Vertical structures and opportunistic behaviour in international markets. An analysis of parallel trade

Giorgio Matteucci, Pierfrancesco Reverberi
Dipartimento di Informatica e Sistemistica, Università degli Studi di Roma "La Sapienza"
Via Buonarroti, 12 – 00185 Roma, Italia
e-mail: {matteucci, reverberi}@dis.uniroma1.it

ABSTRACT

Parallel trade is a trade practice related to arbitrage in international markets, mainly affecting the pharmaceutical industry in the European Union. This paper provides a rationale for parallel trade as an opportunistic behaviour by an international wholesaler having private information about local demand in two distinct markets where a multinational firm operates. This issue is illustrated in a signalling game where the wholesaler signals on market size through the quantities demanded to the multinational. As long as price differentials between countries are remarkable (possibly due to asymmetric regulation regimes) and transport costs are low, the perfect Bayesian equilibria of the game indicate that parallel trade has the effect of transferring profits from the multinational (possibly an innovative firm) to the wholesaler (a non innovative firm). In addition, it is shown that, contrary to the aims of the European Commission, parallel trade does not enhance consumer surplus, unless wholesale competition is granted.

Keywords. International trade, multinational firms, vertical relations, asymmetric information, signalling games.

1. INTRODUCTION

Parallel trade is a trade practice related to forms of arbitrage in international markets. A multinational firm is supposed to have two plants producing the same drug that are located in two different countries where price differentials are high. A local distribution firm buys on the low-price market a product quantity larger than the real market needs and then sells the quantity in excess to an intermediary, known as parallel importer, that in turn sells the product in the other market. In the high-price country, a local distribution firm buys simultaneously the same product both from the domestic production plant and from the parallel importer. Thus, the same product is sold in the same market coming from different sources (Figure 1).

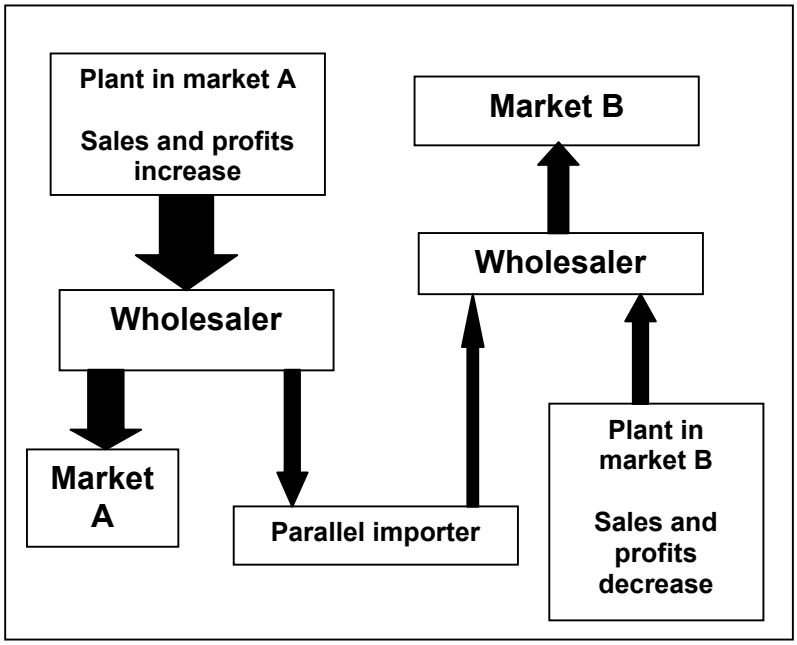

Figure 1. Parallel Trade.

Because of the parallel importer's activity, the subsidiary of the multinational firm in the low-price market increases its production and profits, while the one in the high-price market reduces its production and profits. Due to price differentials between countries, the multinational firm as a whole witnesses a fall in its joint profits (Darba and Rovira, 1998).

According to Datamonitor (1997) and IMS (1999), parallel trade is gaining a growing importance in the pharmaceutical industry and, particularly, within the market of ethical drugs (that is, drugs sold under prescription and totally or partially reimbursed) in the EFTA (European Free Trade Area) countries. At present, the Association of Pharmaceutical Importers estimates that in the UK the market value of parallel trade is about 410 million U.S. dollars at reimbursement prices, that is to say 8% market share and 7.7% of the National Health Service expenditure. Data are even more significant in some specific cases: according to an estimate of the Merck & Co, parallel trade for Timoptic (which is an anti-glaucoma drug) reaches 56% and for Renitec (a cardiovascular drug) 50% of the UK market sales.

In Germany, parallel trade ranges around 350 million dollars at ex-factory prices and about twice as much at market prices. According to estimates of the German Importers' Association, the potential market for parallel trade consists of 70,000 prescription drugs and might reach the value of 3.5 billion dollars. In the Netherlands, parallel imports have reached about 13% of the ethical-drug market and concerns 9 out of the top 10 firms.

Parallel trade would have no point without the Treaty of Rome (1958) that affirms the principle of free circulation of goods in the EU. Parallel trade has been indicated by the European Commission as a possible means to harmonize the European pharmaceutical market and enhance consumers' welfare (European Commission, 1998a, 1998b). Nevertheless, the remarkable price differentials existing among the various EU countries show that parallel trade has no levelling effects on prices. On the other hand, multinational firms claim to be seriously damaged by parallel trade, which mainly affects the most innovative products, that are sold at higher prices and represent the main source of revenues for manufacturers.

An interesting case-study concerns the Bayer group, which is one of the major multinational firms in the pharmaceutical industry world-wide (Datamonitor, 1997). In 1989 Bayer launched Adalat, a drug designed to treat cardiovascular illness that (according to

Bayer) in a few years reached around 8% of the relevant EU market, around 7% and 9% in treatments for coronary insufficiency and hypertension respectively in Spain, 5% and 4% of the same markets in France, and 20% and 17% in the UK.

Adalat provides a clear example of how the same ethical drug manufactured in different countries by the same multinational firm can be affected by parallel trade due to price differentials between countries. Actually, between 1989 and 1993 the prices fixed by the Spanish and French Departments of Health were, on average, 40% lower than prices in the UK. Because of these price differentials, wholesalers in Spain and France exported Adalat to the UK. Adalat represents a large percentage of total turnover of Bayer UK, figures such as 56% having been quoted in recent years. On account of the parallel imports, sales of Adalat by Bayer UK fell by almost half between 1989 and 1993, thus equating to a loss of revenue of 160 million US dollars for the British subsidiary and a loss of 70 million US dollars to Bayer group as a whole.

Faced with this situation, Bayer Spain and Bayer France decided that they would no longer fulfil all orders placed by wholesalers in Spain and France respectively. Thus Bayer stopped responding to orders for supplies from certain wholesalers identified by a system designed to find those wholesalers who had increased their orders by inordinate proportions over the past years. The aim behind this practice was to target the main export suppliers in order to reduce the volumes of product channelled into the parallel import market.

The main problem the manufacturers have regarding the regulation of exports is that as soon as they have sold their products to the wholesalers, they have no further direct control over the product final destination. This issue induced Glaxo Wellcome to introduce an agency distribution scheme in the UK in 1991, in an attempt to gain more control over the distribution of its products. As part of the agreement, the wholesaler had to supply Glaxo Wellcome with detailed sales data on the destination and volumes of some Glaxo Wellcome's

products sold. This was primarily intended to ensure that the wholesaler was not exporting any of its products to Germany, where the prices of such products are higher than in the UK. Since this scheme caused an outrage among wholesalers when it was introduced, Glaxo Wellcome has decided not to extend it to include any further products. It is however worth noting that the wholesalers' discretionary power is often limited by the fact that they have a legal obligation to supply their domestic market first.

The central argument of this paper claims that the scope for parallel trade is related to the wholesalers having private information about final demand in national markets. Actually, parallel trade could be easily prevented if firms were able to monitor local markets. This point is illustrated through defining and solving a signalling game which describes the strategic interactions between two subsidiaries of a multinational firm located in two different countries and an international wholesaler operating in the same markets. In particular, the wholesaler aims at obtaining product quantities larger than the actual demand in the low-price market and lower than the actual demand in the high-price market, so as to rearrange distribution costs at his own benefit.

It is shown that generally this practice -far from enhancing consumers' welfare- simply transfers profits from the manufacturer to the wholesaler. In addition, it is shown that price regulation may emphasize this behaviour and that only downstream competition reduces the wholesalers' market power to the benefit of final consumers.

The remainder of the paper is organised as follows. Section 2 describes the European pharmaceutical industry. Section 3 concerns parallel trade, focusing on its determining factors. Section 4 defines the theoretical model and identifies the agents' optimal strategies. Section 5 analyses welfare implications, while Section 6 contains some concluding remarks.

2. THE PHARMACEUTICAL INDUSTRY IN EUROPE

Virtually all major pharmaceutical firms have subsidiaries world-wide that are involved in manufacturing and selling drugs. This results in an oligopolistic industry structure that is highly concentrated at an international level. Actually, finished pharmaceutical products are produced in more than 90 countries having facilities which essentially consist of the local plants of the main multinational groups (Schweitzer, 1997).

Firms of different size and nature operate in Europe. These can be classified as follows:

- large multinationals carrying out research projects in various countries (most of them are present in all member states) and controlling 65% of the market;
- medium-size firms operating in specialised market segments, controlling 30% of the market;
- a vast number of small local firms.

The pharmaceutical industry represents a key sector in the European economy. At present, the European pharmaceutical expenditure accounts on an average for 15% of the overall health care expenditure, which represents 8% of the GDP of the various countries. In the last fifteen years, production has tripled and exports has quintupled while at the same time payment for pharmaceuticals by statutory health insurance has grown of about 300%. The following table sums up the evolution of this sector in recent years.

	1985	1990	1997	1998	1999
Production	39821	63207	87162	109322	115000
Exports	14854	23180	44032	66533	74000
Imports	9724	16113	30183	46219	50000
R&D expenditures	4310	7871	10787	14229	15000
Employees	437613	500400	504014	519350	520000
R&D employees	63000	76287	79197	82589	82500
Market value:					
at manufacturer's prices	27576	42995	59174	75367	80000
at retail prices	43714	67247	91905	111878	117000
Payment for pharmaceuticals by statutory health insurance	26711	42263	57995	76112	80000

Table 1. Industrial sector figures (in million euros). Source: EFPIA, 2000.

Over the past few years, the pharmaceutical industry in Europe has however been facing ever more binding restraints to free market forces. Moreover, the fragmentation of the health care systems in the different countries as well as the frequent changes in the regulatory regimes have jeopardized firms' planning activities.

The competitiveness of a pharmaceutical firm mainly derives from its innovative activity. Research and development projects in this sector take a long time period, require a huge amount of resources and present a high degree of risk. This is due to the growing complexity of products, to country-specific regulatory measures and to administrative 'delays' linked to the approval process for new drugs. Since the discovery of a new active principle, it takes about 12-13 years to launch it on the market, while the average cost for the whole process is €560million (EFPIA, 2000).

Up to 1990s, Europe used to be the world leader in pharmaceutical research. Nevertheless, currently Europe seems to be less attractive for research investments compared to the United States (US). Between 1990 and 1998, European investments in R&D have become twice as much while the US investments have more than tripled. Actually, the evolution of the pharmaceutical industry in the US has shown that the introduction of a higher grade of competition may promote firms' research activities by providing incentives to innovate (EFPIA, 2000; Schweitzer, 1997).

Pharmaceutical industry is characterized by a rigid vertical structure motivated on the ground that drug distribution is a very hard task and makes downstream integration unprofitable in the great majority of cases. As far as the downstream segment of the industry is concerned, a factor that is likely to have a profound impact on the forms of product distribution is the emergence of pan-European wholesalers.

Companies such as Unichem of the UK have links with several foreign distribution firms in France, Germany and the Netherlands. Gehe, a German distribution firm, has recently become the European market leader by acquiring the French OCP and the British AAH companies. Currently, Gehe controls 19% of the German national market as well as 41% and 30% of the French and UK national markets respectively, thus reaching 24% of the whole European market. As a result, 79% of Gehe's turnover and 55% of its gross profits may be attributed to foreign activities.

This trend towards concentration and internationalisation in the distribution segment, producing pan-European chains, improves wholesalers' bargaining position in front of manufacturers. The table below shows the high degree of concentration in distribution in a number of national EU markets.

Country	Firm	Market share %
Denmark	Nomeco KV Tjellesen Max Jenne	100%
France	Groupe OCP Alliance Santé Les CERP	95%
Germany	Phoenix Gehe Sanacorp	66%
Italy	Alleanza Salute Adivar Unifarma	25%
Netherlands	OPG Brocacef Interpharm	80%
Spain	Cofares SAFA Murciana	32%
Sweden	ADA Kronans Droghandel	100%
UK	AAH UniChem	61%

Table 2. National market shares for the major distribution firms. Source: Mac Arthur, 1997.

3. PARALLEL TRADE

Parallel trade has been spreading in Europe thanks to significant price differentials between national markets and thanks to the guaranteed free circulation of goods. Thus, price differentials have given rise to potential profits in arbitrage, while free trade has created the opportunity.

The main countries where parallel trade originates are Belgium, France, Italy and Spain, which - together with Portugal and Greece - are low-price markets compared to the other EU countries. This is not due to their higher productive efficiency, but rather to price regulation policies pursued by their governments. Indeed, in countries such as Denmark, Germany, Great Britain and the Netherlands it is mainly the higher degree of freedom manufacturers use to have on setting prices that has given rise to high-price markets.

Both price differentials between countries and free trade represent however necessary but not sufficient conditions for parallel trade. Other important features to be taken into account include suitable product characteristics, a capillary distribution network and consumers' attitudes. Historically, ethical drugs represent the main goal for parallel importers for two reasons: first, these drugs are generally associated with the highest price differentials and, second, these drugs are not competitive with generic drugs because they are patented.

3.1 Price differentials

Price differentials between EU countries are the main incentive to parallel trade. In most cases, the difference between the price applied to wholesalers in the exporting country and that applied in the importing country -which creates the wholesaler's gross margin- must exceed 20% to make this form of international arbitrage profitable, though for expensive products 15% may be enough to recover packaging and transportation costs.

	Source				
Destination	**Germany**	**France**	**Italy**	**Spain**	**UK**
Germany	-				
France	36%	-			
Italy	29%	21%	-		
Spain	32%	16%	4%	-	
UK	3%	-21%	-20%	32%	-

Table 3. Ex-manufacturer price differentials. Source: Datamonitor, 1999.

	Source				
Destination	**Germany**	**France**	**Italy**	**Spain**	**UK**
Germany	-				
France	57%	-			
Italy	52%	38%	-		
Spain	30%	18%	-65%	-	
UK	-21%	-24%	-106%	-65%	-

Table 4. Hospital price differentials. Source: Datamonitor, 1999.

Price differentials between countries at ex-factory and hospital prices are reported in Tables 3 and 4, where the columns are associated with the source countries while the rows are associated with the destination countries (for instance, a price differential of 36% between Germany and France means that in Germany ex-factory prices are on an average 36% higher than France).

3.2 Price regulation

Direct price control occurs when regulators impose direct actions on the price of individual products. It is in place in most member states of the EU, with Germany and the UK as exceptions. Where direct price control is used, the price of a newly launched drug has already been decided before its launch date. The price is determined between regulators -usually the

governments- and the manufacturers of the product (this does not mean that prices are necessarily controlled after launch). Indirect price control includes all strategies that do not affect the price of individual products, but instead restrict manufacturers' profit levels or purchasers' budgets. The following table summarizes and describes the price regulation measures adopted in a number of EU countries.

Control	Description	Type	Countries
Average pricing	This method uses an average price of a number of similar products to set the price for all products in a given category.	**Direct**	Italy
International price comparison	International price comparison strategies consider prices of the same product in other countries to set a price in the relevant country.	**Direct**	Spain
Price cut	Price cutting normally only occurs when a new, innovative product enters the market. Authorities may then cut the price for the already existing products in its class to avoid upward spiralling prices in the therapeutic area concerned.	**Direct**	Germany, UK, Spain
Cost pricing	Cost pricing means that a certain margin is added to the actual production costs. It is one of the most basic systems of product pricing.	**Direct**	Spain
Profit control	Profit control. It is a system that the Pharmaceutical Price Regulation Scheme (PPRS) has set up to control profits manufacturers make by selling their products to the National Health Service (NHS). Profit control influences which prices can be set, even though a specific product price is not given.	**Indirect**	UK
Reference pricing	It works by setting a fixed reimbursement price level for a group of products that compete against each other. This reimbursement level is generally set higher than the price of the lowest priced product in the basket and lower than the highest price.	**Indirect**	Germany, Italy
Primary care physician budget	In some countries, primary care physicians are used as gatekeepers for healthcare provision. There has been a trend in recent years towards making these gatekeepers, which also have strong prescribing power, responsible for containing costs by having a fixed budget for each patient's treatment.	**Indirect**	Germany, Italy, UK
Pharmaceutical expenditure ceiling	A set ceiling can exist that determines pharmaceutical expenditure within a nation's budget. This system is very hard to control. In those countries where it is being used, the budget has been exceeded several times.	**Indirect**	Italy, Spain
Generic promotion	Promoting the use of generics instead of branded products (which are generally more expensive) is an easy way for authorities to control costs without affecting the quality of treatment.	**Indirect**	Germany, UK

Table 5. Different forms of price control. Source: Datamonitor, 1999.

4. THE MODEL

The present section analyses formally the scope for parallel trade in vertical relations between manufacturers and wholesalers within partially-integrated multiple markets. For this purpose, it is assumed that a manufacturer has two plants producing the same good located in two different countries (*A* and *B*) and that a wholesaler deals with the sales of the good in both final markets.

Demand in each market is independent of the other market's demand. To satisfy some regularity conditions, demand functions must be monotonically decreasing for growing prices and finite for a null price. Let final demands be linear, which is a feasible assumption in the pharmaceutical industry (see e.g. Danzon, 1997; Elzinga e Mills, 1997; Zweifel and Breyer, 1997). Let q_A, q_B be the produced quantities under complete information. Hence, the final prices in the two markets are determined according to $p_A = a_A - bq_A$ and $p_B = a_B - bq_B$.

Let w_A, w_B denote the intermediate prices of the good in countries *A* and *B*. For simplicity, it is assumed that in each country the producer has null marginal and fixed costs while the only cost incurred by the wholesaler is related to purchasing the good at its intermediate price.

Under complete information, the optimal strategies of the manufacturer (*M*) and the wholesaler (*W*) are determined by solving:

$$\max_{w_A, w_B} \Pi_M = w_A q_A + w_B q_B$$

$$\max_{q_A, q_B} \Pi_W = [(a_A - bq_A)q_A - w_A q_A] + [(a_B - bq_B)q_B - w_B q_B].$$

Thus, the multinational firm chooses intermediate prices maximizing her joint profit, that is given by the sum of the profits obtained in the two countries. On the other hand, the wholesaler chooses the quantities to be sold in each market (that are equal to those demanded to the manufacturer) so that his joint profit is maximized. Note that in this case parallel trade

is prevented since the manufacturer has complete information about final demands. Hence, the optimal intermediate prices and (both intermediate and final) quantities are easily derived:

$$\overline{w}_A = a_A/2;\ \overline{w}_B = a_B/2;\quad \overline{q}_A = (a_A - \overline{w}_A)/2b = a_A/4b;\ \ \overline{q}_B = (a_B - \overline{w}_B)/2b = a_B/4b.$$

The obtained results directly extend to the case of two markets the classical theory of vertical relations between two monopolists in a single market (see e.g. Tirole, 1988) and represent a benchmark case for the following analysis under incomplete information.

In the pharmaceutical industry, wholesalers have more accurate information on final demand levels than manufacturers. Their deeper knowledge of local markets derives from the reciprocal flows of orders and deliveries between wholesalers on the one side and chemists' and hospitals on the other side, enabling wholesalers to forecast demand sizes more thoroughly than manufacturers. It follows that a wholesaler may exploit this information advantage to his own benefit through practicing parallel trade. This consists in modifying the required quantities in such a way that is functional to arbitrage. In particular, the wholesaler would like to induce the manufacturer to produce quantities in excess with respect to the real low-price market size on the one side and less than the real high-price market size on the other side. In this framework, the quantities the wholesaler requires become a signal which the manufacturer must interpret so as to infer the parameters she does not know about market demands and possibly prevent parallel trade.

Now, suppose the wholesaler knows the demand parameters a_A, a_B in markets A and B respectively, while the manufacturer does not know the same parameters. By assumption, the demand in each country may be high (H) or low (L) so that the values which the two parameters may take are H^A, L^A, H^B, L^B respectively. The manufacturer's prior beliefs about the sizes of the two markets can be expressed according to the following probability distribution (which is common knowledge):

Prob(a_A=H^A,a_B=H^B)=P_{HH}

Prob(a_A=H^A,a_B=L^B)=P_{HL}

Prob(a_A=L^A,a_B=H^B)=P_{LH}

Prob(a_A=L^A,a_B=L^B)=P_{LL}

where $P_{ij} \geq 0$ and $\sum_{(i,j)} P_{ij} = 1 \ \forall i, j \in \{H, L\}$ (implicitly meaning that *i* refers to the size of country *A* and *j* to the size of country *B*). Assume the four possible market configurations be assimilated to the wholesaler's types (*i,j*), $\forall i, j \in \{H, L\}$.

The main wholesaler's goal is persuading the multinational firm that demand in *A* be higher and in *B* be lower than the real one by strategically requiring suitable quantities (q_A,q_B), that represent the signal the wholesaler *W* sends to the manufacturer *M*. In practice, *W* aims at transferring to country *B* part of the quantity purchased at a lower price in *A*.

Let *s* be the transport cost (including not merely the cost of physical transportation of the good from *A* to *B*, but also repackaging and other possible distribution costs). Let $w_A + s < w_B$. When this necessary condition holds, the possibility to practice parallel trade determines a difference between the quantities which *W* asks to *M* and those he sells in the two final markets. In this way, part of the quantity purchased in *A* at a price $w_A < w_B$ is re-sold in *B* at a price $p_B > p_A$.

On the basis of the quantities required by *W*, *M* updates her prior beliefs about the sizes of the two markets, thus obtaining the *a posteriori* probability distribution $\text{Prob}((i,j) | (q_A, q_B)) = \hat{P}_{ij}$, $\forall i, j \in \{H, L\}$. Then, *M* determines the intermediate prices and the quantities she sells to *W* -not necessarily equal to (q_A,q_B)- which maximize her (expected) profits:

$$\max_{w_A, w_B} \Pi_M = \sum_{(i,j)} \hat{P}_{ij} \left(w_A q_A + w_B q_B \right).$$

Only in the case whereby -following upon the observation of (q_A,q_B)- *M* correctly infers the values of the unknown parameters, then (q_A,q_B) coincide with the quantities sold from *M* to *W* and then from *W* to final consumers in the two markets. Generally, $q_A \geq Q_A$ and $q_B \leq Q_B$, where Q_A, Q_B (in capital letters) are the quantities sold in the final markets which are distinguished from q_A, q_B (in small letters) that are the quantities required to *M*. It is assumed that the wholesaler cannot create inventories nor can he buy quantities of the good which he does not resell. This implies that the sum of the quantities required to *M* must coincide with the sum of the quantities sold by *W* in the two countries (that is, $q_A + q_B = Q_A + Q_B$).

The wholesaler chooses quantities demanded and sold which maximise his profit, that can be expressed as follows:

$$\max_{q_A,q_B} \Pi_W = (a_A - bQ_A)Q_A + (a_B - bQ_B)Q_B - w_A Q_A - (w_A + s)(q_A - Q_A) - w_B q_B .$$

Note that the wholesaler has a legal obligation to supply final markets according to their demand levels. Hence, Q_A, Q_B always correspond to the actual market sizes, thus equating the quantities determined in the case with complete information, that is: $Q_A = (a_A - w_A)/2b; Q_B = (a_B - w_B)/2b$.

4.1 Strategies and equilibria

The wholesaler may exploit private information about final demands by either revealing the multinational firm the exact market sizes or by trying to convince her that the two markets' sizes are other than the real ones. In the former case, for each possible demand configuration *W* requires the corresponding quantities and he is said to adopt a *separating* strategy. As a consequence, *M* is able to infer the actual levels of final demands. In the latter case, the required quantities do have the same value irrespective of the demand levels and *W* is said to adopt a *pooling* strategy. Therefore, *M* cannot infer the real market sizes so that she produces

quantities of the good different from those she would have produced under complete information.

Intuitively, these strategies can be described through a very simple example. Assume the four possible final demand configurations be described by four different fillings and that the quantities required by *W* to *M* be associated with the same four possible fillings as well. A strategy for *M* consists in suitably combining demand size fillings with required quantity fillings. Thus, in graphical terms, a separating strategy means combining quantities and market sizes of the same filling. On the other hand, a pooling strategy means different fillings may be combined together: for instance, the same quantity filling is associated with any market size filling (see Figure 2).

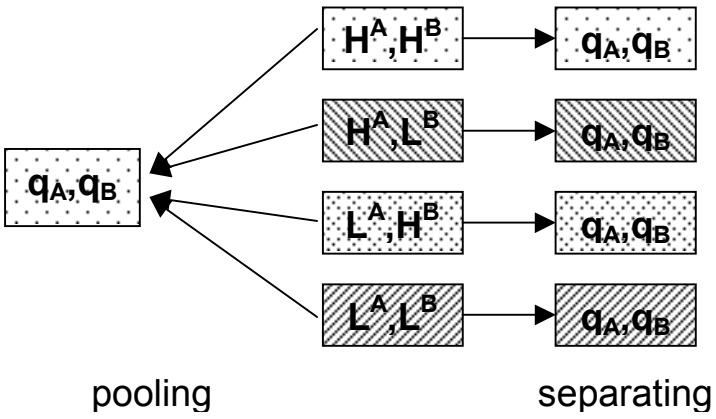

Figure 2. Strategy definition.

When the wholesaler adopts either of these strategies within the whole range of demand configurations, he is said to play *pure strategies*. In the case whereby *W* adopts a pooling strategy for a subset of configurations and a separating strategy for the remaining subset, *W* is playing a hybrid strategy (i.e. a partially-pooling or a semi-separating strategy).

The described game is a signalling game. The appropriate solution concept for this class of games is the perfect Bayesian equilibrium (PBE). The definition of a perfect Bayesian equilibrium consists of a set of strategies and beliefs such that, at each stage of the game,

strategies are optimal given beliefs, and the beliefs are obtained from equilibrium strategies and observed actions using Bayes' rule (Fudenberg and Tirole 1991). A PBE of the described game is *separating* if the wholesaler adopts a separating strategy, while it is *pooling* if the wholesaler adopts a pooling strategy.

Proposition 1. There exists a partially-pooling equilibrium where:

$$(q_A, q_B)^*_{HH} = \left(\frac{H^A}{4b}, \frac{H^B}{4b} \right); \quad (q_A, q_B)^*_{LL} = \left(\frac{L^A}{4b}, \frac{L^B}{4b} \right)$$

$$(q_A, q_B)^*_{HL} = (q_A, q_B)^*_{LH} = \left(\frac{H^A}{4b}, \frac{L^B}{4b} \right)$$

where $(q_A, q_B)^*_{ij}$ indicates the optimal quantities required by type (i, j), $\forall i, j \in \{H, L\}$.

In the following, a qualitative sketch of the proof is provided (for a detailed formal proof, see Matteucci and Reverberi, 2000). Intuitively, if transport costs are not too high, type (*L,H*) draws some benefits in imitating type (*H,L*). Actually, (*L,H*) reduces his costs by purchasing quantities larger than the real demand in market *A* and lower than the real demand in market *B*. In the hybrid equilibrium, *M* produces the same quantities for types (*H,L*) and (*L,H*), thus obtaining a profit $\left[\left(H^A\right)^2 / 8b + \left(L^B\right)^2 / 8b \right]$. If she had correctly identified type (*L,H*) practising arbitrage, she would have obtained a profit $\left[\left(L^A\right)^2 / 8b + \left(H^B\right)^2 / 8b \right]$. It follows that, under some general conditions related to market sizes and transport costs, parallel trade makes the manufacturer perceive profits smaller than those she would have perceived under complete information.

When transport costs exceed a critical threshold level, or the sizes of the two markets are not suitable for parallel trade, the wholesaler adopts a separating strategy so that he does not practice arbitrage. Hence, it is possible to prove the following result (see Matteucci and Reverberi, 2000).

Proposition 2. There exists a separating equilibrium where:

$$(q_A, q_B)^*_{HH} = \left(\frac{H^A}{4b}, \frac{H^B}{4b} \right); \; (q_A, q_B)^*_{LL} = \left(\frac{L^A}{4b}, \frac{L^B}{4b} \right)$$

$$(q_A, q_B)^*_{HL} = \left(\frac{H^A}{4b}, \frac{L^B}{4b} \right); \; (q_A, q_B)^*_{LH} = \left(\frac{L^A}{4b}, \frac{H^B}{4b} \right)$$

where, again, $(q_A, q_B)^*_{ij}$ indicates the optimal quantities required by type (i, j), $\forall i, j \in \{H, L\}$.

Figure 3 shows the wholesaler's optimal strategies, both in the partially-pooling and in the separating equilibria of the signalling game.

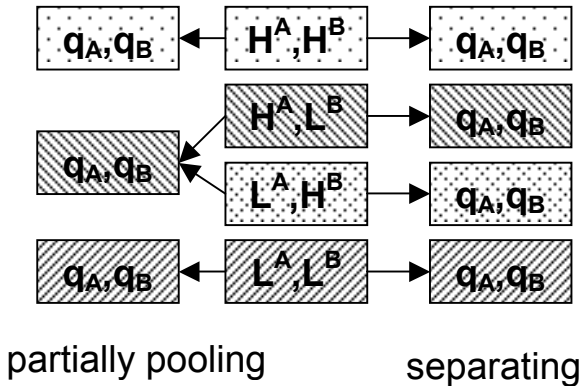

Figure 3. Optimal strategies.

4.2 Price regulation

In reality, the national governments of EU countries exert a number of different forms of price regulation. In order to take account of this issue in the proposed model, it is here assumed that the two markets are not equally regulated. In particular, it is analysed the case where market *A* is regulated whereas market *B* is not.

The main assumptions of the model dealing with regulated prices in *A* are similar to those of the basic model, except for the presence of price restraints in both stages of the manufacturer-wholesaler-final consumer chain. Note that price constraints are determined exogenously to the model (in other words, the regulator is not introduced explicitly as a third player in the game) so that they are stringent compared to the case with complete information.

It is therefore necessary to reformulate the players' optimal strategies in the presence of such price constraints.

Problem of the manufacturer:

$$\max_{(w_A, w_B)} \Pi_M = \sum_{i,j} \hat{P}_{ij} \left(w_A q_A + w_B q_B \right)$$

$$s.t.$$

$$w_A \leq \widetilde{W}$$

$$\forall i, j \in \{H, L\};$$

Problem of the wholesaler:

$$\max_{q_A, q_B} \Pi_W = (a_A - bQ_A)Q_A + (a_B - bQ_B)Q_B - w_A Q_A - (w_A + s)(q_A - Q_A) - w_B q_B$$

$$s.t.$$

$$a_A - bQ_A \leq \widetilde{P}$$

$$q_A + q_B = Q_A + Q_B$$

Similarly to the case in section 4.1, it is possible to prove the existence of a hybrid equilibrium where types (*H,L*) and (*L,H*) adopt a pooling strategy and of a separating equilibrium where type (*L,H*) discriminates (see Matteucci and Reverberi, 2000). Clearly, the actual equilibrium quantities are suitably modified due to the presence of price constraints.

Generally, the regulated market is the one where the consumers' willingness to pay is lower and therefore where prices would be lower anyway. Thus, the regulation effect is that of reducing the price level in the low-price market and further increasing the price differential with the unregulated market. While price differentials grow, the incentives to practice parallel trade increase as well.

4.3 Downstream competition

In this section, the proposed model is generalized by considering a downstream distribution segment that is not completely controlled by a single agent, but where there is competition

among a number of wholesalers. Thus, it is worth analysing the effect of an increase in the number of wholesalers on the rationale and scope for signalling strategies.

For this purpose, it is assumed that there are *n* wholesalers for the homogenous good produced by *M*. The wholesalers are differentiated owing to their geographical dispersion or for marketing reasons. Generally, the linear inverse final demand for wholesaler *x* operating with complete information can be expressed as:

$$p_x = a - bq_x - d\sum_{\substack{y=1 \\ y\neq x}}^{n} q_y$$

where $p_x, q_x, x = 1,2,..,n$ denote respectively prices and quantities relative to wholesaler *x,* while $q_y, y = 1,2,..,n, y \neq x$ denotes the quantity relative to wholesaler *y* different from *x* (see Albaek and Overgaard, 1998).

In the case when the *n* wholesalers operating in both markets have private information about final demands, the players' optimal strategies are determined by solving the following problems.

Problem of the manufacturer

$$\max_{w_A, w_B} \Pi_M = \sum_{i,j} \hat{P}_{ij}\left(w_A q_A + w_B q_B\right)$$
$$\forall i, j \in \{H, L\};$$

Problem of wholesaler x

$$\max_{q_A^x, q_B^x} \Pi_{\mathrm{W}}^x = \left(a_A - bQ_A^x - d\sum_{y\neq x} Q_A^y\right)Q_A^x + \left(a_B - bQ_B^x - d\sum_{y\neq x} Q_B^y\right)Q_B^x - w_A Q_A^x - (w_A + s)\left(q_A^x - Q_A^x\right) - w_B q_B^x$$

where Q_A^x, Q_B^x correspond to the quantities sold to final consumers in markets *A* and *B* by wholesaler *x* and q_A^x, q_B^x correspond to the quantities demanded to the multinational subsidiaries by the same wholesaler.

Although the kinds of PBE of the game are the same as those found in the previous sections (i.e., there exist a partially pooling and a separating equilibria), there are remarkable differences in the amounts of quantities sold by any wholesaler to final consumers due to competition in the distribution segment. The impact of downstream competition on social welfare is analysed in the following section.

5. WELFARE ANALYSIS

Numerical analysis is here used to provide some details about the effect of parallel trade on production, profits and market prices compared with the case whereby *M* is completely informed on final demands (so that parallel trade is prevented). In this respect, Table 6 shows the results of a simple numerical simulation where the relevant parameters have been attached to some fixed values (i.e., $L^A=2$, $H^A=4$, $L^B=8$, $H^B=10$, $s=0$).

	Without PT		With PT	
	A	B	A	B
Produced quantities	0,5	2,5	1	2
Profits (M)	13		10	
Profits (W)	6,5		9,5	
Retail prices	1,05	7,5	1,05	7,5

Table 6. A numerical simulation ($L^A=2$, $H^A=4$, $L^B=8$, $H^B=10$, $s=0$).

Table 6 clearly shows how production and profits change while final prices are not modified in the presence of parallel trade. Note that the manufacturer's profit loss attributable to parallel trade is proportional (in this case, equal) to the wholesaler's profit gain.

On the basis of the theoretical analysis carried out in section 4, as well as of the example above, the following conclusions can be drawn.

Conclusion 1. *In a partially-pooling equilibrium of the game, the quantities demanded to manufacturer M are such that they only partially reveal the actual market sizes. As a*

consequence, the multinational firm is unable to perfectly discriminate between the types of the wholesaler. Hence, she may produce quantities which do not correspond to the real demand levels, thus obtaining a joint profit lower than the one she would have obtained under complete information.

Indeed, the wholesaler's type (*L,H*) succeeds in successfully imitating type (*H,L*) without the producer being aware of that. Since *M* cannot discriminate between the two types, she produces as if demand in country *A* is high whereas it is low. Then the quantity in excess is transported to country *B* by *W* and consequently *M* looses part of the profits she would have obtained under complete information.

Conclusion 2. *The amount of profit lost by the multinational firm is directly transferred to the wholesaler, while consumers' welfare does not change.*

It is worth noting that, in the long run, transferring profits from innovating firms (i.e., manufacturers) to non-innovating firms (i.e., wholesalers) has negative social effects. Actually, the reduction in R&D investments due to the manufacturers' profit losses would damage a crucial sector of the EU economy by making it less competitive and innovative.

Conclusion 3*. Country-specific forms of price regulation in the different EU member states tend to increase the incentives to practice parallel trade.*

In section 4.2 it has been stated that asymmetries in price regulation tend to increase price differentials between EU countries, thus giving more room to the wholesalers' opportunistic behaviour. Note that the attention is focused here on evaluating the effects of parallel trade in terms of social welfare *variations*. In this respect, both the basic model and the one with regulated prices provide the same result, in the sense that final prices do not change due to arbitrage practices. Hence, consumer surplus is not affected by the possible presence of asymmetric forms of reimbursement for ethical drugs in the different national markets.

In the case of downstream competition, consumer surplus increases with the decrease in final prices, which tend to wholesalers' marginal costs as the number of wholesalers grows. Even in this case, different forms of reimbursement do not affect the main result, that is, consumer surplus still increases.

Conclusion 4. *Downstream competition increases consumers' welfare by reducing final prices.*

On several occasions, the European Commission has indicated parallel trade as a possible means to harmonize the pharmaceutical market, as it acts in keeping with the free trade principles. Nevertheless, parallel trade does raise the consumers' welfare only in the case when either (a) lower prices in the exporting country reflect lower production costs due to higher efficiency or to lower input costs; or (b) final consumers in the importing country draw benefits from a possible decrease in market prices.

However, these necessary conditions for parallel trade to determine a welfare increase are not generally met in the pharmaceutical sector (Rapp, Rozek, 1992). Therefore, lower prices in the source countries of parallel trade mainly benefit intermediaries. In these countries low prices are not determined by a higher productive efficiency, but because of stringent regulatory regimes. Hence, regulation may have distorting welfare-reducing effects.

In short, it appears that at present parallel trade cannot be used by EC as the sole instrument for levelling prices (as shown by the price differentials still persisting in the different countries). Only when the possibility of free trade is associated with competition in the distribution segment, the amount of profits transferred from manufacturers to wholesalers would be eroded to the benefit of final consumers. However, this policy instrument is hardly feasible, as the concentration degree in distribution at an international level has been increasing substantially in recent years.

6. CONCLUDING REMARKS

Parallel trade plays a crucial role in vertical relations between multinational manufacturing firms and wholesalers, particularly in the EU pharmaceutical sector. Currently, this industry lies in a transition phase since it is still divided between total integration in sales and segmentation in regulatory measures.

In this paper, parallel trade has been described formally through a signalling game between a multinational firm and a wholesaler operating in two different markets. The wholesaler owns private information about final demands in the two markets and exploits his information advantage so as to practice arbitrage. It has been shown that the scope for the wholesaler's opportunistic behaviour is influenced by the price differentials between countries, by the transport costs and by the downstream market structure.

Furthermore, it has been shown that parallel trade generally transfers profits from manufacturers to wholesalers without enhancing the consumers' welfare. The different forms of price regulation adopted in the different countries may strengthen this phenomenon. Thus, parallel trade cannot be used as a harmonization instrument of EU national markets, unless competition among wholesalers is granted.

REFERENCES

Albaek, Svend & Per-Baltzer Overgaard. 1998. Receiver discretion in signalling models: information transmission to competing wholesalers. *International Journal of Industrial Organization*, 16: 209-228.

Danzon, Patricia. 1997. Price discrimination for pharmaceuticals: welfare effects in the US and the EU. *International Journal of the Economics of Business*, 4: 301-322.

Darba Joseph & Joan Rovira. 1998. Parallel imports of pharmaceuticals in the European Union. *Pharmacoeconomics*, 14: 107-113.

Datamonitor. 1997. Parallel Importing 1996. DMHC0287.

Datamonitor. 1999. Pricing Differentials 1999. DMHC0814.

EFPIA. 2000. The Pharmaceutical Industry in Figures.

Elzinga, Kenneth & David Mills 1997. The distribution and pricing of prescription drugs. *International Journal of the Economics of Business*, 4: 287-300.

European Commission. 1998a. XXXVIII Report on 'Competition Policy'. Directorate General IV.

European Commission. 1998b. Third Round Table on 'Completing the Single Pharmaceutical Market'.

Fudenberg, Drew & Jean Tirole. 1991. *Game Theory*. Cambridge, MA: The MIT Press.

IMS. 1999. Annual Report on Parallel Trade.

MacArthur, Donald. 1997. Pharmaceutical Distribution in Europe. Financial Times, Pharmaceuticals and Healthcare Publishing, Management Report.

Matteucci, Giorgio & Pierfrancesco Reverberi. 2000. Vertical structures and opportunistic behaviour in international markets. An analysis of parallel trade. DIS Technical Report, University of Rome "La Sapienza".

Rapp, Richard & Richard Rozek. 1992. Parallel trade in pharmaceuticals: the impact on welfare and Innovation. *Journal of Economic Integration*, 7.

Schweitzer, Stuart. 1997. *Pharmaceutical Economics and Policy*. Oxford University Press.

Tirole Jean. 1988. *The Theory of Industrial Organization*. Cambridge, MA: The MIT Press.

Zweifel, Peter & Friedrich Breyer. 1997. *Health Economics*. Oxford University Press.