SHOULD THE US ALLOW PARALLEL IMPORT OF PHARMACEUTICALS?
-- LESSONS FROM EUROPE

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Abstract

Should the US allow for parallel import of pharmaceuticals? This issue has long been in the agenda of US policy makers. Various bills have been proposed to the Congress, but none of these attempts have succeeded to be implemented as legislation yet. The reason being is the safety concerns and doubts whether any significant savings will accrue to consumers. In this paper, we theoretically analyse the pricing and welfare implications of a policy allowing parallel trade put into practice together with a health care reimbursement policy promoting the use of parallel imported drugs such as reference pricing. We use a two country model where a monopolist produces a certain drug and supplies both countries. The results show that a policy allowing parallel trade together with a health-care reimbursement policy of reference pricing, contrary to the common theoretical finding in the literature, has unambiguous welfare implications such that total welfare increases. Hence, if parallel trade is allowed between the U.S.A and Canada under a health care reimbursement policy of reference pricing, it will favour the American consumers without any harm to the Canadian ones.

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“There are no miracles from miracle drugs that people cannot afford”.
US Senator Byron Dorgan

Introduction

Should the US government allow parallel imports of pharmaceuticals from Canada? Should the US government deregulate the restrictions on the movement of pharmaceuticals from low-priced countries to the high-priced U.S. market? This issue has long been in the agenda of policy makers. The growing concern among the public for the relatively high prices of prescription drugs in the U. S. has made it a hot-button issue in the policy arena. A 2004 study by the U.S. Congressional Budget Office found that comparable drugs sold for 35 to 55 percent less in Canada than in the U.S. (Rost, 2007; Dorgan, 2007). The advocates, in the Congress, of a legislation allowing parallel trade in pharmaceuticals want to introduce price competition in the U.S. prescription drug market and thus ensure that the US consumers have access to more affordable prescribed drugs.

Parallel trade takes place when a distributor makes use of price difference for the same product in two different countries and ships the product from the low-priced market to the high-priced one without the consent of the manufacturer. In the pharmaceutical industry, parallel trade is the only legal form of creating competition to any specific medicine during the life of its patent\(^2\). Pharmaceuticals are patented products which are developed through a long and an extensive period of research. In a world where parallel trade is legally forbidden, the manufacturers enjoy monopoly prices until the patent expires and the generics enter the market. Given the fact that about 66 % of expenditures on prescription drugs are accounted for by brand-name ingredients (PhRMA, 2005), parallel trade becomes a potentially attractive cost containment policy tool.

U. S. policy makers have recently several times discussed parallel trade in an effort to legalize its practice. Various bills\(^3\) allowing parallel imports of pharmaceuticals have been proposed to the U. S. Congress, but despite the support in the House and Senate, none of these attempts have succeeded to be implemented as legislation yet. One of the concerns

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\(^2\) Report on Parallel Trade by the European Association of Euro-Pharmaceutical Companies

\(^3\) For the recent legislative history see the web page at [http://www.cptech.org/ip/lsl/health-pl-us.html](http://www.cptech.org/ip/lsl/health-pl-us.html)

hindering parallel trade from being a legal practice in the U.S. is the doubts whether it will fulfill its promises and improve the welfare. The opponents have concerns whether any significant savings will accrue to consumers. Another disquiet that casts shadow on support for a measure allowing parallel import of pharmaceuticals is the safety concerns. Parallel trade, it is claimed, could pave the way for counterfeit drugs. Canada, being subject to a possible legislation allowing parallel trade in the U.S. also has some concerns. Canada’s pharmacists asked the federal government to ban the bulk export of prescription drugs to the U.S. with the fear of supply shortages and increased prices.

The question is whether these concerns mounted, in the adherent countries, are legitimate or scaremongering. One finds the answer with justification in the practice of EU which has had three decades of experience with commercial parallel trade of pharmaceuticals. There is evidence based on European countries showing that parallel imports provide not only direct savings but also indirect savings by creating competition and thus forcing down the prices of their domestically sourced counterparts (YHEC Report, 2003; Ganslandt and Maskus, 2004).

Besides evidence on savings from parallel trade, there is no incident except a recent one that counterfeits had made their way into legal supply chains via parallel trade.

European experience, however, reveals several important obstacles to the effectiveness of parallel trade. First, consumers might perceive parallel imported drugs as inferior, even absent any real differences. Since the parallel imported drugs, depending on the requirements of the importing country, are either repacked or relabelled and the patient information leaflets are rewritten in the language of the importing country, they might not be

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5 The European Association of Euro-Pharmaceutical Companies (EAEPC) commissioned the York Health Economics Consortium (YHEC) to produce a report assessing the benefits from parallel distribution of pharmaceuticals and to whom these benefits accrue. As a response to this study, Kanavos et. al. (2004) conducted another analysis with data from Johnson & Johnson. They show that the main benefactors from the parallel trading are the distributors. As, Scheuermann (2006) claims the truth lies somewhere in between.

6 As it is reported by Katrina Megget, May 29, 2007
According to EAEPC website, “parallel distributors actually help to add a layer of safety to the distribution chain, often finding defect products”. In the recent incident of Zyprexa, Eli Lilly’s market-leading antipsychotic drug, this is exactly what happened. Eli Lilly was informed by a company which printed labelling for its products, after a repackager became suspicious and contacted them.

7 The reasons will be discussed in detail in the following section.
considered as perfect substitutes to the locally sourced counterparts. Second, the pharmaceutical companies will respond strategically to the introduction of trade. Pricing decisions are made on a global basis so as to reduce trade. The M. C. Gouy Consulting Company mentions the threat of parallel imports in the document where they discuss the optimal launch sequence for pharmaceuticals within EU and recommends one person should coordinate the price negotiations in different countries. On the other hand, pharmaceutical companies behave strategically and restrict quantities supplied. The German pharmaceutical company Bayer was accused of limiting supplies to Spanish wholesalers to prevent re-exports and the case was taken to the European Court of Justice (ECJ). Although, the practice of parallel trade in pharmaceuticals is still illegal in the U.S., some of the big pharmaceutical companies, GlaxoSmithKline and AstraZeneca declared in the press that they would cut some of the orders to Canada (New York Times, 2003).

Third, also the foreign government may respond strategically, e.g. by reducing consumption subsidies. Fourth, the effectiveness of parallel trade depends crucially on the design of the medical insurance in the home country. Without so-called reference pricing the effects may be limited.

In this study we analyze theoretically the pricing and welfare implications of a policy allowing parallel trade in a setting where we account for the perception of parallel imported drugs as imperfect substitutes and a health policy, in the form of reference pricing, promoting the use of those drugs. There are studies in the literature that analyse the similar issue but except the paper by Jelovac and Bordoy (2005) none of them take into account the consumers’ perception of parallel imported drugs. Moreover, there is no study discussing the role of reference pricing on the effectiveness of a policy allowing parallel trade. Reference pricing is a health care reimbursement policy which has recently been favoured by policymakers as a cost containment tool. With comparison to the commonly used health care reimbursement of fixed copayment, reference pricing introduces a cap and limits the level of public reimbursement. It is a system where a buying agent (the government or the insurer) decides on a price level over which the patient will be reimbursed and the patient pays the difference out of his/her pocket if the chosen drug is more expensive.

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8 Senior members of the House, said the legislation increased the likelihood that counterfeit or adulterated drugs would enter the United States.

9 AstraZeneca sent a letter to Canadian pharmacies and wholesalers on April 8 saying some orders would be cut under a new allotment program that was a response to unexpected sales increases. In January, GlaxoSmithKline said it would stop supplying businesses that resold drugs to Americans. (The New York Times, April 23, 2003).
There are two basic intuitions in the literature pertaining to the implications of parallel trade: (i) parallel trade leads price convergence and (ii) parallel trade benefits consumers in the high price importing country and hurts consumers in the low price exporting country but the combined welfare implications are shown theoretically to be ambiguous. Thus, whether policy should restrict or encourage parallel trade depends on market circumstances: the degree of trade costs (Maskus and Chen, 2004; Chen and Maskus, 2005); bargaining power in the price negotiations (Pecorino, 2002); differences between the two countries (Jelovac and Bordoy, 2005).

We challenge the common intuition that parallel trade benefits consumers in the high price importing country and hurts consumers in the low price exporting country. With a wild guess, one expects that under reference pricing the aforementioned impact of parallel trade will be stronger. We show on the contrary that the positive welfare implications of parallel trade have gained strength while the negative impact has been unchanged.

We develop a theoretical model to analyze these obstacles. The model has two countries. A monopoly producer holds the patent and supplies both countries with a certain drug. The two countries differ in the consumers’ valuations of the drug and in the share of the price paid directly by the consumers. The parallel traders are perfectly competitive. And the cost of trade is zero.

Taking those points into account we show that parallel trading on the contrary to what has been accomplished in the literature does not harm the welfare in the exporting country by increasing the prices there. Results of the model are different than it is claimed like in the case of a beggar-thy-neighbour policy which makes one country better off at the expense of the other trade partner. We found on the contrary that parallel imports increase the welfare in the importing country without changing it in the other country.

In the next section we discuss the evidence that consumers value less the parallel imported drugs and explain the possible reasons for their perception. Then, we present the model. We solve for the equilibrium conditions for two different policy regimes. We discuss the possible robustness checks. Finally, we derive policy implications and conclude in the last section.
Consumers’ Perception of Parallel Imported Pharmaceuticals: Perfect versus Imperfect Substitutes

Parallel imports are genuine goods brought into a country without the authorization of the trademark, copyright owner or patent holder, after those goods have been placed into circulation legitimately in another market (Maskus and Chen, 2000; Chen and Maskus, 2005). The European Association of Euro-Pharmaceutical Companies (EAEPC) representing parallel traders in pharmaceuticals across Europe declare that:

"The medicines traded are those of the original manufacturers, sourced exclusively from inside Europe, and checked thoroughly by the relevant regulatory authorities. They are often produced in the same manufacturing plants and are sold through the same channels as essentially identical products marketed by the domestic trademark owner – but they are cheaper."

Parallel imported pharmaceuticals are therapeutically equivalent to their originally supplied counterparts. There are no real differences between an originally supplied drug and a parallel imported one. However, they might differ in outer packaging, in colour and even in trademark. Because of such noticeable differences they are perceived as inferior by the consumers. Parallel imported drugs being repacked or relabelled raise concerns about the originality of the drugs among the consumers.

Parallel imported drugs, depending on the requirements of the importing country, are either repacked or relabelled and the patient information leaflets are rewritten in the language of the importing country. Moreover, the consumers are informed of the product being subject to parallel trading. Case law requires the parallel trader as well as the company responsible for repackaging and the original manufacturer to be identified on the pharmaceutical product. Besides, for example in Sweden parallel imported drugs as well as generic drugs are subject to reference pricing. The pharmacists are supposed to dispense the cheapest available drug which could be a parallel imported one if an on-patent drug is prescribed. Although, the pharmacists mention that the prescribed brand-name drug and the substituted parallel imported one are the same except the way they are brought to the market, consumers might still doubt the latter being cheaper due to some differences in quality and get into confusion. The potential for confusion in the face of a product with a different name and in a different box seems serious (Irvine, 2005).
There are evidences that consumers value parallel imported drugs less and do not perceive them as perfect substitutes of originally supplied drugs. Sue Mitchell cites a survey on Epilepsy patients where complaints about substituting one version of a drug with another e.g. generic/branded, parallel imported/locally sourced, are revealed. She points out that an increasing number of people report being given a mixture of drugs; some brand names, some generic, some imported brand names, some branded drugs but supplied in parallel traders’ own packaging or plain white boxes. Such a practice is claimed to cause confusion, anxiety, fear among consumers and a loss of trust in the doctor and pharmacist. At worst, it has a negative effect on medication compliance. Associated with the practice of parallel traders unpacking and repacking the drugs before selling them on are the problems patients have in obtaining PILs (Patient Information Leaflets) (Mitchell, 2005). Epilepsy Action’s survey revealed that 53 % of people receiving their drugs in white or plain boxes did not receive a PIL; of the 747 people who had been given different versions of their usual drug in the last year, 18 % were not given a PIL.

Although parallel trade in pharmaceuticals is not yet a legal practice in the U. S., consumers fill their prescriptions in the neighbouring country, Mexico and Canada. Fincham (2006) analyzes the U. S. consumers’ perception of drugs from those countries conducting a choice experiment. The results show that overall respondents are not willing to choose to use imported medications. Besides, consumers make choices based on trade-offs of safety, savings to be gained and the country of origin of the medication.
The Model

We use the two-country model of monopolistic competition with cross-country demand heterogeneity by Jelovac and Bordoy (2005) to analyze the implications of different health care reimbursement policies for the effectiveness of a policy allowing parallel trade. It is assumed that a multinational pharmaceutical firm produces a certain patented drug which is used in the treatment of a certain illness and supplies both the home and foreign country. Demand for the drug differs between these two countries due to (i) the characteristics of the population and the pervasiveness of a certain type of disease and (ii) different health care reimbursement policies. We incorporate the first line of reasoning in our model by assuming that the valuation of the drug within the population differs between two countries. Individuals in each country can differ in their valuation depending on whether or not they had the disease before; if they are currently suffering from the disease, then the severity of the disease is influential on the valuation of the drug treatment\textsuperscript{10}. Hence, by assumption the valuation of the drug differs both among the individuals within a country and between the two countries. An individual in the home country is assumed to have a valuation of $v$, and similarly an individual in the foreign country is assumed to have a valuation of $v^*$ in the foreign country. In order to account for the differences in valuation among the individuals within the same country we assume that the valuations are uniformly distributed on the interval $[v^-, v^+]$ and $[v^{*-}, v^{*+}]$ in the home and foreign countries\textsuperscript{11} respectively with a total mass of 1\textsuperscript{12}.

Although, there are no real differences between a parallel imported drug and a locally sourced one, except that the parallel imported drugs might be repackaged or relabelled, they are not considered as perfect substitutes. They are valued less than their locally sourced counterparts.\textsuperscript{13} In the eyes of the individuals the parallel imports are vertically differentiated. This is captured by assuming that individuals’ gross valuation of the drug is deflated by a factor $\gamma \in (0,1)$. Thus, the perceived quality difference between the two versions of the drug is given by $(1 - \gamma)$.

\textsuperscript{10} There are surveys providing evidence on the influence of severity of a medical condition on the valuation of a drug treatment.

\textsuperscript{11} Throughout the paper, the variables pertaining to the foreign country is denoted by a superscript ‘*’ following the common notation of the international trade literature.

\textsuperscript{12} This assumption is made for simplification in calculations and will be relaxed in the the following section.

\textsuperscript{13} Throughout the paper we refer to the drugs that are directly supplied by the producer as locally sourced and the ones supplied by the parallel traders as parallel imported ones.
We assume that individual drug expenditures are subsidized in both countries. Individuals pay a certain percentage, \( r \), of the price of a drug out of their pocket and the rest \( 1 - r \) is paid by the government where \( r \in (0,1) \). In order to account for the role of health care reimbursement policies on the implications of parallel trade, we allow for two different health care reimbursement policies: fixed co-payment where the individuals simply pay a certain percentage of the price of a drug and reference pricing where the amount that would be paid by the government is capped for each drug over the price of a reference, the cheapest available, drug.

We consider two cases: a case of autarky where parallel trade is legally forbidden and an alternative case where it is legally permitted. Under autarky, the case where the parallel imports are legally forbidden, the producer acts as a monopolist given the patent on its product and sells the drug both in the home and foreign countries, at prices \( p \) and \( p^* \), respectively. However, when the parallel imports are legally allowed, the wholesalers in a perfectly competitive market\(^{14}\) can buy the drug in the foreign country at price \( p^* \) and ship it back to the home country and re-sell it there at price \( p^* \). We assume that the parallel importers incur no other costs like transport costs\(^{15}\) other than the price paid for the drug in the foreign country.

For simplification, the population of each country is normalized to 1.\(^{16}\) Individuals in both countries are assumed to choose to consume or not to consume the drug. So, each individual consumes either one or zero unit of the drug. When parallel imported drugs become available under international exhaustion individuals decide between consuming either a unit of the drug supplied by the manufacturer or the parallel importer and not consuming any drugs at all. We assume that the marginal cost of production \( c \) is zero.

We analyse the role of different health care reimbursement policies on the welfare implications of parallel trade by studying the strategic interaction among the main actors of the model, monopolist, parallel traders and consumers, within a three-stage game. In the first stage, if the prices of the drugs are different between the two countries, the parallel traders

\(^{14}\) We will relax this assumption and consider a monopolistic wholesaler market in the following section as a robustness check of our results.

\(^{15}\) It is mentioned in the literature that the cost of transportation in pharmaceuticals is negligible.

\(^{16}\) This assumption will be relaxed in the following section for robustness check of the results.
can buy the drugs in the low price country and re-sell them in the high price country. So, in
the second stage, the pharmaceutical firm which behaves as Stackelberg leader sets the prices
of the patented drug to be sold in two countries. In the third stage, the individuals in both
countries choose to consume either one unit of the drug supplied by the monopolist, or one
unit of the parallel imported drug, or nothing so as to maximize their utility.

We start with investigating the benchmark case of no parallel imports under fixed percentage
co-payments\(^\text{17}\). Then we move the focus to the case where parallel trade is legally permitted
with a health care reimbursement policy of (i) fixed co-payments and (ii) reference pricing.

**Autarky Case – Parallel Trade Legally Forbidden**

When parallel trade is legally forbidden, the above described three stage game will boil down
to a two stage game. In the first stage the producer decides the prices he charges in each
country. Then in the second stage consumers decide whether to consume a unit of the drug.
Using backward induction we begin solving from the second stage. By solving for this stage
we basically define the demand for the drug in each country. Individuals in each country
decide whether or not to consume a unit of the drug. We define demand in each country
based on the utility of an arbitrary individual who is indifferent between consuming a unit of
drug, \( U_i \), and not consuming at all, \( U_o \). We begin with defining the demand in the home
country. Let’s assume that an arbitrary individual in the home country is indifferent between
consuming a unit of the drug and not consuming at all such that;

\[
\tilde{U}_i = U_o \quad \text{where} \quad \tilde{U}_i = \tilde{v} - r \cdot p \quad \text{is the utility gained from consuming a unit of a drug and} \quad U_o = 0
\]

is the utility when there is no drug consumption.

Then he/she will consume a unit of the drug if;

\[
\tilde{v} \geq r \cdot p
\]

Then, demand for the drug in the home country is

\[
D = \tilde{v} - r \cdot p
\]

Similarly, demand for the drug in the foreign country is

\[
D^* = \tilde{v}^* - r^* \cdot p^*
\]

\(^\text{17}\) When parallel imports are legally forbidden health care reimbursement policy of reference pricing will boil
down to fixed co-payment.
In the first stage of the game, given the demands in both countries the drug manufacturer sets the price in each country that maximizes the total profit.

\[ \Pi = p D + p^* D^* \]

When parallel imports are legally forbidden the equilibrium prices in the home and foreign countries are:

\[ p = \frac{\bar{v}}{2r} \quad \text{and} \quad p^* = \frac{\bar{v}^*}{2r} \]

respectively.

It is shown that the equilibrium prices are functions of the highest willingness to pay in the relevant country.

**Free Trade Case - Parallel Trade Legally Permitted**

When parallel trade is legally allowed the parallel importer can buy the drug in the low price country and ship it to the high price country without incurring any other costs and earn profits as much as the difference in prices per unit he/she ships to the high-price country. For simplicity we assume that parallel importers engage in a competitive market and hence they charge the same market price the monopolist charge in the foreign country for the parallel imported drug in the home country. As a necessary but not sufficient condition we assume that

\[ \frac{\bar{v}}{r} > \frac{\bar{v}^*}{r} \]

and parallel imports are running from the foreign country to the home country.

The consumers in the home country now can choose between the originally supplied drug and parallel imported drug. They will either consume a unit of originally supplied drug, or a unit of parallel imported drug or consume no drugs at all. In this case, the utility a consumer gets will be:

\[ U_0 = 0 \]

\[ U_i = \nu - r p \]

\[ U_p = \gamma \nu - r p^* \]
An individual will be indifferent between consuming a unit of a parallel imported drug and not consuming any drug at all if:

\[ \tilde{v} = \frac{r p^*}{\gamma} \]

An individual will choose either consuming a unit of locally sourced drug or a unit of parallel imported drug if:

\[ \hat{v} = \frac{r(p - p^*)}{(1 - \gamma)} \]

So the consumers who have a valuation higher than \( \tilde{v} = \frac{r p^*}{\gamma} \) and lower than \( \hat{v} = \frac{r(p - p^*)}{(1 - \gamma)} \)

will choose to consume a unit of parallel imported drug. Hence the demand for the parallel imported drug in the home country will be,

\[ D_{pl} = \frac{r(\gamma p - p^*)}{\gamma (1 - \gamma)} > 0 \text{ if } p^* < \gamma p \]

And the individuals who have higher valuations than \( \hat{v} = \frac{r(p - p^*)}{(1 - \gamma)} \) choose to consume a unit of originally supplied drug. Hence, the demand for the locally sourced drug in the home country is

\[ D = \tilde{v} - \frac{r(p - p^*)}{1 - \gamma} \]

Demand for the drug in the foreign country is,

\[ D^* = \tilde{v}^* - r^* p^* \]

The manufacturer will set the price in the two countries such that he would maximize total profits;

\[ \Pi = (r^* - r^* p^*)p^* + \frac{r(\gamma p - p^*)}{\gamma (1 - \gamma)} p^* + \left(\tilde{v} - \frac{r(p - p^*)}{1 - \gamma}\right) p \]

The first term in the profit function is the profits accrue from sales in the foreign country, the second term again from sales in the foreign country but consumed by the consumers of the home country, and the last term corresponds to the direct sales in the home country.
So the equilibrium prices in the home and foreign countries are,

\[
p = \frac{\gamma (\bar{v} + \bar{v}^*)}{2(\gamma r^* + r)}
\]

\[
p^* = \frac{\gamma (1 - \gamma) r^* + r + \gamma \bar{v}^*}{2r(\gamma r^* + r)}
\]

respectively, such that \( p^* = p + \frac{(1 - \gamma) \bar{v}}{2r} \).

When we compare the equilibrium prices with the ones in autarky, due to increased competition via parallel trading prices in the home country are decreased while prices in the foreign country are increased. This result supports the common hypothesis of price convergence which is formally stated in the following proposition as Jelovac and Bordoy (2005):

**Proposition I.** Parallel trading leads price convergence in the sense that the price in the high price country has decreased and price in the low price country has increased.\(^{18}\)

The robustness check of the above discussed proposition leads to another common result in the literature. If \( \gamma = 1 \), which indicates that the parallel imported drug and the locally sourced ones are perceived as perfect substitutes, our results also justify another common hypothesis of price equalisation under certain assumptions. If (i) there are no trade costs; (ii) the parallel imported drugs are perceived as perfect substitutes of locally sourced ones; and (iii) there is perfect competition among the parallel traders, parallel trade leads price equalisation across countries. Under these assumption the results turn out to be as follows:

\[
p = p^* = \frac{\bar{v} + \bar{v}^*}{2(\gamma r^* + r)}
\]

\(^{18}\) See Appendix A for detailed price comparison of different regimes
Policy Change: Reference Pricing

In this section we consider a change in the health care reimbursement policy. We replace the assumption of fixed co-payments with an alternative policy tool of reference pricing. By this policy amendment, we introduce a system of variable co-payment that can vary depending on the choice made. According to this new policy adjustment the pharmacist should dispense the cheapest available drug getting the consent of the consumer even a brand-name drug is prescribed. If the consumer does not accept substitution he/she will be reimbursed over the price of the cheapest available drug and is supposed to pay the difference in price out of his/her pocket. We incorporate this capped system of reimbursement into our model as follows:

Let \( c \) be the co-payment in the home country, then

\[
c = \begin{cases} r p & \text{if } p \leq \bar{p} \\ r \bar{p} + (p - \bar{p}) & \text{if } p > \bar{p} \end{cases}
\]

where \( \bar{p} \) is the reference price, price of the cheapest available drug over which consumers are reimbursed.

Given the fact that parallel imported drugs flow from the foreign country to the home country, with reference pricing, parallel imported drugs will be the cheapest ones and so individuals will be reimbursed over the price of the parallel imported drugs.

When parallel trade is allowed, in the home country with reference pricing, only the individuals with a valuation:

\[
v \in \left[ \frac{r p^*}{\gamma}, \frac{p - p^*}{1 - \gamma} \right]
\]

consume a unit of parallel imported drug. Therefore the demand for the parallel imported drug in the home country is:

\[
D_{p^*} = \begin{cases} 0 & \text{if } p^* > \frac{\gamma}{r(1 - \gamma) + \gamma} p \\ \frac{\gamma (p - p^*) - (1 - \gamma)(r p^*)}{\gamma (1 - \gamma)} & \text{if } p^* \leq \frac{\gamma}{r(1 - \gamma) + \gamma} p \end{cases}
\]
The condition that should hold for parallel imports to be available in the home country becomes less restrictive since

\[ \rho < \frac{\rho}{\alpha_b (1 - \rho) + \rho} . \]

This condition actually demonstrates that reference pricing may promote the use of parallel imports.

Demand in the home country for the locally sourced drugs is

\[ D = \sqrt{\frac{p - p^*}{1 - \gamma}} \quad \text{if} \quad p^* < r\frac{\gamma}{\alpha_b (1 - \gamma) + \gamma} p \]

Demand in the foreign country is

\[ D^* = \sqrt{\gamma - r^* \gamma} \]

Given these demands, the monopolist sets the prices in the two countries that maximize the total profit:

\[ \Pi_m = (D^* + D_{pl})p^* + D p \]

\[ \Pi_m = \left( \sqrt{\gamma - r^* \gamma} + \frac{\gamma p - [\gamma + (1 - \gamma) r] p^*}{\gamma (1 - \gamma)} \right) p^* + \left( \sqrt{\gamma - r^* \gamma} \right) p \]

Then, the equilibrium prices in the home and foreign country will be respectively,

\[ p = \frac{\gamma \sqrt{\gamma - r^* \gamma} + (1 - \gamma) (r^* + r) \gamma + \gamma r}{2 (r^* + r)} \]

and

\[ p^* = \frac{\gamma \left( \sqrt{\gamma - r^* \gamma} \right)}{2 (r^* + r)} . \]

The results indicate that compared to the equilibrium prices within a system characterized by a health care reimbursement policy of fixed co-payments, price in the home country has
decreased while the price in the foreign country has not changed. The impact of policy change on equilibrium prices is quite surprising in the sense that it is not fully in line with the hypothesis of price convergence. Given the fact that reference pricing is characterized as a policy tool promoting use of parallel imported drugs, it is expected that when reference pricing is introduced prices will converge more. We refer, in particular, by price convergence to further decrease in price in the home country, and further increase in price in the foreign country due to increased competition. The intuition is simple. A policy switch to reference pricing encourages parallel trade thereby increasing demand in the foreign country which in turn induces the monopolist to raise price in the foreign country. The monopolist may also have a second motive for raising price in the foreign country as a response to reference pricing, namely to increase his competitors’, the wholesalers’, costs in the home country. However, the results do not turn out to be so. Although the price in the home country has decreased further, the price in the foreign country does not change. In order to explain this outcome, we have a close look at the strategic behaviour of the monopolist.

The monopolist will increase the price in the foreign country strategically to deter parallel trade and correspondingly decrease the price in the home country to compete the parallel imported drugs. Since the price in the home country is decreased due to competition, price in the foreign country will be strategically decreased too. So the impact of strategic interaction on the price in the foreign country is the sum of the strategic and competition effect which work in opposite directions. In our particular case these two effects are equal in absolute terms but opposite in sign hence they cancel out each other and the price in the foreign country stays the same. However, in another setting it may change.

We display our results on a graph in order to provide a better understanding of the strategic interaction we discussed above. On the graph below, we plot the price reaction functions for each regime derived from the conventional first-order profit maximization conditions.

The reaction functions under the health care policy of fixed co-payment are as follows;

\[ p^*_F (p_F) = \frac{\gamma (1-\gamma) \gamma^* + 2\gamma r p_F}{2[\gamma (1-\gamma) r^* + r]} \]

\[ p_F (p^*_F) = \frac{(1-\gamma) \gamma^*}{2r} + p^*_F \]
The reaction functions under health care reimbursement policy of reference pricing are as follows:

\[ p^*_R (p_R) = \frac{\gamma (1-\gamma) \bar{r} + 2 \gamma \bar{p}_R}{2[(1-\gamma)(\bar{r} + r) + \gamma]} \]

\[ p_R (p^*_R) = \frac{(1-\gamma) \bar{r} - \nu}{2} + p^*_R \]
We plot the reaction functions under the health care reimbursement policy of fixed co-payment in red and those under that of reference pricing in blue. The reaction functions, under the two policy regimes, representing price in the home country as a function of price in the foreign country, \( p_F (p_F^*) \) and \( p_R (p_R^*) \), have the same slope and hence are parallel to each other. On the other hand, the reaction function representing price in the foreign country as a function of price in the home country under the health care reimbursement policy of fixed co-payments, \( p_F^* (p_F) \) is steeper than that, \( p_R^* (p_R) \) derived under reference pricing.\(^{19}\)

In order to get the complete picture, we include the condition for parallel trade represented by the line \( p^* = \gamma p \). We also plot the 45° degree line representing uniform pricing under autarky to point out clearly the location of the line \( p^* = \gamma p \). It is quite important to spot the relative position of each line to make sure we get the correct graphical representation of the strategic interaction. We take the line \( p^* = \gamma p \) as our reference curve and figure out the intersection

\(^{19}\) See Appendix B.I for the comparison of the slopes
points of the reaction curves with it. In the appendix\textsuperscript{20}, we show that $p^*_F(p_F)$ intersects $p^* = \gamma p$ at a point denoted by $I'$ in the graph which is located below the point $I''$ where $p^*_R(p_R)$ intersects the reference curve. Besides, those two reaction functions hit each other at the point $A$ which is below the point $I'$. The equilibrium under the health care reimbursement policy of fixed co-payments and reference pricing occur at points denoted by $E_F$ and $E_R$, respectively.

The reaction function $p^*_F(p_F)$ is upward sloping meaning that the price in the foreign country (e.g. Canada) increases as the price in the home country (e.g. U.S.A) increases. The reason being is the fact that when parallel trade is allowed the difference in the prices is the driving force for parallel trade to take place. The rule of the game here is: the larger the price difference, the more the market penetrated by parallel traders and the less the monopolist earns. Hence, the monopolist does not let the difference in prices becomes too large. The monopolist acts strategically and deters parallel trade by increasing the price in both markets. So, the move from the equilibrium under fixed co-payments denoted by the point $E_F$ to the point $E_R'$ is an outcome of the strategic behavior of the monopolist such that he/she charges a higher price in the foreign country for each price charged in the home country.

If we consider our special case of allowing parallel trade between Canada and U.S.A, The main driving force for parallel trading between these two countries is the difference in prices, $\gamma p - p^* = \Delta$, where $p$ is the price in the U.S.A and $p^*$ is the price in Canada. As the difference becomes larger, parallel trading becomes more profitable for the parallel traders and the monopolist’s loss due to parallel trading increases. The monopolist, in order to decrease loss, acts strategically and increases the price in Canada.

On the other hand, the reaction function $p^*_R(p_R)$ is upward sloping meaning that the price in the home country (U.S.A) increases as the price in the foreign country (Canada) increases. The reason being is the fact that the monopolist, as we have shown, always accommodates parallel trade but under certain conditions. As the price in the foreign country has increased the price difference will come closer to the uniform pricing which is a deterrence strategy but

\textsuperscript{20} See Appendix B.II
not as profitable as accommodated trade. So, the monopolist will increase the price in the home country too.

When parallel trade is allowed, the monopolist acts strategically and attempts to deter trade by increasing the price in the foreign country. The movement from the equilibrium point $E_F$ to the point $E_R'$ on the graph captures the monopolist’s such strategic response. However, the availability of parallel imported drugs in the home country triggers price competition and force the monopolist to decrease the price charged for the locally sourced drugs. As the price in the home country is decreased due to competition, the price in the foreign country is also decreased in order not to induce trade further. This so called competition effect corresponds to the movement on the graph from the point $E_R'$ to the equilibrium point $E_R$ under reference pricing. The monopolist first strategically increases the price in the foreign country to deter trade and then decreases it to restrain the volume of parallel trade. Hence, the impact of parallel trade on the equilibrium price in the foreign country is the sum of these two effects (i) strategic effect and (ii) competition which works in opposite directions. In our setting, these two effects are equal in absolute value but differ in sign and hence cancel each other. As a result, the price in the foreign country under the regime of reference pricing is the same as the equilibrium price under the regime of fixed co-payment. We state this main implication of the model in the following proposition:

**Proposition II.** A policy allowing parallel trade under reference pricing, compared to a case with health care reimbursement policy of fixed co-payment, while causes the price to increase in the home country, leaves the price unchanged in the foreign country such that strategic effect and competition effect cancel each other.

Our results indicate that a policy allowing parallel trade under the regime of reference pricing favor consumers’ in the home country without changing the welfare of consumers’ in the foreign country. Hence, parallel trade if supported by a regime like reference pricing, contrary to the common view in the literature, could have a positive unambiguous impact on consumers’ welfare. However, one should note that such a priori policy implications hold within a partial equilibrium analysis of unlimited supply. In the following section, we check whether our results are robust to several extensions of the model.
Extensions: Robustness Check

In this section, we check whether the main implication of the model, price staying the same in the foreign country after a policy switch, hold relaxing the assumptions;

- Population, market size, in each country is normalized to 1
- Income distribution is the same in both countries and normalized to 1,
  \( \nu - \nu = \nu^* - \nu^* = 1 \)

We particularly focus on relaxing those assumptions for the reason that Jelovac and Bordoy (2005) only considers a symmetric model which is quite restrictive to debate on parallel trade between the U.S. and Canada. Canadians may believe that since they are a much smaller country, everything will be geared for the U.S. market.

1) relaxing the assumption that \( \nu - \nu = \nu^* - \nu^* = 1 \)

We assume that average income is the same but the distribution of income differs between the two countries. Since, consumers’ valuations are shaped by their incomes, relaxing the assumption on income distribution affect demand functions and hence pricing in both countries. The equilibrium prices under the regime of

(i) fixed co-payments in the home and foreign country are;

\[
p_f = \frac{\gamma (1-\gamma) g r^* + r \nu + \gamma g r \nu^*}{2 \gamma g r^* + r} \quad \text{and} \quad p_f^* = \frac{\gamma (g \nu^* + \nu)}{2 \gamma g r^* + r}
\]

where \( g = \frac{\nu - \nu}{\nu^* - \nu} \) is the relative distribution of income in the home country.

We consider three cases:

1) If \( \nu - \nu = \nu^* - \nu^* \Rightarrow g = \frac{\nu - \nu}{\nu^* - \nu} = 1 \) we get the same equilibrium values

2) If \( \nu - \nu < \nu^* - \nu^* \Rightarrow g = \frac{\nu - \nu}{\nu^* - \nu} < 1 \) we get

\[
p_f = \frac{\gamma (1-\gamma) g r^* + r \nu + \gamma g r \nu^*}{2 \gamma g r^* + r} > \frac{\gamma (1-\gamma) r^* + r \nu^*}{2 \gamma r^* + r}
\]

\[
p_f^* = \frac{\gamma (g \nu^* + \nu)}{2 \gamma g r^* + r} > \frac{\gamma (g \nu^* + \nu)}{2 \gamma r^* + r}
\]

3) If \( \nu - \nu > \nu^* - \nu^* \Rightarrow g = \frac{\nu - \nu}{\nu^* - \nu} > 1 \) we get

\[
p_f = \frac{\gamma (1-\gamma) g r^* + r \nu + \gamma g r \nu^*}{2 \gamma g r^* + r} < \frac{\gamma (1-\gamma) r^* + r \nu^*}{2 \gamma r^* + r}
\]

\[
p_f^* = \frac{\gamma (g \nu^* + \nu)}{2 \gamma g r^* + r} < \frac{\gamma (g \nu^* + \nu)}{2 \gamma r^* + r}
\]
\[ p_F = \frac{\left( \gamma (1 - \gamma) g r^* + r \right) \gamma + \gamma g r^{-\gamma^*}}{2r \left( \gamma g r^* + r \right)} < \frac{\left( \gamma (1 - \gamma) r^* + r \right) \gamma + \gamma r^{-\gamma^*}}{2r \left( \gamma r^* + r \right)} \]

Above discussed three cases indicate that when the income distribution in one country is relatively skewed or relatively dispersed prices converge less. If the income distribution is relatively dispersed in the foreign country parallel trade harm consumer surplus in the foreign country more and benefits the home consumers less. On the other hand, if the income is relatively unequal in the foreign country the consumers in the foreign country are hurt less and the consumers in the home country gain more.

Based on the figures provided in Picot and Myles (2005), individual income inequality in Canada is well below the U.S. level. According to the comparison of Gini coefficients, Canada’s position (Gini=0.29) is reported to be more egalitarian than the U.S. (Gini=0.37). Besides, they provide the comparison of the percentile ratios for a more intuitive understanding of the differences. In the U.S. family incomes near the top of the distribution (the 90th percentile) are over five times higher than the family incomes near the bottom of the distribution (the 10th percentile) and in Canada about four times higher (Picot and Myles, 2005). Given these figures, among the above discussed cases, the relevant one is the third one where income distribution is relatively more unequal in the home country (U.S.) than it is in the foreign country (Canada).

(ii) reference pricing in the home and foreign country are;

\[ p_F = \frac{\gamma g \gamma^{-\gamma^*} + \left(1 - \gamma \right) \left( \gamma g r^* + r \right) + \gamma g r^{-\gamma^*}}{2 \left( \gamma g r^* + r \right)} \quad \text{and} \quad p_F = \frac{\gamma \left( g \gamma^{-\gamma^*} + \gamma r^{-\gamma^*} \right)}{2 \left( \gamma g r^* + r \right)}, \text{respectively.}^{21} \]

The results show that when we account for the differences in income distribution between countries, the main implication of the model, price staying the same in the foreign country after a policy switch, holds.

ii) Relaxing the assumption that population in each country is normalized to 1

---

21 Same discussion of the cases depending on whether \( g < 1, g = 1 \) or \( g > 1 \) holds for reference pricing too.
We account for the differences in the market size between the two countries and test the impact of market size on pricing. The equilibrium prices under the regime of

(1) fixed co-payment in the home and foreign country are

\[ p_F^* = \frac{(y(1 - \gamma) r^* + m) \sqrt{\gamma} r\sqrt{\gamma}}{2(y r^* + r m)} \quad \text{and} \quad p_F^* = \frac{y \sqrt{\gamma} r^* + \sqrt{\gamma} m}{2(y r^* + r)}, \]

respectively where

\[ m = \frac{n}{n^*} \]

stands for the relative market size in the home country with respect to the market size in the foreign country. We show that the implications of the model change depending on the value of the relative market size such that;

(i) If \( m = \frac{n}{n^*} = 1 \) we get the same equilibrium values

(ii) If \( m = \frac{n}{n^*} > 1 \) we get

\[ p_F^* = \frac{y \sqrt{\gamma} r^* + \sqrt{\gamma} m}{2(y r^* + r)} \quad \text{and} \quad p_F^* = \frac{\gamma} {2(1 - \gamma)} \frac{y r^* + \sqrt{\gamma} m}{y r^* + r} \]

(iii) If \( m = \frac{n}{n^*} < 1 \) we get

\[ p_F^* = \frac{\gamma} {2(1 - \gamma)} \frac{y r^* + \sqrt{\gamma} m}{y r^* + r} \quad \text{and} \quad p_F^* = \frac{\gamma} {2(1 - \gamma)} \frac{y r^* + \sqrt{\gamma} m}{y r^* + r} \]

If the market size in the home country is relatively larger \( (m = \frac{n}{n^*} > 1) \) the pricing implications of parallel trade will be smaller in the home country but larger in the foreign country. While the price increases more in the foreign country, it decreases less in the home country. The parallel imported drugs from a relatively smaller market will account for a relatively less share of a larger market hence where the prices would be harmed less. However, the larger market faces the threat of bulk export. In order to deter trade, the monopolist increases the price in the foreign country more.

(2) reference pricing in the home and foreign country are;
\[ p_k = \frac{\gamma \nu^* + (1-\gamma) \left( \frac{\gamma \ r^* + \gamma \ m}{2} \right) + \gamma \ m \nu}{2 \left( \frac{\gamma \ r^* + \gamma \ m}{2} \right)} \] and \[ p_r^* = \frac{\gamma \left( \nu^* + \nu m \right)}{2 \left( \frac{\gamma \ r^* + \gamma \ m}{2} \right)}, \] respectively.\(^{22}\)

The results show that when we account for the differences in income distribution and market size, the main implication of the model that the equilibrium price stays the same in the foreign country holds.

\(^{22}\) Same discussion of the cases depending on whether \( m < 1, m = 1 \) or \( m > 1 \) holds for reference pricing too.
Welfare Analysis

Given our static partial equilibrium analysis, changes in the consumer surplus, producer’s profit and public expenditure are the main concerns of the welfare analysis. In the previous section we show that when a policy allowing parallel trade is put in practice together with a health care reimbursement policy of reference pricing, the prices in the home country decreases while the prices in the foreign country stay the same. Hence, the individuals in the home country enjoy both decreased prices for the locally sourced drugs and the availability of a cheaper alternative of parallel imported drugs. Based on these implications of our model, we a priori predict that parallel trade improves consumer surplus in the home country without any change in the foreign country consumer welfare. On the other hand, the monopolist earns less while the home country government as the insurer pays less. In order to find out the impact of a policy allowing parallel trade on total welfare, we examine the changes in consumer surplus, producer profit and public expenditure.

I. Change in the consumer surplus

Compared to the fixed co-payment case the price in the home country has decreased more under reference pricing increasing the consumer surplus in the home country, although the price of the parallel imported drug and the total quantity consumed has not changed. On the other hand, in the foreign country, since the price stays the same and the amount consumed does not change, consumer welfare remains unchanged. So, the net impact of a policy allowing parallel trade on consumer surplus is positive. The quantitatively assessed change is as follows:

$$\Delta CS = \frac{1}{2} \left( p_{F} - p_{H} \right) = \frac{(1-\gamma)(1-r)\sigma^{2}}{8r} > 0$$

23 See Table I.
Table I. Equilibrium Quantities demanded in the home and foreign countries under two alternative health-care reimbursement policies

<table>
<thead>
<tr>
<th></th>
<th>Fixed Co-Payment</th>
<th>Reference Pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Home Country</td>
<td>Foreign Country</td>
</tr>
<tr>
<td>Locally Sourced</td>
<td>$\frac{\sqrt{v}}{2}$</td>
<td>$2r\sqrt{v} + \gamma r' (\sqrt{v} - \sqrt{v}) \over 2(\gamma r' + r)$</td>
</tr>
<tr>
<td>Parallel Imported</td>
<td>$\frac{\gamma r' \sqrt{v} - r \sqrt{v}}{2(\gamma r' + r)}$</td>
<td>$\frac{\gamma r' \sqrt{v} - r \sqrt{v}}{2(\gamma r' + r)}$</td>
</tr>
<tr>
<td>Total Demand</td>
<td>$\frac{2\gamma r' \sqrt{v} + r (\sqrt{v} - \sqrt{v})}{2(\gamma r' + r)}$</td>
<td>$\frac{2\gamma r' \sqrt{v} + r (\sqrt{v} - \sqrt{v})}{2(\gamma r' + r)}$</td>
</tr>
</tbody>
</table>

Note that total demand in the foreign country for the monopolist’s product is the sum of:

\[
\frac{2r\sqrt{v} + \gamma r' (\sqrt{v} - \sqrt{v})}{2(\gamma r' + r)} + \frac{\gamma r' \sqrt{v} - r \sqrt{v}}{2(\gamma r' + r)} = \frac{\sqrt{v}}{2}
\]

II. Change in the Monopolist Profit

As it is shown in Table I, since the equilibrium price and the quantity demanded in the foreign country remains the same, the monopoly profits from sales in the foreign country does not change. However, the decreased equilibrium price in the home country without any change in the equilibrium quantity erodes monopoly profits. So, the change in the monopolist profit is;

\[
\Delta \Pi = \frac{\sqrt{v}}{2} (p_f - p_r) = -\frac{(1 - \gamma)(1 - r)\sqrt{v}^2}{4r}
\]

which means that under reference pricing the monopolist earns $\frac{(1 - \gamma)(1 - r)\sqrt{v}^2}{4r}$ less profit.

III. Change in the Public Expenditure

Since the equilibrium price and the quantity demanded in the foreign country do not change, the cost to the public does not change either. However, since the equilibrium price has decreased without any change in the quantity demanded in the home country, the cost to the public sector has also decreased. So, the change in the home country public expenditure is;
\[ \Delta PE = \left( PE_B^F - PE_B^R \right) \]

\[ = \frac{\theta_B}{2} (1 - \alpha_B) P_B^F + \frac{\rho \alpha_A \theta_B}{2 (\rho \alpha_A + \alpha_B)} (1 - \alpha_B) P_A^F - \frac{\theta_B}{2} (1 - \alpha_B) P_A^R - \frac{\rho \alpha_A \theta_B}{2 (\rho \alpha_A + \alpha_B)} (1 - \alpha_B) P_A^R \]

\[ = \frac{\theta_B}{2} (1 - \alpha_B) \left( P_B^F - P_A^R \right) \]

**Given** \( P_B^F = \frac{(1 - \rho) \theta_B}{2 \alpha_B} + P_A^F \) and \( P_A^F = P_A^R \)

\[ = \frac{\theta_B}{2} (1 - \alpha_B) \left( \frac{(1 - \rho) \theta_B}{2 \alpha_B} + P_A^F - P_A^R \right) \]

\[ = \frac{\theta_B}{2} \left( 1 - \alpha_B \right) \left( \frac{(1 - \rho) \theta_B}{2 \alpha_B} \right) \]

\[ = (1 - \rho) (1 - \alpha_B) \frac{\theta_B^2}{4 \alpha_B} \]

**IV. Change in Total Welfare**

Whether the total welfare has increased or decreased depends on the extent the gains in the consumer surplus and the savings in public expenditure compensates for the loss in the monopolist profit.

\[ \Delta TW = \Delta CS + \Delta \Pi + \Delta PE \]

\[ \Delta TW = \left( CS_B^R - CS_B^F \right) + \left( \Pi_B^R - \Pi_B^F \right) + \left( PE_B^F - PE_B^R \right) \]

\[ \Delta TW = \frac{(1 - \rho) (1 - \alpha_B) \theta_B^2}{8 \alpha_B} - \frac{(1 - \rho) (1 - \alpha_B) \theta_B^2}{4 \alpha_B} + \frac{(1 - \rho) (1 - \alpha_B) \theta_B^2}{4 \alpha_B} \]

\[ \Delta TW = \frac{(1 - \rho) (1 - \alpha_B) \theta_B^2}{8 \alpha_B} \]

This result indicates that under reference pricing the total welfare increases. This is may be a limited case but we show that under reference pricing the welfare implications of a policy
allowing parallel trade is not ambiguous. It worths noting that the loss in monopoly profits is compensated by the savings in public expenditures. Such an outcome can be considered as a sign of reference pricing being a policy favouring both the consumers and the third party payers at the expense of the monopoly profits. The main criterion of government policies targeting cost containment is to decrease public expenditures at least without any harm to consumers. Policy makers put reference pricing into practice to introduce competition in the drug market thereby to decrease prices while increasing consumer surplus and decreasing public expenditure. It will naturally be the monopolist who will lose if the government introduce a policy triggering competition.

Conclusion

In this paper, we analyse the implications of a policy allowing parallel trade together with a health-care reimbursement policy of reference pricing. We use the two country model developed by Jelovac and Bordoy (2005) and replace the assumption on health-care reimbursement policy of fixed co-payments with reference pricing. The results of the model turn out to be somewhat different than expectations developed a priori based on convergence hypothesis. One predicts that under reference pricing a policy allowing parallel trade stimulates convergence such that the price in the home country decreases more while the price in the foreign country increases further. However, the implications of the model fulfil these expectations partly. The results show that the price in the foreign country remains the same while the price in the home country decreases further. The proof lies in strategic effect being equal to the competition effect in absolute terms but differing in sign. We furthermore show that a policy allowing parallel trade together with a health-care reimbursement policy of reference pricing, contrary to the common theoretical finding in the literature, has unambiguous welfare implications. The results indicate an increase in the total welfare.

We conclude based on the implications of our model the following policy implications: (i) If a policy allowing parallel trade between the U.S.A and Canada is put in practice together with a health care policy of reference pricing, it will favour the American consumers without any harm to the Canadian consumers; (ii) Allowing parallel trade within a regime promoting the use of parallel imported drugs does not function as a beggar-thy-neighbour policy and does not improve welfare in the destination country at the expense of eroded consumer surplus in the foreign country. We still emphasize that the results of the model are derived
based on certain assumptions and hence the policy implications should be assessed drawing on the judgements to what extent the assumptions capture the real life phenomenon.

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Appendix A. Comparison of Equilibrium Prices in Autarky versus Trade

The results have shown that, due to increased competition via parallel trading, with comparison to equilibrium prices in autarky, prices in the home country has decreased

$$\frac{\sqrt{\gamma}}{2} - \frac{\gamma (1-\gamma) r^* + r}{2r (\gamma r^* + r)} + \gamma r^* > 0$$

while prices in the foreign country has increased.

$$\frac{\gamma (\sqrt{\gamma} + \sqrt{r^*})}{2(\gamma r^* + r)} - \frac{\sqrt{r^*}}{2} = \frac{\gamma r^* - r^*}{2r (\gamma r^* + r)} > 0$$

We claim so given $\gamma r^* > r \sqrt{r^*}$ by the assumption that $\frac{\sqrt{\gamma}}{r} > r^*$ and condition that $p^* < \gamma p$.

Appendix B.I Comparison of the slopes of $p_F^*(p_F)$ and $p_R^*(p_R)$

$$\frac{2\gamma r}{2\gamma (1-\gamma) r^* + r} < \frac{2\gamma r}{2\gamma (1-\gamma) r^* + r + \gamma}$$

$$\gamma (1-\gamma) r^* + r + (1-\gamma) r^* + \gamma r < \gamma (1-\gamma) r^* + r$$

$$y (1-\gamma) r^* + r + (1-\gamma) r^* < \gamma (1-\gamma) r^* - (1-\gamma) r^*$$

$$\gamma (1-\gamma) r^* - (1-\gamma) r < \gamma (1-\gamma) r^* (1-r)$$

$$-r(1-r) < \gamma r^* (1-r)$$

$$\gamma r^* + r > 0$$

So, $p_F^*(p_F)$ is steeper than $p_R^*(p_R)$.

Appendix B.II Relative situation of the lines $p_F^*(p_F)$ and $p_R^*(p_R)$ given $p^* = \gamma p$

Intersection of $p_F^*(p_F)$ with $p^* = \gamma p$
\[ p_F = \frac{\gamma (1 - \gamma) \bar{v}^* + 2 \gamma r p_F}{2 [\gamma (1 - \gamma) r^* + r]} \]

\[ \gamma p_F = \frac{\gamma (1 - \gamma) \bar{v}^* + 2 \gamma r p_F}{2 [\gamma (1 - \gamma) r^* + r]} \]

\[ 2 \gamma (1 - \gamma) r^* p_F + 2 r p_F = (1 - \gamma) \bar{v}^* + 2 \gamma r p_F \]

\[ 2 \gamma (1 - \gamma) r^* p_F = (1 - \gamma) \bar{v}^* \]

\[ p_F = \frac{\bar{v}^*}{2 \gamma r^*} \]

Intersection of \( p_R^* (p_R) \) with \( p^* = \gamma p \)

\[ p_R = \frac{\gamma (1 - \gamma) \bar{v}^* + 2 \gamma p_R}{2 [\gamma (1 - \gamma) r^* + r + \gamma]} \]

\[ \gamma p_R = \frac{\gamma (1 - \gamma) \bar{v}^* + 2 \gamma p_R}{2 [\gamma (1 - \gamma) r^* + r + \gamma]} \]

\[ 2 \gamma (1 - \gamma) r^* p_R + 2 (1 - \gamma) r p_R + 2 \gamma p_R = (1 - \gamma) \bar{v}^* + 2 p_R \]

\[ 2 \gamma (1 - \gamma) r^* p_R + (1 - \gamma) r p_R - (1 - \gamma) p_R = (1 - \gamma) \bar{v}^* \]

\[ 2 (1 - \gamma) \gamma r^* + r - 1] p_R = (1 - \gamma) \bar{v}^* \]

\[ p_R = \frac{\bar{v}^*}{2 (\gamma r^* + r - 1)} \]

Note that \( \gamma r^* + r > 1 \)

Since \( \frac{\bar{v}^*}{2 \gamma r^*} < \frac{\bar{v}^*}{2 (\gamma r^* + r - 1)} \), \( p_F^* (p_F) \) intersects with \( p^* = \gamma p \) at a point below where \( p_R^* (p_R) \) intersects with \( p^* = \gamma p \).
Intersection of $p_F^*(p_F)$ and $p_R^*(p_R)$

\[
\frac{\gamma (1-\gamma) \gamma^{-1} + 2\gamma r \cdot p}{\gamma (1-\gamma) r^* + r} = \frac{\gamma (1-\gamma) \gamma^{-1} + 2\gamma p}{\gamma (1-\gamma) (\gamma r^* + r) + \gamma}
\]

\[
\frac{(1-\gamma) \gamma^{-1} + 2r \cdot p}{\gamma (1-\gamma) r^* + r} = \frac{(1-\gamma) \gamma^{-1} + 2p}{(1-\gamma) (\gamma r^* + r) + \gamma}
\]

\[
(1-\gamma) \gamma^{-1} [(1-\gamma) r^* + (1-\gamma) r + \gamma - (1-\gamma) r^* - r] = 2p [(1-\gamma) r^* - r (\gamma r^* + r) + r]
\]

\[
\gamma^{-1} [r - \gamma r + \gamma - r] = 2p [(1-\gamma) r^* - r (\gamma r^* + r) + r]
\]

\[
p = \frac{\gamma \gamma^{-1} (1-r)}{2 [\gamma r^* - r (\gamma r^* + r) + r]}
\]

Besides, $p_F^*(p_F)$ and $p_R^*(p_R)$ intersects each at a point

\[
\frac{\gamma \gamma^{-1} (1-r)}{2 [\gamma r^* - r (\gamma r^* + r) + r]},
\]

denoted by $A$ on the graph. One can show that point

\[
\frac{\gamma \gamma^{-1} (1-r)}{2 [\gamma r^* - r (\gamma r^* + r) + r]}
\]

is below the point

\[
\frac{\gamma^{-1}}{2 \gamma r^*}.
\]
\[
\frac{\gamma \sqrt{r^*(1-r)}}{2 \left[ \gamma r^*-r\left[ \gamma r^*+r \right]+r \right]} < \frac{\sqrt{r^*}}{2\gamma r^*}
\]

\[\gamma^2 r^*(1-r) < \gamma r^* - \gamma r^* r - r^2 + r \]

\[\gamma^2 r^* - \gamma^2 r^* r < \gamma r^* - \gamma r^* r - r^2 + r \]

\[\gamma r^* r - \gamma^2 r^* r < \gamma r^* - \gamma^2 r^* r - r^2 + r \]

\[\gamma r^* r(1-\gamma) < \gamma r^* (1-\gamma) + r (1-r) \]

\[\gamma (1-\gamma) r^* (1-r) + r (1-r) > 0 \]

\[(1-r) (\gamma (1-\gamma) r^* + r) > 0 \]