

Does the WTO Increase the U.S. Trade of Pharmaceuticals?

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I am interested in submitting this paper to the special issue of the **Review of International Organizations** devoted to papers from the conference.

Abstract: The World Trade Organization (WTO) is enforcing the protection of intellectual property rights (IPR) thanks to the trade-related aspects of intellectual property rights agreement (TRIPS) Agreement. The United States, which spearheaded the movement for the globalization of patent protection, is also pushing for strong IPR protection in the free trade agreements and bilateral investment treaties it signs. The goal of the WTO is to facilitate and increase world trade. Has patent protection, through the TRIPS Agreement, increased the United States' trade of pharmaceuticals? A gravity model using panel data from 1993 to 2007 shows that a free trade agreement has a higher impact on US imports and exports of pharmaceuticals than the implementation of the TRIPS Agreement or belonging to the WTO. In particular, implementing the TRIPS Agreement does not appear to significantly increase the trade of pharmaceuticals.

Keywords: World Trade Organization, Pharmaceuticals, International trade, Intellectual Property Rights

JEL: F13, F14, O19, O34

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1. Introduction

The implementation of the 1995 Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement by World Trade Organization (WTO) countries triggered a fierce debate. Proponents argued that the protection of intellectual property rights (IPR) was necessary to pursue the development of trade and foster the diffusion of technology worldwide. Opponents feared that the TRIPS agreement would hinder developing countries' ability to access essential medicines: if intellectual property rights were to be implemented in all WTO countries, developing countries would be unable to manufacture or trade copies of drugs protected by patents. The direct consequence of the TRIPS agreement would therefore be to restrain the access of developing countries to inexpensive essential drugs.

WTO countries agreed on transitional periods to let enough time for developing countries to implement the new standards of intellectual property protection. While developed countries had to implement the TRIPS provisions by January 1st 1996, developing countries and former centrally-planned economies benefited from four more years to adapt their legislations (Part VI "Transitional Arrangements" articles 65-67). In 2001, the Doha "Declaration on the TRIPS Agreement and Public Health" gave flexibility to the TRIPS agreement's original rules for pharmaceutical products: "the TRIPS Agreement does not and should not prevent members from taking measures to protect public health (...) In this connection, we reaffirm the right of WTO members to use, to the full, the provisions in the TRIPS Agreement, which provide flexibility for this purpose" (Article 4). The Doha Declaration gives least developed countries until 2016 to implement the TRIPS requirements.

However, the United States has been implementing free trade agreements which include stronger measures to protect intellectual property rights than the TRIPS Agreement¹. Some authors question this strategy which undermines the intent of the Doha Declaration (Correa, 2006). The main pharmaceutical interest group in the United States, Pharmaceutical Research and Manufacturers of America (PhRMA), responds that "it is important to recognize that implementation of TRIPS and other trade rules may, in fact, increase access to drugs. Our industry depends on the presence of consistent and fair trade rules, including those that protect our intellectual property rights. Without such practices,

¹ These measures are called "TRIPS-Plus."

pharmaceutical companies and those who invest in them would be discouraged from providing the necessary capital to pursue the research and development of new medicines. This, in turn, will jeopardize patients' access to medicines not only in developing countries but worldwide.”²

Most papers dealing with the TRIPS agreement issue focus on its effects on welfare and access to drugs in developing countries (i.e. Lai and Qiu, 2003; Attaran, 2004; Oliveira, Bermudez, Chaves and Velásquez, 2004; Chaudhuri, Goldberg and Jia, 2006; Milstien and Kaddar, 2006; Westerhaus and Castro, 2006; Orsi et al., 2007). Few discuss its effects on the trade of pharmaceutical products. However, the WTO's primary objective is to promote trade. In the TRIPS Agreement's preamble, countries stress their desire “to reduce distortions and impediments to international trade, and taking into account the need to promote effective and adequate protection of intellectual property rights, and to ensure that measures and procedures to enforce intellectual property rights do not themselves become barriers to legitimate trade³.” But Bhagwati (2004) argues that the TRIPS Agreement should not be part of the WTO because the agreement's goal is not to promote trade.

Has the TRIPS agreement increased pharmaceutical trade? If the answer is no, then one might question whether its implementation should be pursued, when poor countries risk having limited access to essential medicines. If the protection of intellectual property rights does not increase trade, is it worth risking a loss of welfare in developing countries? To answer this fundamental question, this paper will study the United States' trade of pharmaceutical products between 1993 and 2007, using a standard gravity equation.

The use of U.S. data helps to determine the separate effects of the TRIPS Agreement and bilateral trade agreements with strong IPR protection. The United States was the lead country in pushing for the protection of patents for pharmaceutical products, because it dominates the industry especially regarding research and development.

The paper is organized as follows. Section 2 reviews the literature on the impact of trade agreements and the implementation of IPR on trade. Section 3 details the econometric specification and the data. Section 4 gives the results, while section 5 checks the robustness of the results from section 4. Section 6 concludes.

² “Do trade rules, such as the TRIPS Agreement, prevent developing countries from obtaining essential drugs?” <http://world.phrma.org/faq.html#ip.6>, accessed September 9th, 2009.

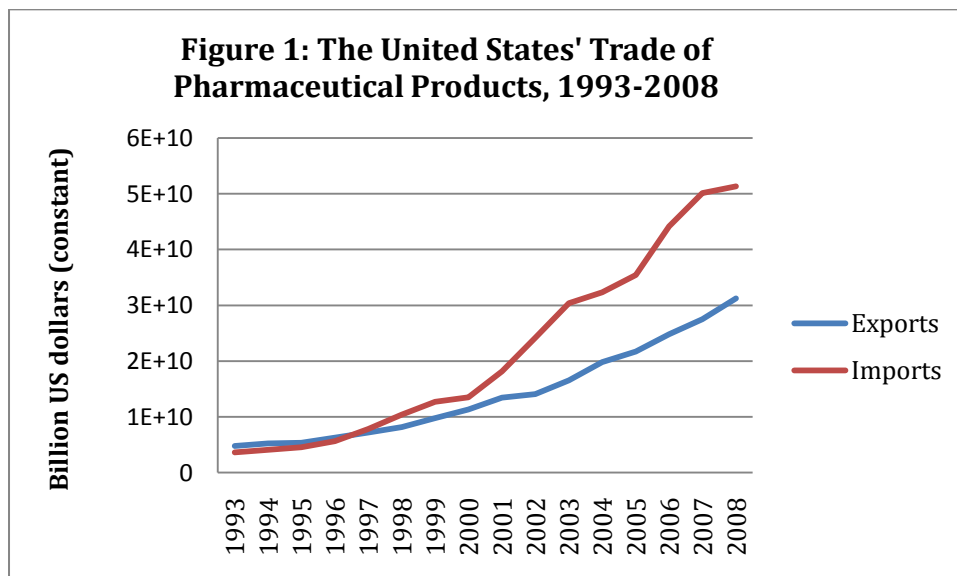
³ http://www.wto.org/english/tratop_e/trips_e/t_agm1_e.htm

2. Do trade agreements increase the trade of pharmaceutical products?

Economists debate whether free trade agreements increase trade. For instance, regarding the WTO, Subramanian and Wei (2007) find that the WTO increases trade. But Rose (2004) argues that the WTO does not significantly increase trade, because membership may not affect countries' trade policies very much. Ghosh and Yamarik (2004) find little evidence that regional trade agreements are trade creating. Baier and Bergstrand (2007) are among the economists who find that free trade agreements are trade creating.

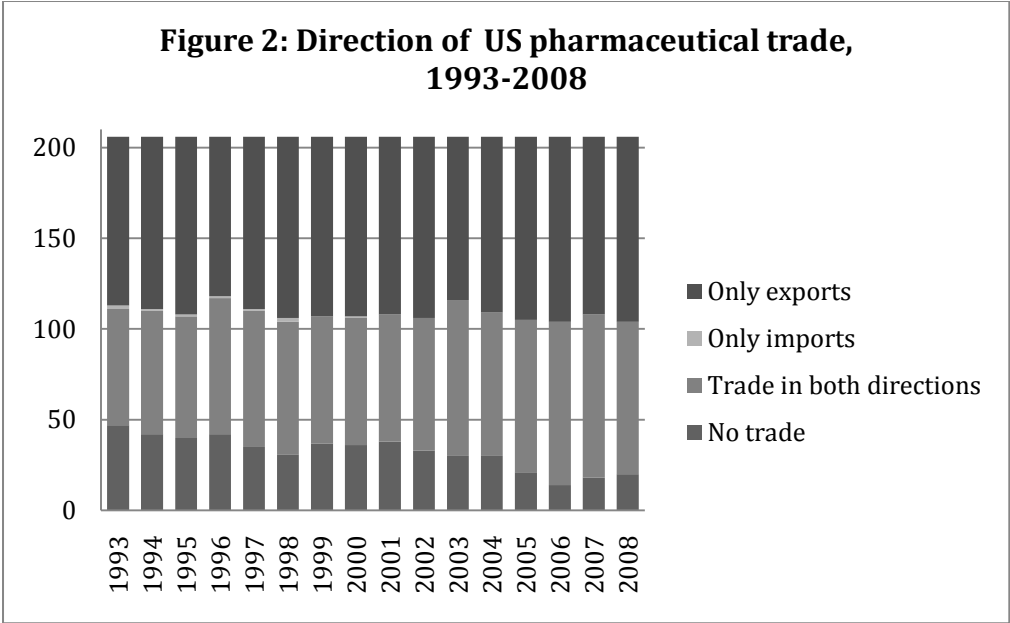
The impact of intellectual property rights protection on trade is also uncertain. Primo-Braga and Fink (1999) show that patent protection does not increase trade in high technology goods. Maskus and Penubarti (1995) find that protecting intellectual property rights can increase bilateral manufacturing imports.

What does the data suggest for the U.S. trade of pharmaceuticals? The TRIPS Agreement may have had an impact on pharmaceutical trade. The United States, which has the largest market and pharmaceutical companies in the world, posts a high trade deficit for pharmaceutical products, with over 20 billion dollars in 2008. Figure 1 shows that the United States' trade deficit appeared in 1997, one year after the TRIPS Agreement came into force.



Source: data from STAT-USA and the Foreign Trade Division, U.S. Census Bureau, 2009

Figure 2 shows that over the past few years, the United States has been trading with a greater number of countries. By the end of 2008, there were only a handful of countries with which the United States did not trade pharmaceuticals. Trade in both directions has also grown since 1996, which suggests that the implementation of the TRIPS Agreement may have had an impact on pharmaceutical trade.



Source: data from STAT-USA and the Foreign Trade Division, U.S. Census Bureau, 2009

The TRIPS Agreement may have had a different impact on imports compared to exports. The average annual growth rate of exports reached 13.4% between 1993 and 2008, compared to 19.8% for imports. Figure 2 shows that unilateral trade consists almost exclusively of exports. The United States imports from far fewer countries than it exports to: in 2008, the United States exported pharmaceuticals to 186 countries and imported from 82 countries⁴. In 1993, the United States imported pharmaceuticals from 66 countries and exported to 157 countries. Therefore, the impact of the implementation of intellectual property rights on American imports and exports of pharmaceuticals will be tested separately.

⁴ Out of 206 countries, see appendix 1 for the list of countries.

3. Econometric specification and data

The theoretical model: the gravity equation using panel data

Baier and Bergstrand (2007) find that the best way to evaluate the impact of a free trade agreement (FTA) on trade is to use a theoretically-motivated gravity equation using either panel data with bilateral fixed and country-and-time effects or differenced panel data with country-and-time effects. They find that the use of such techniques yields a positive effect of an FTA on two members' bilateral trade. They also find that it helps to deal with the problem of endogeneity of the FTA variable. Baier and Bergstrand (2007) show that a panel approach adjusts better for endogeneity than an instrumental-variable or a control-function approach. The panel data approach will be the one used in this paper to deal correctly with endogeneity issues. This paper develops a gravity equation using panel data between 1993 and 2007 and incorporating the trade of pharmaceuticals between the United States and 206 countries (list appendix 1). The strategy used is the same as in Rose (2004): controlling for "natural" causes of trade and extracting the effect of IPR protection in the residual.

The model tested is:

$$\begin{aligned} \ln(M_{kt} \text{ or } X_{kt}) = & \beta_0 + \beta_1 \ln D_k + \beta_2 \ln(Y_k)_t + \beta_3 \ln(Y_k / \text{Pop}_k)_t + \beta_4 \text{Lang}_k \\ & + \beta_5 \ln \text{Area}_k + \beta_6 \text{Border}_k + \beta_7 \text{Island}_k + \beta_8 \text{Landl}_k + \beta_9 \text{CU}_{kt} \\ & + \beta_{10} \text{WTO}_{kt} + \beta_{11} \text{TRIPS}_{kt} + \beta_{12} \text{FTA}_{kt} + \beta_{13} \text{BIT}_{kt} \\ & + \varphi_t T_t + \varepsilon_{kt} \end{aligned}$$

The parameters of interest in this equation are β_{10} , β_{11} , β_{12} and β_{13} . k is the trading partner for year t .

The regressand

Subramanian and Wei (2007) find that Rose (2004) underestimated the impact of membership to GATT/WTO because he used an average of imports and exports as the regressand. Subramanian and Wei (2007) find that membership to WTO increases trade when using unidirectional trade as the regressand. They therefore use imports as the regressand. In the following estimations, imports (M_{kt}) and exports (X_{kt}) will be used as regressands separately, because the data suggest that the TRIPS Agreement may have had a different impact on both types of trade. Import and export data come from the *USA Trade Online* database published by the US Bureau of the Census: Foreign Trade Division, 2009. The data is expressed in constant 2005 dollars by deflating the original current dollar data

using the Bureau of Labor Statistics Import and Export Price Indexes for pharmaceutical products.

The “natural” causes of trade

D_k is the distance between the two largest cities of each country (CEPII and CIA World Fact Book data).

Y_k is the trading partner’s real gross domestic product in 1990 dollars. The database comes from the United Nations Statistics Division⁵.

Pop_k represents country k ’s population (database from the U.S. Census Bureau, International Data Base, Population Division⁶).

$Lang_k$ is a dummy variable, equal to 1 if at least 9% of the partner country’s population speaks English (CEPII and CIA World Factbook data).

$Area_k$ is the size of country k (data from the CIA World Factbook).

$Border_k$ is a dummy variable, equal to 1 if the trade partner shares a border with the United States.

$Island_k$ is a dummy variable, equal to 1 if the trade partner is an island.

$Landl_k$ is a dummy variable, equal to 1 if the trade partner is a landlocked territory.

CU_{kt} is a dummy variable, equal to 1 if the trade partner uses U.S. dollars as its official currency or if the local currency is interchangeable 1:1 with U.S. dollars (CEPII and CIA World Factbook data).

The variables of interest

WTO_{kt} is a dummy variable, equal to 1 if the trade partner is a member of the WTO (or GATT before 1995).

$TRIPS_{kt}$ is a dummy variable, equal to 1 if the trade partner has implemented the TRIPS Agreement’s requirements in its legislation (data from the WTO, WIPO and national patent offices).

FTA_{kt} is a dummy variable, equal to 1 if the trade partner has a bilateral trade agreement with the United States (data from the Office of the United States Trade Representative).

BIT_{kt} is a dummy variable, equal to 1 if the trade partner has signed a bilateral investment

⁵ GDP data from <http://unstats.un.org/unsd/snaama/selectionbasicFast.asp>

⁶ www.census.gov/ipc/www/idb/informationGateway.php

treaty with the United States (data from the Office of the United States Trade Representative).

T_t is a time fixed effects variable.

ε_{kt} represents the unobserved characteristics of country k for year t .

Expected results

The WTO's goal is to increase trade, so the WTO and TRIPS variables should increase the exports and imports of U.S. pharmaceuticals. However, there are some reasons why belonging to the WTO or implementing the TRIPS Agreement might not be significant variables. Belonging to the WTO may not be significant because many WTO countries have not implemented the protection of patents in their legislations. The TRIPS Agreement may not increase trade flows either. Indeed, pharmaceuticals are a high-technology good, so trade may not increase even with countries which protect IPR (Primo-Braga and Fink, 1999). Furthermore, the Doha Declaration has weakened the original intent of strong patent protection in the TRIPS Agreement. Another reason why the TRIPS Agreement may not come out as a significant variable is because of enforcement problems in many countries. Finally, Bernieri (2006) finds that stronger IPR rules included in bilateral investment treaties and free trade agreements may undermine the WTO's role as the central institution for regulating IPR in trade. Therefore, the TRIPS Agreement and the WTO may not significantly increase imports and exports of US pharmaceuticals. Instead, free trade agreements and bilateral investment treaties may have an impact on the U.S. trade of pharmaceuticals. If it is significant, what impact should it have on imports and exports? The answer isn't obvious. If effects compensate each other, this might explain why Rose found insignificant impact of WTO on trade.

Free trade agreements between the United States and other countries (see appendix 2 for a list of free trade agreements involving the United States) could increase pharmaceutical trade, since the United States should feel more comfortable in exporting and importing pharmaceutical products that are protected by patents. This could explain why the United States is pushing for stronger intellectual property rights protection in the free trade agreements and bilateral investment treaties it enters. However, Bernieri (2006) finds that more stringent IPR protection in free trade agreements is not necessarily trade-creating.

4. Empirical results

Table 1 shows the benchmark results for the gravity equation, estimated using ordinary least squares (OLS), with robust standard errors clustering by countries. The Hausman test was conducted to determine whether fixed or random effects should be used. The results suggest that imports and exports of pharmaceuticals should be estimated with fixed effects, which is consistent with the literature on the gravity equation. In Table 1, four models are tested. The first one covers the period 1993-2007 and all countries. The second one leaves out all developed countries⁷. The third only includes all countries between 1996 (the year the TRIPS Agreement came into force in developed countries) and 2007. The fourth one covers countries between 2001 and 2007, to see whether the Doha declaration has had an impact on trade.

The model seems to work quite well to explain imports. However, it does not perform as well for exports. Real GDP appears to be a consistent factor explaining imports and exports of pharmaceuticals: the United States tends to trade more pharmaceuticals with richer countries. Per capita GDP is significant for imports, but not for exports. Having a common language seems to have an impact on exports, but not on imports. Having a common border also seems to have a positive impact on exports, but doesn't appear to significantly explain imports. Distance seems to play a stronger role for imports.

Our variables of interest, however, yield interesting results. First of all, it seems that belonging to the WTO, implementing the TRIPS Agreement or having signed a bilateral investment treaty with the United States does not significantly have an impact on pharmaceutical exports. However, having a regional free trade agreement with the United States increases the exports of pharmaceuticals from the United States. Free trade agreements also appear to have a positive impact on US pharmaceutical imports. Free trade agreements, which include clauses protecting intellectual property rights, seem to increase the American trade of pharmaceuticals. Belonging to the WTO appears to have a significant impact on imports only recently. At best, the TRIPS Agreement has only a small impact on imports, but its significance is uncertain. A rather surprising result is that bilateral investment treaties appear to consistently and significantly decrease the United States' imports of pharmaceuticals.

⁷ Following the IMF's definition of "industrial countries", i.e. countries with an IFS country code less than 200, as in Rose (2004).

Table 1. Benchmark Results

	Exports				Imports			
	Default	No ind. count.	Post TRIPS	Post Doha	Default	No ind. count.	Post TRIPS	Post Doha
Log GDP	0.98*** (0.15)	0.86*** (0.17)	1.00*** (0.15)	1.00*** (0.16)	1.33*** (0.18)	1.11*** (0.24)	1.41*** (0.19)	1.55*** (0.24)
Log GDP per capita	-0.16 (0.18)	-0.19 (0.21)	-0.19 (0.18)	-0.19 (0.19)	0.67*** (0.22)	0.06 (0.32)	0.64*** (0.23)	0.59** (0.28)
Currency Union	0.34 (0.71)	0.13 (0.70)	0.48*** (0.18)	0.49 (0.70)	0.93 (0.86)	1.45* (0.80)	1.01 (0.88)	0.82 (1.05)
Common language	0.77** (0.36)	0.99*** (0.38)	0.73 (0.71)	0.75** (0.38)	0.65 (0.48)	0.46 (0.53)	0.64 (0.50)	0.57 (0.53)
Border	0.83 (0.73)	1.28** (0.60)	0.88 (0.75)	1.51* (0.85)	-1.82 (1.00)	-0.05 (1.01)	-1.68 (1.07)	-1.12 (1.24)
Landlocked	-0.07 (0.42)	-0.17 (0.44)	0.004 (0.42)	-0.17 (0.44)	1.21** (0.61)	0.31 (0.60)	1.20* (0.63)	0.89 (0.75)
Island	0.66 (0.52)	-0.01 (0.67)	0.71 (0.52)	0.55 (0.57)	-0.13 (0.61)	-0.69 (0.65)	-0.11 (0.64)	-0.14 (0.74)
Log area	-0.10 (0.11)	-0.17 (0.13)	-0.12 (0.11)	-0.13 (0.11)	-0.13 (0.12)	-0.25* (0.14)	-0.18 (0.13)	-0.26* (0.15)
Log distance	-0.57* (0.34)	-0.42 (0.36)	-0.58* (0.35)	-0.42 (0.41)	-0.98*** (0.34)	-0.57 (0.41)	-0.94*** (0.36)	-1.01** (0.48)
WTO	-0.03 (0.35)	-0.15 (0.35)	0.09 (0.38)	-0.04 (0.40)	1.05 (0.65)	0.88* (0.51)	1.35* (0.69)	2.40*** (0.74)
TRIPS	0.07 (0.17)	-0.06 (0.19)	0.06 (0.21)	-0.01 (0.39)	0.37* (0.21)	0.69*** (0.24)	0.25 (0.29)	0.05 (0.72)
Free Trade Agreement	0.95** (0.45)	0.90** (0.45)	0.93* (0.48)	0.75 (0.55)	2.13*** (0.69)	2.80*** (0.91)	2.12*** (0.72)	1.91** (0.77)
Bilateral Inv. Treaty	-0.07 (0.41)	0.34 (0.40)	-0.11 (0.38)	-0.08 (0.37)	-1.42*** (0.42)	-1.02** (0.40)	-1.43*** (0.43)	-1.11** (0.49)
Observations	2,571	2,164	2,089	1,085	1,137	784	927	469
R ²	0.44	0.32	0.44	0.42	0.68	0.51	0.68	0.68
RMSE	2.32	2.29	2.34	2.41	2.37	2.19	2.41	2.54

Note: OLS with year effects. Robust standard errors are indicated in parentheses (clustering by country)

5. Robustness

In this section, the model is modified in different ways to check the robustness of the initial estimation. Table 2 shows the results of the four variables of interest in a cross-sectional estimation of the default gravity equation for the years 1993 to 2007. The WTO, TRIPS and bilateral investment treaty variables are consistently insignificant when estimating exports. The TRIPS variable is generally insignificant when estimating imports, whereas the WTO variable is linked to a significant increase in imports starting in 2002-2003, after the Doha Declaration. In fact, the WTO variable becomes more significant after

2003, when paragraph 6 of the Doha Declaration⁸ was implemented by a decision of the General Council of August 30th, which adds flexibilities to the TRIPS Agreement. The bilateral investment treaty (BIT) variable significantly reduces imports between 1997 and 2002, but is not significant in other years (apart from 2004). The most interesting variable is the free trade agreement variable, which strongly increases exports and imports of pharmaceuticals until 2003. Before 2004, the United States had enforced free trade agreements with only four countries: Canada, Mexico, Israel and Jordan (see appendix 2). The United States included TRIPS-plus clauses in free trade agreements that came into force *after* 2003. The results of the cross-sectional analysis suggest that strong intellectual property right clauses may reduce the trade of pharmaceuticals.

Table 2. Cross-Sectional Analysis

	Exports				Imports			
	WTO	TRIPS	FTA	BIT	WTO	TRIPS	FTA	BIT
1993	-0.29 (0.44)	—	1.39*** (0.52)	0.78 (0.86)	0.30 (1.13)	—	3.45*** (0.73)	-0.53 (2.84)
1994	-0.36 (0.46)	—	1.31** (0.59)	0.28 (0.67)	0.60 (1.15)	—	3.60*** (0.68)	-1.54 (1.39)
1995	-0.64 (0.42)	0.52 (0.88)	1.47*** (0.57)	-0.22 (0.71)	0.68 (1.08)	-0.32 (1.04)	3.05*** (0.67)	-0.92 (0.83)
1996	0.29 (0.47)	0.28 (0.56)	2.32*** (0.60)	-0.03 (0.55)	0.54 (1.16)	0.49 (1.02)	3.71*** (0.92)	-0.30 (0.97)
1997	0.26 (0.45)	0.36 (0.54)	1.87*** (0.57)	-0.25 (0.51)	-0.09 (1.76)	1.05 (1.06)	4.86*** (1.08)	-2.94*** (1.06)
1998	0.39 (0.45)	0.88 (0.63)	2.05*** (0.52)	0.11 (0.48)	0.94 (1.41)	1.48* (0.84)	4.25*** (1.00)	-2.69*** (0.92)
1999	0.05 (0.49)	-0.07 (0.47)	2.08*** (0.48)	-0.06 (0.49)	-0.44 (0.94)	0.54 (0.62)	3.43*** (0.80)	-2.32*** (0.63)
2000	0.08 (0.51)	-0.19 (0.42)	2.00*** (0.51)	-0.31 (0.56)	-0.09 (1.32)	0.36 (0.87)	3.70*** (0.61)	-2.37*** (0.92)
2001	0.36 (0.55)	0.09 (0.47)	1.75*** (0.41)	-0.14 (0.46)	-0.25 (1.29)	1.08 (0.67)	3.93*** (0.57)	-1.71** (0.75)
2002	-0.02 (0.48)	0.20 (0.43)	1.46*** (0.39)	-0.17 (0.48)	2.07* (1.14)	-0.002 (1.02)	3.78*** (0.88)	-1.30* (0.70)
2003	0.001 (0.50)	0.73 (0.48)	1.48*** (0.61)	0.03 (0.43)	2.29* (1.34)	-0.22 (1.14)	3.84*** (0.65)	-1.23 (0.79)
2004	0.06 (0.48)	0.11 (0.45)	0.80 (0.56)	-0.32 (0.42)	3.19*** (1.15)	0.29 (1.13)	1.46 (1.06)	-1.71** (0.77)
2005	0.03 (0.47)	-0.56 (0.51)	0.66 (0.79)	-0.18 (0.43)	1.77** (0.86)	0.04 (1.82)	1.49 (1.07)	-0.74 (0.74)
2006	-0.30 (0.50)	-0.27 (0.49)	0.61 (0.60)	0.03 (0.41)	2.75** (1.09)	0.10 (1.33)	1.99** (0.92)	-0.77 (0.74)
2007	-0.004 (0.48)	-0.27 (0.53)	0.78 (0.71)	0.10 (0.44)	3.40** (1.66)	1.63* (0.96)	1.93** (0.86)	-1.05 (0.69)

Note: OLS with intercept not reported. Robust standard errors are indicated in parentheses

⁸ http://www.wto.org/english/tratop_E/TRIPS_e/implem_para6_e.htm

Table 3 shows the results of the four variables of interest in regional estimations of the default gravity equation for the years 1993 to 2007. Least developed countries⁹ that belong to the WTO have until 2016 to implement the TRIPS Agreement. However, some of them have already implemented the main clauses of the TRIPS Agreement. The estimation of the gravity equation on least developed countries yields insignificant results for all three¹⁰ variables of interest on imports and exports of pharmaceuticals.

The TRIPS Agreement appears to be linked to a reduction in the exports and imports of pharmaceuticals when only advanced economies¹¹ or European Union countries are taken into account. The WTO and TRIPS variables yield contradicting and often insignificant results, depending on the group of countries that is taken into account. The positive impact of free trade agreements on imports is the only consistent and significant result.

Making changes to the default gravity equation also gives interesting results (table 4). In the left hand side column of table 4, the results of a basic gravity equation which only includes the log of real domestic product, real domestic product per capita and distance variables, as well as our four variables of interest, show that exports significantly increase only with an increase in the log of GDP and the free trade agreement variables. The only insignificant variable for imports is the TRIPS Agreement variable. It is only when all gravity variables are dropped, that our four variables of interest become significant for imports. The bilateral investment treaty variable remains insignificant for exports. The R-squared also drops significantly when all gravity variables are dropped. In the third column from the left, the WTO and TRIPS variables are replaced by a dummy variable, Paris Convention, which equals one if the United States' trading partner has signed the Paris Convention for the Protection of Industrial Property. The fourth column replaces the Paris Convention variable with a dummy variable for another patent treaty: the Patent Convention Treaty. While neither dummy variable is significant for imports or exports, the overall estimation does not lose in its explanation power when the WTO and TRIPS variables are dropped: the R-squares remain at 0.44 for exports and 0.67 for imports (compared to 0.44 with the default equation for exports and 0.68 for imports).

⁹ Least developed countries as defined by the United Nations.

¹⁰ There are no free trade agreements between the United States and least developed countries.

¹¹ The list is defined by the CIA World Fact Book, see appendix 4

Table 3. Regional analysis

	Exports				Imports			
	WTO	TRIPS	FTA	BIT	WTO	TRIPS	FTA	BIT
Least dev. countries	0.03 (0.62)	0.07 (0.63)	—	1.68 (1.55)	0.49 (1.53)	-1.36 (2.73)	—	1.00 (2.95)
Isl. dev. countries	1.02 (0.70)	0.30 (0.59)	-0.63 (0.84)	2.87*** (1.19)	0.36 (0.89)	0.90* (0.49)	1.39*** (0.33)	-0.42 (0.40)
Advanced eco	-0.59 (1.06)	-0.49*** (0.16)	0.87 (1.03)	-1.34 (1.80)	0.89 (1.02)	-0.80*** (0.28)	3.15*** (0.85)	3.92** (1.87)
Europe	0.54 (0.54)	0.57*** (0.21)	—	0.92* (0.55)	1.04 (1.38)	-1.10*** (0.37)	—	0.94 (1.36)
South-East Asia	-4.56** (1.97)	0.67* (0.35)	-0.58 (1.36)	—	0.68 (0.45)	1.03** (0.41)	3.24*** (0.20)	—
South Asia	0.21 (0.14)	-0.46 (0.48)	—	6.75*** (1.25)	0.14 (0.17)	1.82* (1.08)	—	6.69 (12.58)
Western Asia	-0.53 (0.95)	-1.39*** (0.37)	1.33* (0.72)	-2.29** (0.90)	-1.43* (0.86)	0.92 (0.96)	7.02*** (1.79)	-3.70*** (0.95)
Asia	-1.29 (0.87)	0.23 (0.36)	1.03 (0.76)	-0.75 (1.13)	-0.15 (0.81)	1.08*** (0.31)	5.85*** (0.69)	-2.81*** (0.98)
Caribbean	1.86** (0.89)	0.73 (0.55)	-0.61** (0.26)	-6.45*** (1.18)	-0.46 (1.51)	0.37 (0.46)	1.12*** (0.24)	-1.05 (0.88)
Latin America	1.04*** (0.34)	0.04 (0.26)	-0.14 (0.28)	-0.63 (0.41)	0.89 (0.90)	-0.20 (0.51)	0.82 (0.57)	-0.09 (0.44)
Sub-Sah Africa	0.93 (1.02)	-0.30 (0.38)	1.18 (1.07)	0.58 (1.44)	0.79 (0.58)	-0.29 (0.53)	2.17*** (0.46)	-1.73*** (0.28)
Africa	1.07 (0.82)	-0.17 (0.32)	0.17 (1.06)	0.74 (0.87)	0.37 (1.24)	0.55 (0.35)	2.02*** (0.65)	-0.67 (0.61)
PCT count. ¹²	0.39 (0.54)	0.12 (0.24)	0.60 (0.76)	-0.11 (0.50)	1.13 (0.93)	-0.14 (0.25)	2.36*** (0.63)	-1.41** (0.58)
Paris Conv ¹³	0.20 (0.46)	-0.03 (0.19)	0.57 (0.50)	-0.14 (0.41)	1.14 (0.70)	0.30 (0.22)	2.03*** (0.64)	-1.32*** (0.44)
European Union	—	-1.39*** (0.17)	—	0.29 (1.05)	—	-1.76*** (0.44)	—	2.07 (2.50)

Note: OLS with year effects, intercept not reported. Robust standard errors (clustering by country) are indicated in parentheses

¹² Countries that have signed the Patent Cooperation Treaty, which facilitates the procedures for filing patent applications throughout the world.

¹³ Countries that have signed the Paris Convention for the Protection of Industrial Property

Table 4. Perturbations of the Gravity Model

	Exports				Imports			
	Default	No ind. count.	Post TRIPS	Post Doha	Default	No ind. count.	Post TRIPS	Post Doha
Log GDP	0.76*** (0.08)	—	0.97*** (0.15)	0.97*** (0.15)	1.09*** (0.11)	—	1.38*** (0.18)	1.34*** (0.18)
Log GDP per capita	0.08 (0.11)	—	-0.15 (0.18)	-0.15 (0.19)	0.84*** (0.16)	—	0.77*** (0.22)	0.72*** (0.22)
Currency Union	—	—	0.40 (0.68)	0.35 (0.69)	—	—	0.45 (0.93)	0.71 (0.94)
Common language	—	—	0.77** (0.36)	0.77** (0.35)	—	—	0.91 (0.47)	1.11 (0.48)
Border	—	—	0.87 (0.73)	0.82 (0.71)	—	—	-1.94** (0.97)	-2.00** (0.94)
Landlocked	—	—	-0.08 (0.41)	-0.06 (0.41)	—	—	1.24** (0.62)	1.11* (0.63)
Island	—	—	0.66 (0.52)	0.65 (0.52)	—	—	-0.24 (0.62)	-0.41 (0.62)
Log area	—	—	-0.11 (0.11)	-0.10 (0.11)	—	—	-0.14 (0.13)	-0.15 (0.12)
Log distance	-0.76 (0.29)	—	-0.54 (0.35)	-0.56* (0.34)	-0.79** (0.33)	—	-0.98*** (0.34)	-0.94*** (0.33)
PCT	—	—	—	0.03 (0.27)	—	—	—	0.67 (0.42)
Paris Conv.	—	—	0.18 (0.31)	—	—	—	0.08 (0.45)	—
WTO	0.15 (0.35)	1.17*** (0.37)	—	—	1.18* (0.67)	2.39*** (0.68)	—	—
TRIPS	-0.13 (0.18)	1.57*** (0.27)	—	—	0.35 (0.22)	3.39*** (0.36)	—	—
Free Trade Agreement	1.42*** (0.38)	2.72*** (0.71)	0.96** (0.45)	0.96** (0.44)	1.84*** (0.71)	2.47** (1.00)	2.15*** (0.61)	2.05*** (0.63)
Bilateral Inv. Treaty	-0.21 (0.42)	-0.38 (0.47)	-0.09 (0.41)	-0.06 (0.41)	-1.31*** (0.45)	-3.12*** (0.64)	-1.25*** (0.44)	-1.33*** (0.44)
Observations	2,571	2,571	2,571	2,571	1,137	1,137	1,137	1,137
R ²	0.41	0.13	0.44	0.44	0.66	0.27	0.67	0.67
RMSE	2.38	2.88	2.32	2.32	2.42	3.52	2.39	2.38

Two main issues undermine the standard gravity equation expressed in logs: endogeneity of our variables of interest and missing data. Baier and Bergstrand (2007) find that a panel data approach using fixed-effects is a good way of dealing with the endogeneity issue. Other techniques can also be used however. The first line of table 5 gives the result of the Hausman-Taylor regression, which considers our four variables of interest as endogenous. This estimator deals with the problem of potentially endogenous variables which may be correlated with the unobserved fixed effects (Couttenier, 2008). The Hausman-Taylor regression suggests that the TRIPS Agreement and bilateral investment

treaties significantly increase exports of pharmaceuticals from the United States. However, the increase is moderate, i.e. about 40% ($\approx \exp(0.34)-1$). As in the default equation, the only variable of interest that is insignificant regarding U.S. imports is the WTO variable. Another way to correct for endogeneity is by using instrumental variables to replace the trade agreement variables. However, economists have found no instrumental variable which would be suitable to replace the trade agreement variables (Rose, 2004). The Arellano-Bond GMM estimator can also be a good way of dealing with the endogeneity issue, by first-differencing the gravity equation and thus removing the omitted-variable bias. The use of the Arellano-Bond GMM estimator confirms this gravity equation's main result: protecting intellectual property rights does not appear to increase the U.S. trade of pharmaceuticals. The TRIPS Agreement is the only variable which significantly impacts exports. Yet its impact remains weak (31%). The Arellano-Bond estimator suggests that the WTO variable significantly reduces imports. The only positive impact on imports is performed by bilateral investment treaties.

The main problem with the estimation of the gravity equation in logarithm is the zero trade issue: the estimation does not take into account the fact that the United States does not trade with all countries in the sample. Missing data can therefore introduce an important bias in our results. Rose's (2004) results have been criticized because he does not take into account zero trade. Table 5 shows the results for four ways to deal with this issue: using an ad hoc correction for the presence of zeros, a Tobit model, the Poisson estimator (Silva and Tenreyro, 2006) and the Heckman Sample Selection model. All four methods yield positive and significant relationships between the WTO variable and imports and exports of pharmaceuticals. However, the TRIPS Agreement decreases exports and increases imports in the Poisson estimation, while increasing both imports and exports in the Heckman Sample Selection model. Free trade agreements consistently increase imports and generally have a positive impact on exports. Bilateral investment treaties tend to decrease imports while increasing exports in the Tobit and Poisson estimations.

Table 5. Estimation sensitivity analysis

	Exports				Imports			
	WTO	TRIPS	FTA	BIT	WTO	TRIPS	FTA	BIT
Hausman-Taylor regression	-0.16 (0.12)	0.34*** (0.06)	-0.00 (0.16)	0.33** (0.14)	-0.17 (0.28)	0.37*** (0.11)	0.56** (0.24)	0.63** (0.30)
Arellano-Bond GMM estimator	-0.01 (0.21)	0.27*** (0.09)	-0.13 (0.28)	0.28 (0.26)	-1.00* (0.58)	-0.00 (0.13)	-0.03 (0.32)	1.51** (0.65)
Tobit	1.63*** (0.27)	0.16 (0.26)	2.06*** (0.70)	0.84*** (0.32)	4.57*** (0.56)	2.60*** (0.45)	3.55*** (1.07)	-1.04* (0.55)
Ad hoc correction	1.80*** (0.51)	0.15 (0.29)	-1.01 (0.71)	0.62 (0.38)	1.38** (0.54)	2.60*** (0.38)	3.35*** (1.30)	-1.81*** (0.62)
Original model by Poisson	0.13*** (0.01)	-0.05*** (0.01)	0.10*** (0.03)	0.07*** (0.02)	0.66*** (0.03)	0.39*** (0.03)	0.40*** (0.04)	-0.01 (0.03)
Heckit (two-step)	0.37** (0.17)	0.22* (0.12)	1.34*** (0.34)	0.15 (0.16)	2.43*** (0.34)	1.03*** (0.24)	2.79*** (0.51)	-1.43*** (0.27)

6. Concluding remarks

The standard gravity equation suggests that the protection of intellectual property rights through the TRIPS Agreement does not appear to significantly increase the trade of U.S. pharmaceutical products. While it may have a positive impact on imports, its overall effect remains uncertain. Simply belonging to the WTO appears to be positively correlated to trade when zero trade is taken into account in the estimation. The two variables which are the more consistently associated with a significant change in trade are the free trade agreement and bilateral investment treaty variables. Free trade agreements appear to be consistently and positively correlated to an increase in imports. However, as the United States continues to implement more stringent IPR protection clauses in their trade agreements, the positive impact on trade may wither. Finally, bilateral investment treaties appear to have a significant negative impact on the trade of pharmaceuticals with the United States.

The fact that the United States increasingly imports its pharmaceuticals may suggest that pharmaceutical companies are more likely to implement their businesses in foreign countries where patent rights are protected. For instance, the United States has significantly increased its imports from Singapore since 2003, just as the United States-Singapore Free Trade Agreement was being signed. The government of Singapore had decided to become a strong manufacturing center for pharmaceuticals in Asia, which could explain why it wanted to sign the free trade agreement with the United States. The

protection of intellectual property rights through trade agreements is probably one element explaining the increase in trade between the United States and other countries. A country's political will to cater to the pharmaceutical industry is also an important factor. Of course, this does not guarantee better access of poor countries to essential medicine.

The gravity equation's results show that there exist two different strategies for the United States to implement patent protection in foreign countries: with free trade agreements and bilateral investment treaties. The United States seem to be more selective regarding the countries with which it signs a free trade agreement. It might select those countries where it could outsource part of its production at cheaper costs than if the drugs were to be manufactured in the United States. The impact of free trade agreements and bilateral investment treaties on the trade of pharmaceutical products with the United States probably deserves further research. Nonetheless, these two variables seem to have a much more significant impact on the trade of pharmaceuticals than the WTO and the TRIPS Agreement. The TRIPS Agreement does not appear to be trade creating.

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Appendix 1: List of Trading Partners

Afghanistan	Denmark	Kazakhstan	Peru	Vanuatu
Albania	Djibouti	Kenya	Philippines	Venezuela
Algeria	Dominica	Kiribati	Poland	Vietnam
Andorra	Dominican Rep.	Korea, South	Portugal	
Angola		Kuwait		West Bank
Anguilla	East Timor	Kyrgyzstan	Qatar	West. Samoa
Antigua and Barbuda	Ecuador			
Argentina	Egypt	Laos	Rep. Yemen	Zambia
Armenia	El Salvador	Latvia	Romania	Zimbabwe
Aruba	Equatorial Guinea	Lebanon	Russia	
Australia	Eritrea	Lesotho	Rwanda	
Austria	Estonia	Liberia		
Azerbaijan	Ethiopia	Libya	San Marino	
		Liechtenstein	Sao Tome and Principe	
Bahamas	Fed. Rep. Germany	Lithuania	Saudi Arabia	
Bahrain	Fed. St. Micronesia	Luxembourg	Senegal	
Bangladesh	Fiji		Serbia Montenegro	
Barbados	Finland	Macao	Seychelles	
Belarus	France	Macedonia (Skopje)	Sierra Leone	
Belgium	French Polynesia	Madagascar	Singapore	
Belize		Malawi	Slovakia	
Benin	Gabon	Maldives	Slovenia	
Bermuda	Gambia	Mali	Solomon Islands	
Bhutan	Georgia	Malta	Somalia	
Bolivia	Ghana	Marshall Islands	South Africa	
Bosnia-Herzegovina	Greece	Mauritania	Spain	
Botswana	Greenland	Mauritius	Sri Lanka	
Brazil	Grenada	Mexico	St Kitts and Nevis	
British Virgin Islands	Guatemala	Moldova	St Lucia	
Brunei	Guinea	Monaco	St Vincent Grenadines	
Bulgaria	Guinea-Bissau	Mongolia	Sudan	
Burkina	Guyana	Montserrat	Suriname	
Burma (Myanmar)		Morocco	Swaziland	
Burundi	Haiti	Mozambique	Sweden	
	Honduras		Switzerland	
Cambodia	Hong Kong	Namibia	Syria	
Cameroon	Hungary	Nauru		
Canada		Nepal	Tajikistan	
Cape Verde	Iceland	Netherlands	Tanzania	
Cayman Islands	India	Netherlands Antilles	Thailand	
Central African Republic	Indonesia	New Caledonia	Togo	
Chad	Iran	New Zealand	Tonga	
Chile	Iraq	Nicaragua	Trinidad and Tobago	
China	Ireland	Niger	Tunisia	
Colombia	Israel	Nigeria	Turkey	
Comoros	Italy	North Korea	Turkmenistan	
Congo (Brazzaville)		Norway	Turks and Caicos Islands	
Congo (Kinshasa)	Jamaica		Tuvalu	
Cook Islands	Japan	Oman		
Costa Rica	Jordan		Uganda	
Cote d'Ivoire		Pakistan	Ukraine	
Croatia		Palau	United Arab Emirates	
Cuba		Panama	United Kingdom	
Cyprus		Papua New Guinea	Uruguay	
Czech Republic		Paraguay	Uzbekistan	

Appendix 2: Free Trade Agreements Involving the United States

(Source: <http://www.ustr.gov/trade-agreements>)

The United States-Australia Free Trade Agreement (entered into force on January 1, 2005)

The United States-Bahrain Free Trade Agreement (entered into force in August 2006)

The North American Free Trade Agreement (NAFTA) between the United States, Canada and Mexico (entered into force on January 1, 1994)

The United States-Chile Free Trade Agreement (entered into force on January 1, 2004)

The Dominican Republic-Central America-United States Free Trade Agreement (CAFTA-DR) with five Central American countries (Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua) and the Dominican Republic (entered into force for El Salvador on March 1, 2006, for Honduras and Nicaragua on April 1, 2006, for Guatemala on July 1, 2006, for the Dominican Republic on March 1, 2007, and now for Costa Rica on January 1, 2009)

The United States-Israel Free Trade Area Agreement (entered into Force August 19, 1985)

The United States-Jordan Free Trade Area Agreement (entered into force on December 17, 2001)

The United States-Morocco Free Trade Agreement (entered into force on January 1, 2006)

The United States-Oman Free Trade Agreement (entered into force on January 1, 2009)

The United States-Peru Trade Promotion Agreement (entered into force on February 1, 2009)

The United States-Singapore Free Trade Agreement (entered into force on January 1, 2004)

Appendix 3: Bilateral Investment Treaties Involving the United States

(Source:

http://tcc.export.gov/Trade_Agreements/Bilateral_Investment_Treaties/index.asp)

Albania Bilateral Investment Treaty (Entered into Force January 4, 1998)
Argentina Bilateral Investment Treaty (Entered into Force October 20, 1994)
Armenia Bilateral Investment Treaty (Entered into Force March 29, 1996)
Azerbaijan Bilateral Investment Treaty (Entered into Force August 2, 2001)
Bahrain Bilateral Investment Treaty (Entered into Force May 31, 2001)
Bangladesh Bilateral Investment Treaty (Entered into Force July 25, 1989)
Bolivia Bilateral Investment Treaty (Entered into Force June 6, 2001)
Bulgaria Bilateral Investment Treaty (Entered into Force June 2, 1994)
Cameroon Bilateral Investment Treaty (Entered into Force April 6, 1989)
Congo, Democratic Republic Of, Bilateral Investment Treaty (Entered into Force July 28, 1989)
Congo, Republic Of, Bilateral Investment Treaty (Entered into Force August 13, 1994)
Croatia Bilateral Investment Treaty (Entered into Force June 20, 2001)
Czech Republic Bilateral Investment Treaty (Entered into Force December 19, 1992)
Ecuador Bilateral Investment Treaty (Entered into Force May 11, 1997)
Egypt Bilateral Investment Treaty (Entered into Force June 27, 1992)
Estonia Bilateral Investment Treaty (Entered into Force February 16, 1997)
Georgia Bilateral Investment Treaty (Entered into Force August 17, 1997)
Grenada Bilateral Investment Treaty (Entered into Force March 3, 1989)
Honduras Bilateral Investment Treaty (Entered into Force July 11, 2001)
Jamaica Bilateral Investment Treaty (Entered into Force March 7, 1997)
Jordan Bilateral Investment Treaty (Entered into Force June 13, 2003)
Kazakhstan Bilateral Investment Treaty (Entered into Force January 12, 1994)
Kyrgyzstan Bilateral Investment Treaty (Entered into Force January 12, 1994)
Latvia Bilateral Investment Treaty (Entered into Force November 26, 1996)
Lithuania Bilateral Investment Treaty (Entered into Force November 11, 2001)
Moldova Bilateral Investment Treaty (Entered into Force November 25, 1994)
Mongolia Bilateral Investment Treaty (Entered into Force January 1, 1997)
Morocco Bilateral Investment Treaty (Entered into Force May 29, 1991)
Mozambique Bilateral Investment Treaty (Entered Into Force March 3, 2005)
Panama Bilateral Investment Treaty (Entered into Force May 30, 1991)
Poland Business and Economic Relations Treaty (Entered into Force August 6, 1994)
Romania Bilateral Investment Treaty (Entered into Force January 15, 1994)
Senegal Bilateral Investment Treaty (Entered into Force October 25, 1990)
Slovakia Bilateral Investment Treaty (Entered into Force December 19, 1992)
Sri Lanka Bilateral Investment Treaty (Entered into Force May 1, 1993)
Trinidad And Tobago Bilateral Investment Treaty (Entered into Force December 26, 1996)
Tunisia Bilateral Investment Treaty (Entered into Force February 7, 1993)
Turkey Bilateral Investment Treaty (Entered into Force May 18, 1990)
Ukraine Bilateral Investment Treaty (Entered into Force November 16, 1996)
Uruguay (Entered Into Force November 1, 2006)

Appendix 4: List of Advanced Economies

<https://www.cia.gov/library/publications/the-world-factbook/appendix/appendix-b.html>)

Andorra
Australia
Austria
Belgium
Bermuda
Canada
Denmark
Finland
France
Germany
Greece
Hong Kong
Iceland
Ireland
Israel
Italy
Japan
Korea, South
Liechtenstein
Luxembourg
Monaco
Netherlands
New Zealand
Norway
Portugal
San Marino
Singapore
Spain
Sweden
Switzerland
United Kingdom