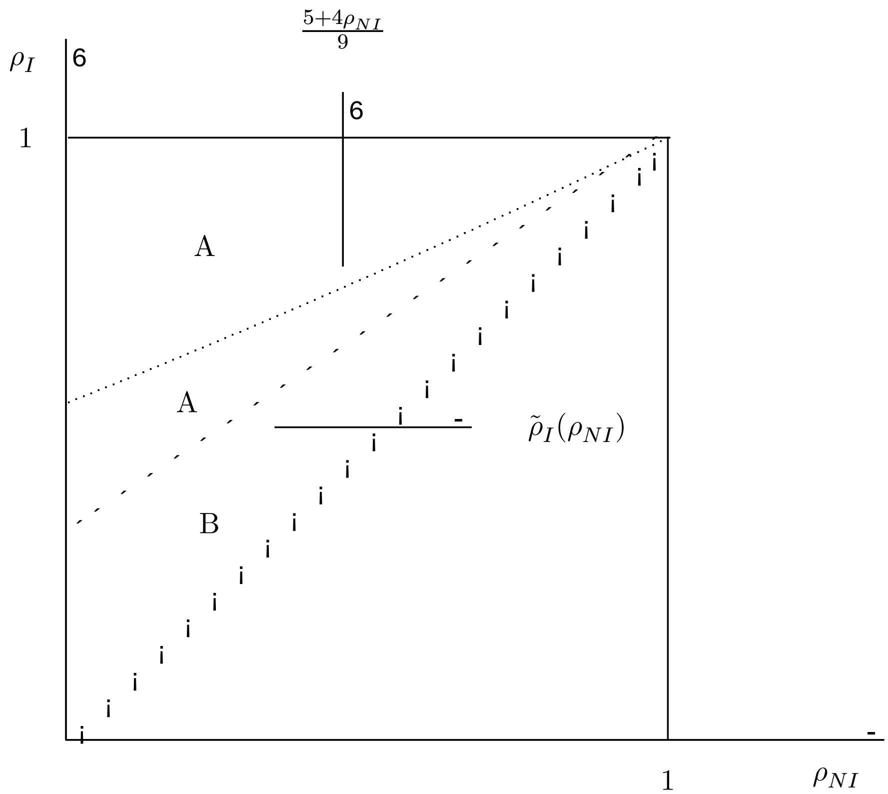

Figure 3
Welfare levels in equilibrium

In the no competition case, i.e. if $\rho_I > \frac{5+4\rho_{NI}}{9}$, the imitating country always attains a higher level of welfare. The reason is that the imitative abilities in this country are large enough to more than compensate the absence of the multinational, which only serves the non-imitating country.

In the competition case, i.e. if $\rho_I < \frac{5+4\rho_{NI}}{9}$, the function $\widetilde{\rho_I}(\rho_{NI})$ gives, for any ρ_{NI}, the critical ρ_I for which the welfare in both countries is equal. As ρ_{NI} increases, the critical ρ_I also increases. The reason is that being non-imitator becomes more profitable, since the multinational, by Proposition 5, always enters the non-imitating country, and the quality of the local product in this country becomes higher. Hence, country I's imitative abilities need to be larger in order to match country NI's welfare. Region B is the area where the non-imitating country obtains more welfare than the imitating country.

As one would expect, the country with the weakest threat of imitation always succeeds in attracting the multinational's production to its market. Moreover, contrary to the previous case, it may attain a higher level of welfare than the imitating country. This will be the case if country I's imitative abilities are weak enough.

5 Endogenous Choice of Imitation Regime

In the last sections, we have compared the welfare levels attained by two countries that differed in the degree of accomplishment of the TRIPs agreement as regards IPR protection. Whereas the imitating country did not meet the TRIPs requirements, the non-imitating country did satisfy those provisions. In this section, we endogenize the countries' decision of whether or not to adhere to the TRIPs agreement. Thus, at the beginning of the game, countries can choose between imitating (meeting the TRIPs requirements) and not imitating (eluding the TRIPs requirements). We analyze the equilibria for the one-plant case.

After the first stage of the game, three cases are possible: both countries choose to imitate (I), both choose not to imitate *(NI)* or they choose different strategies. Let $TW_i(a,b)$ denote the total welfare obtained by country i when country A chooses strategy a and country B chooses strategy b, where $i \in \{A, B\}$ and $a, b \in \{I, NI\}$. If the two countries choose the same strategy, it is obvious that the only possible equilibrium at the second stage of the game is $\lambda = 0$, since otherwise at least one country would have an incentive to undercut its level of protection. In this case, the multinational will be indifferent between entering both countries, and we then assume that it enters each country with probability one half. This implies that the payoffs are $TW_i(NI, NI) = TW_i(I, I) = \frac{1}{2}TW_{iM}(0) + \frac{1}{2}TW_{iA} = \frac{1}{16}s_m(1 + 7\rho_i)$. Recall that $TW_{iM}(0)$ is the welfare in country i if the multinational enters and the protection level is zero, whereas TW_{iA} is the welfare in country i in absence of the multinational.

Equilibria at the second stage of the game in case the countries choose different strategies have been studied in the previous section (see Proposition 5). If $\frac{\Delta_{NI}}{3}$ is smaller than $\overline{\lambda_{NI}}(0)$ (i.e., if $\rho_I > \frac{5+4\rho_{NI}}{9}$), then an equilibrium of type NC is played at the second stage of the game and the payoff matrix for countries A and B is the following.

		Country B: NI	Country B: I
Country A	NI	$\frac{1}{16}s_m(1 + 7\rho_{NI}), \frac{1}{16}s_m(1 + 7\rho_{NI})$	$\frac{s_m}{6}(1 + 2\rho_{NI}), \frac{1}{2}\rho_I s_m$
	I	$\frac{1}{2}\rho_I s_m, \frac{s_m}{6}(1 + 2\rho_{NI})$	$\frac{1}{16}s_m(1 + 7\rho_I), \frac{1}{16}s_m(1 + 7\rho_I).$

If $\frac{\Delta_{NI}}{3}$ is larger than $\overline{\lambda_{NI}}(0)$ (i.e., if $\rho_I < \frac{5+4\rho_{NI}}{9}$), then an equilibrium of type C is played at the second stage of the game. For simplicity we skip ε. Countries obtain the payoffs defined by the following matrix:

		Country B: NI	Country B: I
Country A	NI	$\frac{1}{16}s_m(1 + 7\rho_{NI}), \frac{1}{16}s_m(1 + 7\rho_{NI})$	$\Gamma(\rho_{NI}, \rho_I), \frac{1}{2}\rho_I s_m$
	I	$\frac{1}{2}\rho_I s_m, \Gamma(\rho_{NI}, \rho_I)$	$\frac{1}{16}s_m(1 + 7\rho_I), \frac{1}{16}s_m(1 + 7\rho_I),$

where $\Gamma(\rho_{NI}, \rho_I) = TW_{NIM}(\overline{\lambda_{NI}}(0)) = \frac{s_m}{2} + \frac{1}{8}(-4\Delta_N + 4\sqrt{\Delta_I \Delta_N} - 3\Delta_I)$.

At stage $t = 1$, countries can choose either simultaneously or sequentially and we analyze both cases. In the following proposition we analyze the simultaneous game. In this proposition, let

$$\widehat{\rho_I}(\rho_{NI}) = 40\rho_{NI} - 39 + 16\sqrt{6}(1 - \rho_{NI}).$$

Proposition 7 *Equilibria in the simultaneous game.*
a) If $\rho_I < \frac{1+7\rho_{NI}}{8}$ *then there is a unique equilibrium in which both countries do not imitate.*
b) If $\rho_I \in \left(\frac{1+7\rho_{NI}}{8}, \widehat{\rho_I}(\rho_{NI})\right)$ *then there exist two equilibria in which one country imitates and the other does not.*
c) If $\rho_I > \widehat{\rho_I}(\rho_{NI})$ *then there is a unique equilibrium in which both countries imitate.*

Proof. Left to the reader.

Figure 4 summarizes proposition 7.

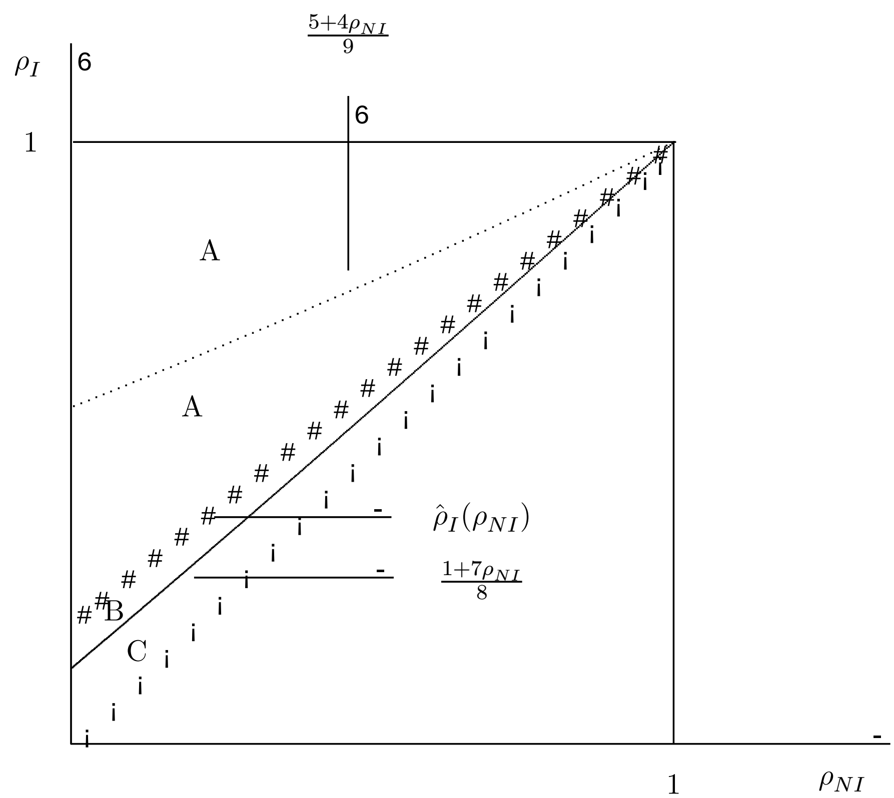

Figure 4

The intuition for this result is as follows. If the imitative abilities, ρ_I and ρ_{NI}, are very low (case a), region C in Figure 4), then it is a dominant strategy for both countries not to imitate. The reason is that by imitating, the possible increase in consumers' welfare is too small compared to the loss generated by the multinational's absence.

If country I's imitative abilities are sufficiently higher than country NI's (case c), region A in Figure 4), then it is a dominant strategy for both countries to imitate since by not imitating, the decrease in consumers' welfare is too large compared to the increase in government's revenues generated by the multinational's presence.

When the difference between ρ_I and ρ_{NI} is intermediate (case b), region B in Figure 4), then it is optimal for the countries to choose different strategies. Consider the equilibrium (NI, I). If country A chooses not to imitate, then the difference in country B's payoffs from the two strategies reduces to the difference in consumer surplus, since government revenues are zero independently of country B's strategy (if B imitates the multinational enters country A, whereas if country B chooses not to imitate, the tariffs are equal to zero in equilibrium). If country B imitates, its consumers will buy a drug of quality $\rho_I s_m$ at price equal to zero. If country B does not imitate, with probability one half, its consumers buy a drug of quality $\rho_{NI} s_m$ at price equal to zero; and, with probability one half, consumers with the highest θs consume a drug of quality s_m, whereas the rest buy the local drug. When imitating, the possible loss in consumers' welfare generated by the multinational's absence is being compensated, since ρ_I is sufficiently higher than ρ_{NI}.

Consider the equilibrium (I, NI). If country A chooses to imitate, then country B's government revenues will be positive if and only if B chooses not to imitate, since in this case the multinational will enter with probability equal to one, and the tariff is positive in equilibrium. If country B does not imitate, consumers with the highest $\theta' s$ purchase the multinational drug and the rest buy the local drug, of quality $\rho_{NI} s_m$. If country B imitates, with probability one half its consumers purchase the local drug, of quality $\rho_I s_m$; with probability one half consumers with the highest $\theta' s$ buy the multinational's drug. When not imitating, the possible loss in consumers' welfare of consumers with the lowest $\theta' s$ is compensated by the gain in welfare of consumers with the highest $\theta' s$ and by the gain in government revenues.

We now analyze the case in which countries choose sequentially. We assume that country A moves first.

Proposition 8 *Equilibria in the sequential game.*
a) If $\rho_I < \frac{1+7\rho_{NI}}{8}$ *then there is a unique equilibrium in which both countries do not imitate.*
b) If $\rho_I \in \left(\frac{1+7\rho_{NI}}{8}, \widehat{\rho}_I(\rho_{NI})\right)$ *then there is a unique equilibrium in which country A chooses not to imitate and country B imitates.*
c) If $\rho_I > \widehat{\rho}_I(\rho_{NI})$ *then there is a unique equilibrium in which both countries imitate.*

Proof. Left to the reader.

The only difference with the simultaneous case is that in case b) there is only one equilibrium left. In this equilibrium, the first mover exploits the advantage of being non-imitating. Country A knows that, independently of its own strategy, country B will choose the alternative one. Thus, if A chooses to imitate, its entire market will be served by the local industry. On the contrary, if A chooses not to imitate, its consumers with the highest $\theta' s$ will purchase the multinational's drug, and the rest will buy the local drug, of quality $\rho_{NI} s_m$. When not imitating, the gain in welfare of consumers with the highest $\theta' s$ and the gain in government revenues compensates the possible welfare loss of consumers with the lowest $\theta' s$, since ρ_I is not much higher than ρ_{NI}.

6 Conclusions

The aim of this paper was to shed some light on the effects that the requirements established by the TRIPs agreement with regard to IPR protection may have on the welfare of developing countries. In particular, our focus is on comparing the levels of welfare in two countries that differ in the strength of their IPR systems, which influences the decision of a multinational to serve or not those two markets. The role played by multinational companies in developing countries is important, since the prohibition to imitate may lead countries with less developed drug industries to rely on the supply of pharmaceutical products by those firms. Thus, the effort exerted by governments in attracting the multinational will depend on the level of development of the local industry, that is, on the imitative abilities. In order to study the welfare effects of the establishment of IPR systems in developing countries, we have proposed a world in which consumers have preference for quality and a multinational firm supplies a good of a certain quality. Governments decide about its trade policy, which affects the multinational's profits. Two different scenarios have been examined. If the multinational sells its product in both countries, the trade policy is used to countervail the multinational's monopoly power, which is higher in the country with the strongest patent rights. We have shown that in this context the total welfare is higher in the imitating country. However, if the multinational sells only in one country, we have found that in equilibrium the multinational never enters the imitating country. The total welfare levels in this case depend upon the imitative abilities of the imitating and non-imitating country. In particular, if the imitative abilities of the imitating country are weak enough, then the non-imitating country obtains a higher level of welfare.

If countries are allowed to choose either a strong or weak IPR system, we distinguish two possible scenarios: one in which both countries decide simultaneously, and one in which they choose sequentially. In both scenarios, if the imitative abilities of the imitating and non-imitating country are close, both countries decide not to imitate. If, on the other hand, their abilities to imitate are sufficiently distinct, both countries will choose to be an imitating country. For intermediate values in the first scenario, there are two equilibria in which one country imitates and the other does not. In the second scenario, for such values, there is a unique equilibrium in which the first mover decides not to imitate, and the second mover decides to imitate.

We may conclude that the establishment of a strong IPR system will not have the same effect in all developing countries since the threat of imitation depends not only on the level of IPR protection but also on their imitative abilities. A country which meets the TRIPs requirement might achieve a higher level of welfare than a country which does not meet that requirement if the first country has sufficiently strong imitative abilities. The reason is that in that case its consumers will not only enjoy drugs with higher average quality, but will also induce a harsher competition with the multinational.

7 Appendix

Proof of Proposition 5. a) From Lemma 2 we know that if country NI sets a level of protection λ_{NI} smaller than $\overline{\lambda_{NI}}(0)$, then the multinational enters country NI for any λ_I. Thus, if $\frac{\Delta_{NI}}{3}$ is smaller than $\overline{\lambda_{NI}}(0)$, there exists an equilibrium in which country NI chooses $\lambda_{NI} = \frac{\Delta_{NI}}{3}$, country I chooses an arbitrary $\lambda_I > 0$ and firm m enters country NI.

b) If Δ_{NI} is larger or equal than $\overline{\lambda_{NI}}(0)$, then, according to the reaction functions of countries NI and I (see Lemmas 3 and 4), the only possible equilibrium in this case is such that $\lambda_I = 0$, $\lambda_{NI} = \overline{\lambda_{NI}}(0) - \varepsilon$, and the multinational enters country NI. ¥

Proof of Proposition 6. a) Equilibrium type NC. In this equilibrium, $\lambda_{NI} = \frac{\Delta_{NI}}{3}$. By substituting this equality in (3), one obtains

$$\begin{aligned} TW_{NIM} &= TW_{NIM}\left(\Delta_{NI}\right), \\ &= s_m \left(\frac{1}{2} - \frac{1-\rho_{NI}}{3}\right), \end{aligned}$$

which gives $TW_{NIM} - TW_{IA} = \frac{s_m}{6}\left(1 + 2\rho_{NI} - 3\rho_I\right)$. This is positive for all ρ_I smaller than $\frac{1}{3}\left(1 + 2\rho_{NI}\right)$, and negative otherwise. However, this equilibrium occurs only for values $\rho_I > \frac{5+4\rho_N}{9}$, and one can check that $\frac{5+4\rho_N}{9} > \frac{1}{3}\left(1 + 2\rho_{NI}\right)$, which implies that $TW_{NIM} - TW_{IA} < 0$ for all $\rho_I > \frac{5+4\rho_N}{9}$.

b) Equilibrium type C. Total welfare in the imitating country is given by (2), while total welfare in the non-imitating country is given by

$$TW_{NIM} = TW_{NIM}\left(\lambda_{NI}^C\right),$$

where $\lambda_{NI}^C = \overline{\lambda_{NI}}(0) - \varepsilon$. Assuming for simplicity that ε is zero, we have that

$$TW_{NIM} = \frac{s_m}{2} + \frac{1}{8}\left(-4\Delta_{NI} + 4\sqrt{\Delta_{NI}\Delta_I} - 3\Delta_I\right),$$

so

$$TW_{NIM} - TW_{IA} = \frac{1}{8} s_m \left(-3 - \rho_I + 4\rho_{NI} + 4\sqrt{\left(1-\rho_{NI}\right)\left(1-\rho_I\right)}\right).$$

One can check that this function is positive for all $\rho_I > -11 + 12\rho_N + 8\sqrt{2}(1-\rho_N)$, and negative otherwise. ¥

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IV. Pricing and Welfare Implications of Parallel Imports in the Pharmaceutical Industry

1. Introduction

Parallel imports (PI) are goods produced under intellectual property right (IPR) protection, distributed in one market by the local owner of the IPR and then imported into a second market without the authorization of the right-holder. Parallel trade occurs in the majority of countries and affects a wide range of goods, such as pianos, automobiles, pharmaceuticals, chemicals, computers, cameras, Levi jeans, etcetera[1]. Since intellectual property rights are granted on a territorial basis, the *exhaustion* of these rights, which is sometimes referred to as the 'first sale doctrine' constitutes the technical issue. When a good that benefits from IPR protection is sold, its distributor has realized the benefits of his/her rights, and these are considered exhausted. This implies that the purchaser of the good may resell it, even in competition with the original manufacturer. The key issue is the territory considered. Under a principle of national exhaustion PI may be prevented, since the local distributor holds the right to sell the good within the country, so any unauthorized commercialisation of the same good within the country borders is illegal. However, under a principle of international exhaustion PI are legal, since the rights are considered exhausted upon first sale anywhere. In the EU the legal framework is characterized by a regional exhaustion principle, so PI are permitted within the EU zone but excluded when coming from non-members[2]. Moreover, the European Court of Justice has maintained the view that free circulation of goods (stated in the Treaty of Rome) precedes IPR rules[3].

Under the WTO/TRIPs rules, countries may decide for themselves how to handle PI. Article 6 states that:

> *For the purposes of dispute settlement under this Agreement, subject to the provisions of Articles 3 and 4, nothing in this Agreement shall be used to address the issue of the exhaustion of intellectual property rights.*

The issue of whether or not to allow for parallel imports has been especially controversial in the context of pharmaceutical drugs for several reasons. In this market, price differences are quite substantial[4] and the volume of parallel trade is very important in some counties[5]. Second, by permitting parallel imports, countries can lower their national expenditures on pharmaceuticals. In this context, the economic literature has extensively explored the welfare effects of parallel imports. (See Chard and Mellor 1989, Danzon 1997 and 1998, Maskus 2000, Malueg and Schwartz 1994 and Towse 1998). However, to our knowledge, there has not yet been a study of this phenomenon taking into account the endemic situation of

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[1] See www.cptech.org for a detailed discussion of parallel imports.
[2] In the case *Silhouette International vs Hartlauer* (C-355/96), the ECJ allowed the authorized local distributor in the UK to prevent PI from outside the European Economic Area.
[3] January 1, 1996: The EC rejected a request from ten member states to ban PI of cheap drugs from Spain and Portugal.
[4] As an example, prices set by Glaxo, Ciba-Geigy and Pfizer were from 43 to 69 times as much for the same drug in the US as in India (www.cptech.org). Also, by comparing the UK list price for HIV drugs to the best price from five parallel importers, the average savings was 41 percent. Source: Informedica.
[5] In 1997 parallel imports accounted for 9% of total market in Denmark, 8% in the Netherlands and 7% in the UK. Source : GIRP European Pharmaceutical Data 1997 (IMS).

countries between which trade takes place. This paper, in contrast, studies the welfare effects of allowing PI of pharmaceutical drugs when the importing and exporting country have different valuations for the same drug.

PI occur because there exist significant price differences for the same good in different countries. These price differences reflect the diversity of market conditions existing in different countries, based on price regulations, degree of competition among producers or differences in income that induce price discrimination. The access to medicines in poor countries has recently raised much concern about the convenience to allow PI of pharmaceutical drugs. This controversy has been well illustrated by the South Africa case[6]. Moreover, in the U.S. there has been a debate about the question whether drug reimports from Canada, where prices controls exist, should be allowed. Despite the objection by the U.S. pharmaceutical industry, Pecorino (2001) shows that the profits made by the U.S. drug producers do not necessarily decrease from such reimports.

In this paper, we try to shed some light on the ongoing debate over the benefits and drawbacks from allowing parallel imports among countries. To make the analysis tractable, we do not address the dynamic effects on R&D of allowing parallel trade of medicines and we limit our study to explore the static effects. Contrary to previous studies in which differences in income are considered[7], we investigate the effects of allowing parallel imports of pharmaceutical drugs between two countries that are different in terms of both, health systems and drug needs. In our model, different co-payments reflect differences in health systems, while as a consequence of having different drug needs, patients' valuations of the same drug will differ. In our model, the monopolist sets prices freely. Although the prices of pharmaceutical drugs are being controlled in many countries, prices are still freely chosen in some OECD countries, including the US, Germany and Denmark. Moreover, many countries (such as the Netherlands, Italy, Norway, Sweden, Hungary and the Czech Republic) only apply control to a part of the prescription market[8].

Danzon (1998) has pointed out that PI make poor (exporting) countries worse off, and the richest (importing) countries better off. However, this would be true if prices reflected only income and countries differed only in terms of their income. More generally, prices reflect the willingness to pay, and this not only reflects income, but also the valuation of the good. Depending on their endemic situation, countries may differ in the mean valuation of a drug and, as a consequence, PI could now benefit the ones with a higher valuation and worsen the ones with a lower valuation. This argument is very relevant, especially with regard to the

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[6] In 1997, the government of South Africa passed legislation (the Medicines and Related Substances Control Amendment Act, Act 90 of 1997) that set up a system to permit the parallel trade of medicines, in order to make the access to medicines more affordable to the population. However, the Pharmaceutical Manufacturers' Association of South Africa (PMA) filed a lawsuit to block it, and both the US and the EU placed a lot of pressure on the South African government to modify Act 90, adopting the argument that this act was in violation of the TRIPs agreement. Finally, they both softened their position and subsequently the PMA dropped the suit.

[7] See Ganslandt and Maskus 2001.

[8] OECD 2000

question raised by Maskus (2001) : « Why might the prices be higher in poor countries ? »[9]. On the other hand, Danzon (1998) and Darba and Rovira (1998) conclude that PI reduce total welfare because they assume that the manufacturer will set a uniform price in order to deter PI. However, as we will see below, this is not always the optimal strategy.

On the basis that PI will result in equalized prices, some authors (Ganslandt et al. 2001, Danzon 1998, Darba and Rovira 1998) have argued that PI undermine price discrimination and, consequently, they cause a welfare loss. However, this statement ignores the increase in the level of competition caused in the importing country when a parallel trader enters this market. Thus, as we will see below, the global effect on welfare is ambiguous: on the one hand, it increases because of harsher competition in one of the markets and, on the other hand, it decreases as a result of the lower price discrimination across countries.

In the next section we describe the model. Section 3 discusses the equilibrium of the game. In Section 4 we analyze the welfare implications of allowing PI. Finally, we conclude in Section 5.

2. The Model

We consider a multinational firm producing a patented drug. The variable cost of producing the drug is zero. The producer acts as a monopolist given the patent on his product. He sells the drug in two countries, *A* and *B*, at prices p_A and p_B, respectively. If parallel imports are tolerated, one or more wholesalers can buy the drug in country *i*, *i*= *A*, *B*, at price p_i, and re-sell it in the other country at price p_w, and at no cost except the price paid for the drug in the first country[10].

Each country has a population whose size is normalized to one. For simplicity, individuals in both countries are assumed to have a utility additively separable in the consumption of a numeraire composite good and the consumption *x* of the drug, with $x \in \{0,1\}$. They have an income *I* at their disposal to buy the composite good and one or zero units of the drug. In each country, individuals differ in their valuation of the drug, reflected in θ_i, with:

$$\theta_i \sim U[\underline{\theta_i}, \overline{\theta_i}],$$

in country *i*, *i*= *A*, *B*, and, for simplicity,

$$\overline{\theta_i} - \underline{\theta_i} = 1 .$$

In order to avoid degenerate cases where the monopolist would serve the whole market, we shall assume that $\overline{\theta_i}$ is between 0 and 2.

[9] This question is based on the finding reported by Maskus (2001) that « prices are elevated in such countries as South Africa, Mexico and Brazil relative to those in Canada, Spain and Italy ». The author points at two reasons for such phenomenon. First, the decision of manufacturers to supply only the inelastic segment of those markets at a high markup, and second, the existence of a limited number of domestic distributors.
[10] For the role of transport costs, see Ganslandt and Maskus (2001).

For a particular drug, θ_i represents the valuation of the drug of individuals in each country. In the case of a malaria vaccine, if A is a developing country and B is an EU country, consumers in country A, where the disease is active, will have, on average, larger θ_i s than consumers in country B, where the disease is inactive.

Moreover, we assume that individuals prefer to consume the drug supplied by the monopolist to the one supplied by the parallel importer. Therefore, their valuation of the drug is 1 if the drug is supplied by the monopolist, and $\rho < 1$ if the drug is supplied by the parallel importer. The assumption that the perceived quality of the parallel import is smaller than that of the monopolist's drug reflects the fact that, according to Maskus (2001) among others, "goods that are parallel imported may not be perceived to be of the same quality between markets, even if they were placed on the market originally by the manufacturer, because of differences in packaging or guarantees".

Also, as noted by Danzon (1998), although a license is required for parallel importers, chemical testing for equivalence is not performed, which implies that parallel imported drugs may include counterfeit products of inferior quality. This increases the risk faced by consumers, and, as a consequence, the perceived quality of parallel imports is lower than that of the original manufacturer.

We assume that the expenses for drug consumption of an individual, *px,* are partially reimbursed by some public health insurer in both countries, so that the individuals only pay a share α_i of it in country *i*. Therefore, the indirect utility function of an individual in country *i* with valuation θ can be written as:

$$U_i = I + Max\left\{\theta - \alpha_i p_i; \rho\theta - \alpha_i p_w; 0\right\},$$

if there are parallel imports available in country *i*. Otherwise, the utility function reduces to:

$$U_i = I + Max\left\{\theta - \alpha_i p_i; 0\right\}.$$

The timing of our game is as follows. If parallel trade is permitted, then the monopolist sets the prices p_A and p_B in the first stage of the game so as to maximize his profits:

$$\Pi_m = p_A(D_A + D_w) + p_B D_B,$$

where D_i, $i = A$, B, stands for the demand of the drug directly supplied by the monopolist in country *i*, and D_w stands for the demand faced by the parallel importer in the importing country, *B*. Then, in the second stage of the game, the parallel importer sets the price p_w, as a Stackelberg follower. If the parallel importer is unique, he sets p_w so as to maximize his profit:

$$\Pi_w = (p_w - p_A)D_w.$$

If there are many wholesalers competing with each other in the parallel imports market, then they set a price equal to their marginal cost: $p_w = p_A$. In the third stage of the game, the individuals in both countries choose to consume either one unit of the drug supplied by the monopolist, or one unit of the parallel import if it is available, or nothing, so as to maximize their utility. If parallel trade is legally forbidden, then the second stage of the game previously described vanishes, and $D_w = 0$.

We solve the game by backward induction to derive the subgame perfect equilibrium.

Without loss of generality, we assume throughout the paper the following inequality:

$$\frac{\bar{\theta}_A}{\alpha_A} < \frac{\bar{\theta}_B}{\alpha_B}.$$

This implies that, if parallel trade takes place, it does so from country A towards country B.

3. The equilibrium of the game

3.1. Benchmark: parallel imports are illegal.

We first present, as a benchmark case, the equilibrium of the game when parallel imports are legally forbidden. This result is stated in the following proposition.

Proposition 1. *In the benchmark case:*
a) prices that maximize the monopolist's profits are

$$p_i^* = \frac{\bar{\theta}_i}{2\alpha_i},$$

b) equilibrium demands are

$$D_i^* = \frac{\bar{\theta}_i}{2},$$

c)monopoly profit is

$$\Pi_m^* = \frac{1}{4}\left(\frac{\bar{\theta}_A^2}{\alpha_A} + \frac{\bar{\theta}_B^2}{\alpha_B}\right),$$

d) consumer surplus is

$$CS_i^* = I + \frac{\bar{\theta}_i^2}{8},$$

e) public expenses for paying a share $1-\alpha_i$ of the drug in country i are

$$PE_i^* = (1-\alpha_i)p_i^* D_i^* = \frac{1-\alpha_i}{\alpha_i}\left(\frac{\bar{\theta}_i}{2}\right)^2$$

where i = A,B.

Proof. In the last stage of the game, individuals choose to consume either one unit of the good supplied directly by the monopolist in their country, or nothing. Given the utility:

$$U_i = I + Max\{\theta - \alpha_i p_i ; 0\},$$

only the individuals in country i with a valuation for the drug $\theta \geq \alpha_i p_i$ are going to buy one unit of the good. Therefore, the demand faced by the monopoly in country i is:

$$D_i = \min\{\overline{\theta}_i - \underline{\theta}_i, \overline{\theta}_i - \alpha_i p_i\}, \ i = A, B.$$

Given these demands, the monopolist sets the prices p_A and p_B so as to maximize his profit:

$$\Pi_m = p_A D_A + p_B D_B.$$

The equilibrium prices that maximize this profit are:

$$p_i^* = \frac{\overline{\theta}_i}{2\alpha_i}, \ i = A, B.$$

Here we have used the assumption that $\overline{\theta}_i$ is between 0 and 2, which implies that p_i^* is never lower than $\frac{\underline{\theta}_i}{\alpha_i}$, the maximum price at which the whole market is served.

In country i, only the individuals with a valuation:

$$\theta > \frac{\overline{\theta}_i}{2},$$

buy the drug in equilibrium. The resulting equilibrium demands for the drug are therefore :

$$D_i^* = \frac{\overline{\theta}_i}{2}, \ i = A, B.$$

At the equilibrium, the monopoly profit is :

$$\Pi_m^* = \frac{1}{4}\left(\frac{\overline{\theta}_A^{\,2}}{\alpha_A} + \frac{\overline{\theta}_B^{\,2}}{\alpha_B}\right).$$

The consumer surplus in country i is:

$$CS_i^* = \int_{\underline{\theta}_i}^{\overline{\theta}_i/2} I \, d\theta + \int_{\overline{\theta}_i/2}^{\overline{\theta}_i} \left(I + \theta - \frac{\overline{\theta}_i}{2}\right) d\theta,$$

which, given the assumption $\overline{\theta}_i - \underline{\theta}_i = 1$, reduces to :

$$CS_i^* = I + \frac{\overline{\theta}_i^{\,2}}{8}.$$

The public expenses for paying a share $1-\alpha_i$ of the drug in country i are :

$$PE_i^* = (1-\alpha_i) p_i^* D_i^* = \frac{1-\alpha_i}{\alpha_i}\left(\frac{\overline{\theta}_i}{2}\right)^2.$$

Q.E.D.

Notice that the equilibrium monopoly price increases with the maximum valuation for the drug in the country, and decreases with the patients' level of co-payment for the drug. The assumption:

$$\frac{\overline{\theta}_A}{\alpha_A} < \frac{\overline{\theta}_B}{\alpha_B},$$

implies that the price is lower in country *A*:

$$p_A^* < p_B^*.$$

Therefore, in the benchmark case, the monopoly producer discriminates as much as possible the prices between the two countries.

Note also that the equilibrium demands do not depend on the level of the patients' co-payment for buying the drug, since the price faced by the individuals in both countries, $\alpha_i p_i$, only depends on the maximum valuation for the drug in their country.

3.2. Parallel imports are legal.

When parallel imports are legally permitted, the demands for both the parallel import and the drug supplied by the producer are realized in the third stage of the game. We assume, *a priori*, that parallel trade, if it takes place, does so from country *A* towards country *B*.

Lemma 1. *In equilibrium, the consumer demands at the third stage are given by*

$$D_A = \overline{\theta}_A - \alpha_A p_A,$$

$$D_w = \begin{cases} 0 & \text{if } p_w \geq \rho p_B, \\ \dfrac{\alpha_B(\rho p_B - p_w)}{\rho(1-\rho)} & \text{if } p_w \leq \rho p_B. \end{cases}$$

$$D_B = \begin{cases} \overline{\theta}_B - \alpha_B p_B & \text{if } p_w \geq \rho p_B, \\ \overline{\theta}_B - \dfrac{\alpha_B(p_B - p_w)}{1-\rho} & \text{if } p_w \leq \rho p_B. \end{cases}$$

Here, D_A, D_w and D_B denote the demand served by the monopolist in country A, the demand served by the wholesaler in country B at price p_w and the demand served by the monopolist in country B, respectively.

Proof. In country *A,* where the drug is not available as a parallel import, the individuals with a valuation $\theta \geq \alpha_A p_A$ buy one unit of the drug supplied by the monopoly producer in this country. Therefore,

$$D_A = \overline{\theta}_A - \alpha_A p_A.$$

In country *B,* where parallel imports are available, only the individuals with a valuation :

$$\theta \in \left[\frac{\alpha_B p_w}{\rho}; \frac{\alpha_B(p_B - p_w)}{1-\rho}\right],$$

buy one unit of the parallel import :

$$\rho\theta - \alpha_B p_w \geq Max\{\theta - \alpha_B p_B; 0\}.$$

Therefore,

$$D_w = Max\left\{\frac{\alpha_B(p_B - p_w)}{1-\rho} - \frac{\alpha_B p_w}{\rho};0\right\},$$

which is equivalent to :

$$D_w = \begin{cases} 0 & \text{if } p_w \geq \rho p_B, \\ \dfrac{\alpha_B(\rho p_B - p_w)}{\rho(1-\rho)} & \text{if } p_w \leq \rho p_B. \end{cases}$$

If the parallel import attracts some individuals in country *B*, i.e. if $p_W \leq \rho p_B$, individuals in country *B* with a valuation :

$$\theta \geq \frac{\alpha_B(p_B - p_W)}{1-\rho},$$

are better off buying one unit of the good supplied by the monopolist. Otherwise, individuals with a valuation $\theta \geq \alpha_B p_B$ buy one unit of the good supplied by the monopolist in country *B*. Therefore, the demand for the drug supplied directly by the monopolist in country *B* is :

$$D_B = \begin{cases} \bar{\theta}_B - \alpha_B p_B & \text{if } p_W \geq \rho p_B, \\ \bar{\theta}_B - \dfrac{\alpha_B(p_B - p_W)}{1-\rho} & \text{if } p_W \leq \rho p_B. \end{cases}$$

Q.E.D.

For parallel trade to be attractive to the individuals in country *B*, the price p_w needs to be not only lower than p_B, but lower than ρp_B as well, to account for the fact that, *ceteris paribus*, individuals prefer the drug supplied by the monopolist to the parallel import.

The next lemma characterizes the equilibrium in the second stage of the game.

Lemma 2. *a) If* $p_A \leq \rho p_B$*, the price set by the wholesaler in country B is as follows:*
a.1) if the parallel imports market is competitive then the equilibrium price is $p_w = p_A$*,*
a.2) if the parallel imports market is a monopoly then the equilibrium price is

$$p_W = \frac{p_A + \rho p_B}{2}.$$

b) If $p_A > \rho p_B$*, then it is not optimal for the wholesaler to supply.*

Proof. In the second stage of the game, the parallel importer(s) can buy drugs in country *A*, and decide upon the price p_w, anticipating the demands D_A, D_B and D_w as given in Lemma 1.
a.1) In case of perfect competition, it is clear that $p_w = p_A$. From Lemma 1 we know that D_w will be strictly positive if $p_w \leq \rho p_B$, that is, $p_A \leq \rho p_B$.
a.2) If there is only one monopolistic parallel importer, then the equilibrium price is the one that maximizes $\Pi_w = (p_w - p_A)D_w$, that is, $p_W = \dfrac{p_A + \rho p_B}{2}$. From Lemma 1 it follows that the wholesaler will only supply at this price if $p_A \leq \rho p_B$. *Q.E.D.*

Notice that, if the prices charged by the monopolist in both countries are not sufficiently distinct (that is, if the condition $p_A \le \rho p_B$ does not hold), then there will be no room for parallel imports.

Lemma 3. *The demand anticipated in stage 1 by the monopolist is as follows :*
a) if the parallel imports market is competitive then

$$D_B = \begin{cases} \bar{\theta}_B - \alpha_B p_B & \text{if } p_A \ge \rho p_B, \\ \bar{\theta}_B - \dfrac{\alpha_B (p_B - p_A)}{1-\rho} & \text{if } p_A < \rho p_B. \end{cases}$$

b) if the parallel imports market is a monopoly, then

$$D_B = \begin{cases} \bar{\theta}_B - \alpha_B p_B & \text{if } p_A \ge \rho p_B, \\ \bar{\theta}_B - \dfrac{\alpha_B ((2-\rho) p_B - p_A)}{2(1-\rho)} & \text{if } p_A < \rho p_B. \end{cases}$$

Proof. In stage 1, the monopoly producer sets the prices p_A and p_B to maximize his profit, anticipating the parallel import price and the demands D_A, D_B and D_w. The demand for the drug supplied by the monopoly producer in country *A* is unaffected by the decision of the parallel importer in stage 2. Therefore, the demand D_A that is anticipated in stage 1 is :

$$D_A = \bar{\theta}_A - \alpha_A p_A .$$

The demand D_B that is anticipated in stage 1 depends on the market for parallel imports. If it is a competitive market, then, using Lemma 1 and Lemma 2 a.1):

$$D_B = \begin{cases} \bar{\theta}_B - \alpha_B p_B & \text{if } p_A \ge \rho p_B, \\ \bar{\theta}_B - \dfrac{\alpha_B (p_B - p_A)}{1-\rho} & \text{if } p_A < \rho p_B. \end{cases}$$

If it is a monopolistic market, then, using Lemma 1 and Lemma 2 a.2):

$$D_B = \begin{cases} \bar{\theta}_B - \alpha_B p_B & \text{if } p_A \ge \rho p_B, \\ \bar{\theta}_B - \dfrac{\alpha_B ((2-\rho) p_B - p_A)}{2(1-\rho)} & \text{if } p_A < \rho p_B. \end{cases}$$

Q.E.D.

Given the demands D_A, D_B and D_w, the equilibrium prices p_A and p_B that maximize the producer's profit :

$$\Pi_m = p_A (D_A + D_w) + p_B D_B ,$$

are presented in Table 1. The corresponding demands (D_A, D_B and D_w), profits (Π_A and Π_B), consumer surplus (CS_A and CS_B), and public expenses (PE_A and PE_B), are also presented in table 1.

For the sake of clarity, we use the following notation :

$$\Delta \in \{\Delta_0, \Delta_m, \Delta_c\},$$

with :

- $\Delta = \Delta_0 = 0$, if $\rho\alpha_A\overline{\theta}_B \leq \alpha_B\overline{\theta}_A$, and/ or if parallel imports are legally forbidden.
- $\Delta_m = \dfrac{\rho\alpha_A\overline{\theta}_B - \alpha_B\overline{\theta}_A}{2(\rho(2-\rho)\alpha_A + \alpha_B)}$, if $\rho\alpha_A\overline{\theta}_B > \alpha_B\overline{\theta}_A$, parallel imports are permitted, and their market is monopolistic.
- $\Delta_c = \dfrac{\rho\alpha_A\overline{\theta}_B - \alpha_B\overline{\theta}_A}{2(\rho\alpha_A + \alpha_B)}$, if $\rho\alpha_A\overline{\theta}_B > \alpha_B\overline{\theta}_A$, parallel imports are permitted, and their market is competitive.

Table 1

	Country A	Country B	Parallel importer
Prices	$p_A = \dfrac{1}{\alpha_A}\left(\dfrac{\overline{\theta}_A}{2} + \Delta\right)$	$p_B = \dfrac{1}{\alpha_B}\left(\dfrac{\overline{\theta}_B}{2} - \rho\Delta\right)$	$p_w = \dfrac{\rho}{\alpha_B}\left(\dfrac{\overline{\theta}_B}{2} - \Delta\right)$
Demands	$D_A = \dfrac{\overline{\theta}_A}{2} - \Delta$	$D_B = \dfrac{\overline{\theta}_B}{2}$	$D_w = \Delta$
Cons. surplus	$CS_A = CS_A^* - \dfrac{\Delta}{2}(\overline{\theta}_A - \Delta)$	$CS_B = CS_B^* + \dfrac{\rho\Delta}{2}(\overline{\theta}_B + \Delta)$	
Profits	$\Pi_m = \Pi_m^* - \dfrac{\Delta}{2\alpha_A\alpha_B}(\rho\alpha_A\overline{\theta}_B - \alpha_B\overline{\theta}_A)$		$\Pi_w = \Delta\left\{\dfrac{\rho}{\alpha_B}\left(\dfrac{\overline{\theta}_B}{2} - \Delta\right) - \dfrac{1}{\alpha_A}\left(\dfrac{\overline{\theta}_A}{2} + \Delta\right)\right\}$
Public expenses	$PE_A = \dfrac{1-\alpha_A}{\alpha_A}\left\{\left(\dfrac{\overline{\theta}_A}{2}\right)^2 - (\Delta)^2\right\}$	$PE_B = \dfrac{1-\alpha_B}{\alpha_B}\left\{\left(\dfrac{\overline{\theta}_B}{2}\right)^2 - \rho(\Delta)^2\right\}$	

The term Δ allows us to present the equilibrium solution in Table 1 in an uniform way, independently on the situation considered : either no market for parallel imports, or monopolistic parallel imports market, or competitive parallel imports market. Thus, in order to compare these three situations, it is enough to focus on Δ.

If $\rho\alpha_A\overline{\theta}_B \leq \alpha_B\overline{\theta}_A$, then allowing or not parallel imports does not make any difference, since $\Delta = \Delta_0 = 0$. In that case, the market conditions in both countries are very similar. That can be seen adding our assumption on the market asymetry :

$$\frac{\overline{\theta}_A}{\alpha_A} < \frac{\overline{\theta}_B}{\alpha_B},$$

to the condition characterizing the situation discussed now :

$$\rho\alpha_A\overline{\theta}_B \leq \alpha_B\overline{\theta}_A < \alpha_A\overline{\theta}_B.$$

With such a similarity between the market conditions of both countries, the room for the monopoly producer to price discriminate is very limited, whenever parallel imports are tolerated or not. Therefore, no parallel importer could take advantage of this price difference to attract clients in country *B*.

If $\rho\alpha_A\overline{\theta}_B > \alpha_B\overline{\theta}_A$, market conditions in both countries are different enough, so that parallel trade occurs if it is allowed. We can discuss the effects of allowing parallel imports, independently on whether the parallel imports market is competitive or monopolistic. In both cases, $\Delta>0$, which can be compared to the benchmark situation where parallel imports are forbidden and $\Delta=0$.

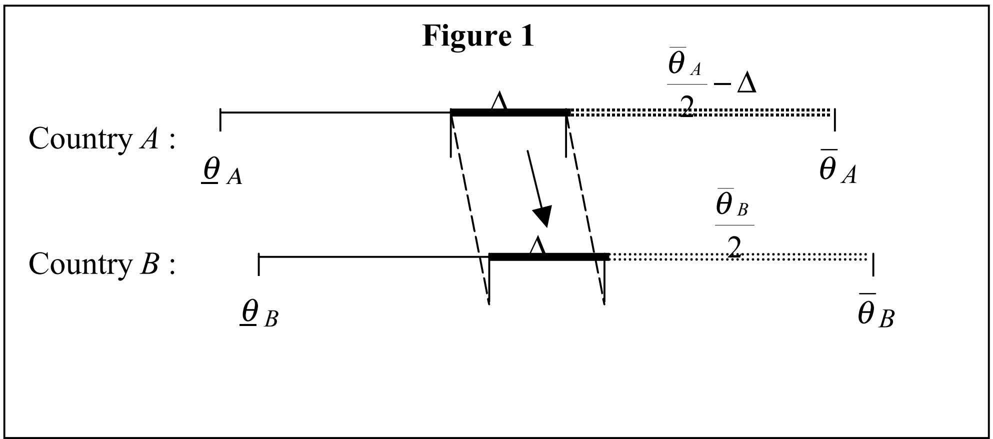
In Table 1, we see that allowing parallel imports makes the prices in both countries converge : p_A increases and p_B decreases. The intuition of this result is as follows. When PI are not allowed, the monopolist maximizes his profits by price-discriminating between the two countries. When parallel imports are allowed, the monopolist increases p_A and decreases p_B, thus making prices converge, in order to limit the effect of competition associated with the parallel trade in country B.

The main difference between a competitive parallel import market and a monopolistic one can be understood when realizing that $\Delta_m < \Delta_c$. This implies that the price convergence due to parallel imports is stronger when the parallel import market is competitive. This happens because the afore-mentionned trade-off and its resulting price effect are stronger when the potential competition from parallel importers is stronger, thus when the parallel imports market is competitive. Consequently, all the remaining effects associated with parallel imports are stronger when the parallel import market is competitive.

The price set by the parallel importer is naturally higher or equal than the price paid in country *A*, and it is lower than the price of the competing drug supplied by the producer in country *B*. Given the convergence in price, we have that :

$$p_A^* < p_A \le p_w < p_B < p_B^*.$$

Therefore, individuals in country *B* enjoy better prices than without parallel imports, while individuals in country *A* face a higher price.
Analyzing the demands in Table 1, we depict a re-allocation of the drug consumption from country *A* to country *B*. This can be seen graphically in Figure 1 :



Clearly, the consumers in country *B* are better off, enjoying more consumption at lower prices. The opposite happens in country *A*. This explains that CS_A is lower and CS_B is higher when $\Delta > 0$ than when $\Delta = 0$.

The monopoly producer profit is reduced due to both the competition from parallel imports in country *B*, and the lower price discrimination. The profit of the parallel importer(s) is *a fortiori* at least as high as when they do not operate on the market.

Last, one can show that the public expenses are lower in both countries when parallel imports are tolerated.

4. The welfare analysis

We now analyze how the changes induced by the parallel imports affect the total welfare[11]. We define the total welfare as the sum of consumers' surplusses net of the public expenses in both countries, and profits of both the monopoly producer and the parallel importer(s) :

$$TW = CS_A + CS_B - PE_A - PE_B + \Pi_m + \Pi_w.$$

We already know that, on the one hand, parallel imports, when they take place, provoque a positive effect on the total welfare through CS_B, PE_A, PE_B, and eventually Π_w (if the parallel importer is a monopoly ; otherwise, Π_w=0). On the other hand, they have a negative effect on the total welfare through CS_A and Π_m. In order to determine the circumstances under which the positive effect outweights the negative one, it is useful to compare the total welfare when parallel imports are allowed, *TW*, with the one characterizing the benchmark case, *TW** :

$$TW = TW^* + \frac{\Delta}{2}\left(\rho\bar{\theta}_B - \bar{\theta}_A - (1+\rho)\Delta\right),$$

where :

$$TW^* = CS_A^* + CS_B^* - PE_A^* - PE_B^* + \Pi_m^*$$

One can show that parallel imports increase the total welfare only if :

$$\rho\bar{\theta}_B - \bar{\theta}_A > (1+\rho)\Delta .$$

Given our assumptions, and the condition for the parallel imports to take place ($\rho\alpha_A\bar{\theta}_B > \alpha_B\bar{\theta}_A$), parallel trade can result either in an increase or in a decrease of the total welfare. When decomposing the total welfare into the sum of the consumers' surplusses on the one hand, and the sum of the profits net of the public expenses on the other hand, we notice that an increase in welfare can occur only when the gain for the consumers in country *B* is sufficiently larger than the loss for the consumers in country *A*. This happens because the sum of the profits net of the public expenses always decreases due to parallel trade :

$$\sum_{j=m,w}\Pi_j + \sum_{i=A,B} PE_i = \sum_{j=m,w}\Pi_j^* + \sum_{i=A,B} PE_i^* - (1+\rho)\Delta^2 .$$

On the other hand, the sum of the consumers surplusses,

$$\sum_{i=A,B} CS_i = \sum_{i=A,B} CS_i^* + \frac{\Delta}{2}\left(\rho\bar{\theta}_B - \bar{\theta}_A + (1+\rho)\Delta\right),$$

increases with parallel imports when

$$\rho\bar{\theta}_B - \bar{\theta}_A + (1+\rho)\Delta > 0 .$$

This condition holds when countries only differ in the distribution of valuations for the drug, reflected in $\bar{\theta}_i$, *i*= *A*, *B*. This is the case when we consider countries with similar health systems, but with different valuations for the drug due, for instance, to differences in the endemic illnesses suffered by their populations. In that case, the condition under which parallel imports would take place reduces to $\rho\bar{\theta}_B > \bar{\theta}_A$. Therefore, in this situation, the increase in the consumers surplus in country *B* more than compensates the decrease in the one of country *A*. One explanation for that relies on the re-allocation of the drug consumption from country *A* towards country *B*. The parallel imports would make the individuals in country *A* with a valuation :

$$\theta \in \left[\frac{\bar{\theta}_A}{2}, \frac{\bar{\theta}_A}{2} + \Delta\right],$$

give up consuming the drug. While in country *B*, individuals with a valuation :

$$\theta \in \left[\frac{\bar{\theta}_B}{2} - \Delta, \frac{\bar{\theta}_B}{2}\right],$$

start consuming the drug thanks to the parallel trade. Therefore, we have a re-allocation from individuals valuing the drug less towards individuals valuing the drug more, since :

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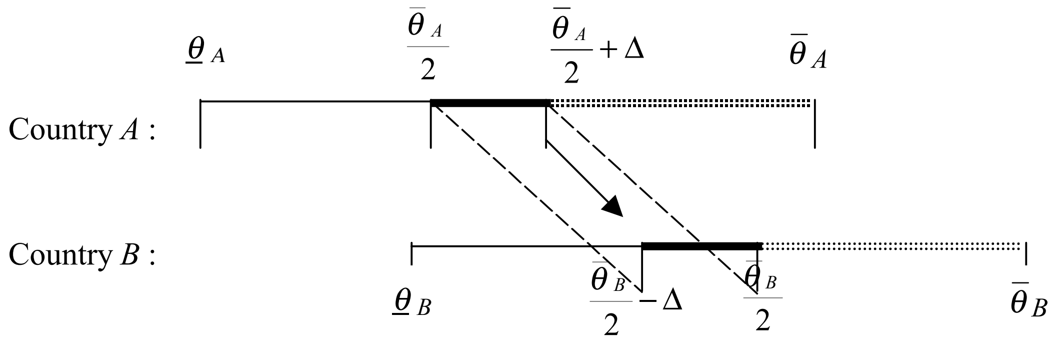
[11] We do not examine country welfare because the effects of parallel imports on the level of national welfare depend on the location of the firms (i.e., the wholesaler and the monopolist).

$$\frac{\overline{\theta}_A}{2} + \Delta < \frac{\overline{\theta}_B}{2} - \Delta,$$

whenever $\Delta \in \{\Delta_m, \Delta_c\}$. This intuition can be seen graphically in Figure 2.

Figure 2



As a general result, we have thus that parallel imports increase the total welfare when they take place between countries differing only in the distribution of the valuations for the drug among their population.

Another interesting case considers two countries differing only in their health care system, reflected in the co-payment for buying the drug. We can think of countries with similar health needs and different social security systems. Some countries in the European Union satisfy these characteristics. In this case, $\overline{\theta}_A = \overline{\theta}_B = \overline{\theta}$, and the condition for parallel trade to take place is $\rho\alpha_A > \alpha_B$. The total welfare can be rewritten as :

$$TW = TW^* - \frac{\Delta}{2}\left((1-\rho)\overline{\theta} + (1+\rho)\Delta\right).$$

Therefore, parallel imports decrease the total welfare in this case, even when the sum of the consumers surplusses is positive, which occurs only when :

$$\rho > \frac{\overline{\theta} - \Delta}{\overline{\theta} + \Delta}.$$

We have now a re-allocation of the drug consumption from individuals in country A with a higher valuation :

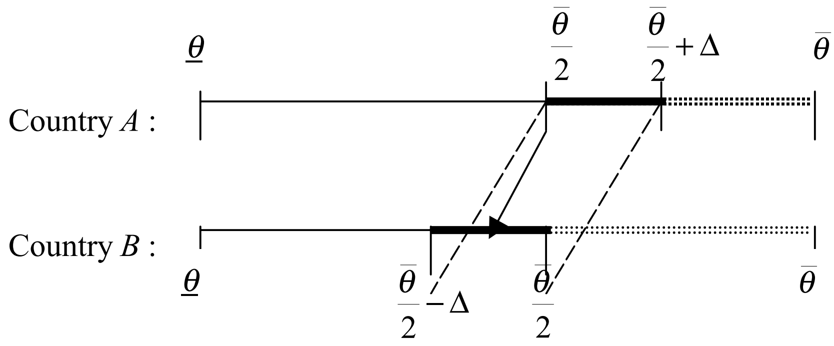
$$\theta \in \left[\frac{\overline{\theta}}{2}, \frac{\overline{\theta}}{2} + \Delta\right],$$

towards individuals in country B with a lower valuation :

$$\theta \in \left[\frac{\overline{\theta}}{2} - \Delta, \frac{\overline{\theta}}{2}\right].$$

This can be seen graphically in Figure 3.

Figure 3



5. Conclusions

With this paper, we participate to the ongoing debate over the benefits and drawbacks from allowing parallel trade among countries. We use a model that accounts for the differences between countries in terms of health system (reflected in the level of patients co-payments), and in terms of drug needs (reflected in the patients valuation for the drug). Our main findings are the following.

First, we confirm some results already discussed in the ongoing debate : Parallel trade makes the prices converge between countries, it makes the individuals in the importing country better off, while making the ones in the exporting country worse off, and they decrease the profit of the monopoly producer. Moreover, we show that the public expenses in both the importing and the exporting countries are reduced with parallel trade.

Second, we show that the effect of parallel imports on the total welfare is ambiguous. This certainly contrasts with the numerous statements made over the negative effect of parallel trade on the total welfare, associated with a lower international price discrimination. These statements ignore the positive effects associated with the increased competition faced by the monopoly producer in the importing country.

We then identify two cases where the effect of allowing parallel trade on the total welfare can be stated unambiguously. On the one hand, parallel trade is shown to increase the total welfare when it takes place between two countries differing in their health needs only. The rationale behind this positive effect relies on the re-allocation of the drug consumption from individuals with relatively low drug needs in the exporting country, towards individuals with relatively higher drug needs.

On the other hand, parallel trade is shown to decrease the total welfare when it takes place between countries differing in their health system only. In that case, the drug consumption is re-allocated from individuals with relatively more drug needs to individuals with relatively less drug needs.

Our analysis is made maintaining the level of income equal between the countries. Therefore, our results are applicable to trade taking place between countries of similar income levels. A direct interpretation of our results would be the following : On the one hand, parallel trade would increase the total welfare when it takes place between two developing countries with the same level of income and patients co-payments, and different drug needs, to account for the higher needs for malaria or AIDS treatment in some developing countries than in other ones. On the other hand, parallel trade between industrialized countries, characterized by similar high income levels and epidemiological conditions, and differents drug reimbursement levels, would decrease the total welfare.

When we consider parallel trade between countries with different income levels, such as the trade between developing countries and developed ones, we should carefully add the well known effects of parallel trade between a poor country and a rich country (re-allocation of the consumption from the poor country towards the rich one) to the effects identified in the present paper.

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