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Intellectual property rights and U.S. information goods exports: the role of imitation threat

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Abstract Trade in information goods is particularly sensitive to the strength of intellectual property rights (IPR) and encounters an apparently different pattern of imitation threat compared with manufacturing trade, but the information goods trade–IPR nexus is less systematically investigated. This article analyzes whether and how U.S. information goods exports are sensitive to national differences in IPR protection and the degree of threat-of-imitation from the dynamic perspective. Employing the technique of instrumental variables for a dynamic panel model to consider the hysteretic effect and controlling the endogeneity problem, the empirical results show that the strength of the importing country's IPR protection overall exhibits a trade-enhancing effect, supporting the standpoint that stronger IPR protection will induce more trade. Moreover, we adopt the piracy rate as a proxy for threat-of-imitation to examine its role on the information goods trade–IPR nexus. Empirical findings validate the prevalence of the market expansion effect wherever the degree of imitation threat of importing countries is high or low, because the technology level and production cost of reproduction are very low. It implies that

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the existing theory on threat-of-imitation may not apply to the information goods trade.

Keywords IPR · Information goods trade · Threat-of-imitation

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1 Introduction

The emerging issue of the intellectual property rights (IPR)–trade nexus has attracted wide attention among economists and policy makers since the Agreement on Trade-Related Intellectual Property Rights (TRIPs) was enacted in 1995.[1] IPR laws and the enforcement of existing laws differ substantially across countries due to national differences in economic development and trade policy. Is stronger IPR protection really beneficial for economic development and technological progress? The divergence in the effects of strengthening IPR between North and South countries has widened in the recent years. Some developing countries argue that an extension of international IPR harms their technological progress and economic growth. Alternatively, developed countries use the trade policy as a main vehicle for strengthening IPR across bilateral or multilateral negotiations, implying that a stronger IPR does in fact influence international trade flows.[2]

The relationship between IPR protection and trade is quite complex. Theoretical and descriptive works on IPR and trade come with mixed results that trade flows might increase or decrease, depending on two contradictory effects of strengthening IPR. The market expansion effect increases the demand curve facing the foreign firms and increases trade flow toward countries with relatively stronger patents, because strengthening IPR reduces the ability of importing countries' firms to imitate technologies embodied in imported products. The market power effect alternatively reduces the elasticity of demand facing the foreign firms and decreases exports toward countries with strong patents, because the holder of the patent is ensured the exclusive rights to innovation goods by stronger patents. Due to strong patent protection, firms owning patented technologies or products in a foreign market may exercise their monopoly power by restricting export volumes and raising prices.

During the last decade, there has been an increasing amount of studies examining the relationship between IPR and trade by focusing on agricultural products (Yang and Woo 2006), biological products and pharmaceuticals (Smith 2002), manufacturing industries (Maskus and Penubarti 1995; Smith 1999, 2001; Co 2004; Falvey et al. 2006), and high-tech products (Fink and Maskus 2005; Fink and Primo-Braga 2005; Liu and Lin 2005). An IPR regime is found to play unequally important roles

[1] TRIPs is a foundation of the World Trade Organization (WTO), which sets the minimum standards of IPRs protection to be provided by each WTO member.

[2] For the interrelationships among IPRs, regulatory systems, and economic structures, see Maskus (1998).

across sectors, depending on the degree of imitation threat and imitation costs. While both the market expansion effect and market power effect co-exist in most studies, the market expansion effect is found to be prevailing in most studies (Appendix Table 7 summarizes the studies offered above). Thus, a clear picture emerges only from the empirical work.

Although previous studies have contributed to our understanding of the importance of IPR and threat-of-imitation on trade, there is little systematical investigation of their impacts on information goods trade. Indeed, international trade flows of information goods have grown very rapidly over the last decade, and their liberalization and IPR protection will be the important issues for future multilateral trade negotiations. As is well recognized, IPR does not play an equally important role in all sectors or even in all technology-intensive industries (Mansfield 1995). The patent system is sometimes not thought of as being an effective mechanism for appropriating returns to R&D for manufacturing goods, relative to other non-patent strategies, such as secrets and technological lead (Cohen et al. 2000). However, the market and trade of information goods are extremely relevant to IPR protection.

Information goods include anything that can be digitized, such as books, records, movies, and software (Varian 1999).[3] Information goods are costly to produce, but cheap to reproduce (both legally and illegally), and therefore, the trade of information goods depends heavily on the legal environment of IPR. Moreover, the reproduction of information goods requires only a low technological level and takes a low marginal cost, implying that the threat-of-imitation suffered by information goods trade is substantially different from the manufacturing products. Even for a less developed country, it is very easy for local firms to reproduce the same quality of information goods at an extraordinarily low cost.[4] Thus, the role of threat-of-imitation on the IPR–trade nexus predicted by Smith (1999)—that a market expansion effect or market power effect acts depending on the imitative ability of the importing country—may not apply to the relationship between IPR and information goods trade. This suggests the need to reconsider how to define the threat-of-imitation for information goods and how it acts in the information goods trade–IPR nexus.

How much does IPR affect the information goods trade and whether the IPR–export nexus is different between the exports of information goods and manufacturing goods are interesting and important questions, yet they seem to be little discussed in the existing literature. This article provides empirical evidence on how information goods exported from the U.S. are influenced by national differences in IPR enforcement. Furthermore, this study attempts to contribute in line with the empirical literature by providing the following two distinct types of empirical evidence.

First, we examine whether and how national differences in IPR do affect trade in information goods. Although developing countries have strong concerns about the

[3] It does not require that the information actually be digitized.

[4] For example, the average sale price of a copyrighted music CD is about US $8 in Taiwan. However, if someone wants to illegally recode that CD, then she/he just buys a blank space CD that costs her/him only about US $0.25, and then uses recoding software (maybe acquired also illegally) to recode it.

TRIPs agreement and most of them have implemented even higher IPR standards than those required by TRIPs, the phenomenon of information goods piracy remains widespread among developing countries. Developed countries have raised serious concerns on this piracy problem and have used trade policy as the main instrument for strengthening IPR across bilateral or multilateral negotiations. On the other hand, information goods are easy to be reproduced without the requirements of high cost and a high technology level, indicating that the degree of threat-of-imitation information goods encounter is substantially different from the manufacturing goods across countries. Whether threat-of-imitation serves a different role on the information goods, trade–IPR nexus is also a question examined in this study.

Second, this study uses a panel dataset of U.S. information goods exports to 48 countries during 1997–2005 and employs longitudinal and consistent IPR indices surveyed by the World Economic Forum (WEF) and the International Institute for Management Development (IMD) to investigate the dynamic process between IPR and trade. The IPR protection is inherently a dynamic process, involving both a secular evolution within one country over time and the need for new standards of protection (Maskus 1998). Due to the availability of the IPR index, previous empirical studies, except Co (2004), Falvey et al. (2006), and Yang and Woo (2006), utilize cross-sectional and pre-1990 data to examine the impact of IPR protection on trade. This panel data study allows us to account for changing IPR regimes and threat-of-imitation, to control for the overall business cycle, and to disentangle the time invariant country-specific effects and unmeasured country heterogeneity. More importantly, the empirical evidence provides a clearer and more dynamic portrait, yielding an insightful viewpoint on the importance of copyrights on trade after the implementation of the TRIPs Agreement. From the perspective of estimating technique, this study employs the instrumental variables approach for the dynamic panel data model to deal with the endogenous problem of IPR degree. Previous studies assume that the strength of IPR protection is exogenous which rules out the possibility that a country's decision on the strength of IPR is related to its imports. If a country's imports are simultaneously determined with the strength of IPR protection, then the estimates on the IPR effect would be biased. By employing a more appropriate econometric method, this study can assess the effects of IPR and threat-of-imitation more accurately.

The rest of the article proceeds as follows. Section 2 briefly first introduces the treaties covering copyright and provisions of TRIPs related to copyright. We then introduce the features of information goods and how IPR and threat-of-imitation affect the trade flow of information goods. The essential point of this discussion is to point out the possible differences in the roles of IPR and threat-of-imitation between manufacturing goods and information goods trade. We go on in the third section to specify an econometric model of bilateral trade, borrowing from the Gravity model, and describe the data. Section 4 presents the empirical estimates on the information goods trade–IPR nexus by utilizing the panel data model. We next employ the instrumental variables approach for the dynamic panel data model to deal with the autocorrelation and endogenous problems. Section 5 discusses the role of threat-of-imitation on the relationship between IPR and trade in information goods. Concluding remarks are provided in the final section.

2 Copyright and the relations among information goods trade, IPR, and imitation threat

2.1 Copyright and related rights

There are two types of intellectual property rights. One is industrial property right which protects ideas, such as inventions, designs, trademarks, and service marks. The other is copyright which protects forms of expression of ideas, such as books, music paintings and sculptures, films, computer program, multimedia productions, and electronic databases. The property rights associated with information goods trade discussed in this article are closely related to copyrights, which were first legally approved in the *Berne Convention* for the Protection of Literary and Artistic Works in 1886. The *Berne Convention* became the basic standard of international copyright protection and is now administrated by the World Intellectual Property Organization (WIPO). The *Berne Convention* provides basic protection principles, offers the minimum standards of protection related to works and duration to be granted, and sets up special provisions to developing countries.[5]

In addition to the *Berne Convention*, the WIPO administrates another five international treaties on copyrights and related rights for different subjects.[6] The *Rome Convention* of 1961 protects performers, producers of phonograms, and broadcasting organizations. The *Geneva Convention* of 1971 protects producers of phonograms against unauthorized duplication. The *Brussels Convention* of 1974 prevents the unauthorized distribution of program-carrying signals transmitted by satellite. The *WIPO Copyright Treaty* (WCT) of 1996, a special agreement under the *Berne Convention*, protects copyrights on computer programs and databases. Finally, the *WIPO Performances and Phonograms Treaty* (WPPT) of 1996 ensures copyrights for performers and phonogram producers. Summarizing the above discussion, the intentions of copyright treaties are to grant protection to creators to use or to authorize others to use their original works in certain ways.

In addition to all the above treaties, the most comprehensive multilateral agreement on intellectual property is TRIPs, administrated by the WTO. The major goal of TRIPs is to prohibit unfair trade from pirates. In order to fulfill the goal without causing the members to adopt protectionist intellectual property rules similar to the non-tariff barriers (NTBs), the TRIPs request WTO members to comply with the *Berne Convention* under the rules on national and most-favored-nation treatments. Moreover, harmonizing members' rules of intellectual property rights is recommended if the WTO attempts to promote free trade in intellectual property goods and services (Samuelson 1999).[7]

[5] Please visit http://www.wipo.int/treaties/en/ip/berne/ for the full text of the *Berne Convention*.

[6] Please visit http://www.wipo.int/copyright/en/treaties.htm for the full text of the five international treaties.

[7] TRIPs cover also the issue surrounding parallel imports. While parallel imports are legal in some countries and are illegal in others, the TRIPs grant flexibility to WTO members under multilateral agreement during the Uruguay Round.

2.2 Information goods trade, IPR, and imitation threat

As defined by Varian (1999), information goods are anything that can be digitized, such as books, records, movies, and software. Information goods also are described as a subset of cultural goods defined by Untied Nations Educational, Scientific, and Cultural Organization (UNESCO).[8] Due to the progress of digitization technology, most new audio-visual content, photographic, and textual creations are available in digital form.

Trade in information goods has shown an impressive growth over the past decades. According to the UNESCO (2000) statistics, the global trade of cultural goods has increased 347% from US $47.8 billion in 1980 to US $213.7 billion in 1998. Moreover, most of the world trade in cultural goods is concentrated in a small number of countries, especially the U.S. Despite the liberalization of trade in cultural goods being one of the most sensitive issues of current multilateral negotiations that some fear will generate a worldwide standardization of tastes and behaviors,[9] trade in information goods is actually culture related. Recent literature on the economic impacts of cultural proximity, such as Schulze (1999), Marvasti and Canterbery (2005), and Disdier et al. (2007), have found that linguistic similarity, past colonial and migrant links, and bilateral trust are trade enhancing. As a consequence, trade between very dissimilar countries is limited.

Despite the emerging rise of trade flows in information goods, one widespread concern is about piracy of information goods. As the world has become more networked, combined with technological progress in both digitization and computer networking, these developments make it much easier to transfer digital content from one person to another as well as to replicate a new copy. From data shown in BSA (2007),[10] the PC software piracy loss of the U.S. in 2006 reached a staggering amount of over US $7.2 billion. Many developing countries, such as Brazil, China, India, Indonesia, and Mexico, are in the top-20 list of high-piracy countries, causing a loss of trade in information goods. Besides the pecuniary loss, the piracy of information goods has many negative economic consequences on exporting countries, including the shrinking of related industries, lost tax revenues and jobs, from a lack of legitimate markets. However, despite the wide concern, the relationship between IPR and information goods trade has not received much attention in the literature.

There is also concern about the availability of the third characteristic, imitative ability, on the information goods trade–IRP nexus. The production of information goods usually has high fixed as well as sunk costs, while the marginal cost of reproduction (or piracy) is very low. For example, the production of Hollywood movies is a complex combination of good ideas, computer technology, and audio-visual technology, while a reproduction may need only one finger to click on a

[8] Cultural goods included in UNESCO's definition are printed matter, literature, music, visual arts, cinema, photography, radio, television, games, and sporting goods. Please see UNESCO (2000) for details.

[9] See Francois and van Ypersele (2002) for an academic justification for this view.

[10] BSA is the abbreviation of Business Software Alliance.

keyboard to copy.[11] From the perspective of production technology, the original of the information good is very knowledge intensive and technology intensive, while it is extremely easy to reproduce the same product with minimum technology requirement. However, manufacturing goods, even without IPR protection, are sometimes not easy to imitate due to the requirements of technological knowledge and pecuniary cost, making it difficult to reproduce manufacturing products with the same quality. The exporting firms therefore can exercise their market power to charge a higher price for innovative products in countries with weak imitative ability. Since the technology structure—a high technology level to produce the original and easy to copy—of information goods causes most countries to have the ability to replicate imported information goods, this distinct feature of information goods challenges the traditional view on the role of threat-of-imitation on affecting the trade–IPR nexus.

3 Empirical model and data

In order to investigate the effect of IPR on information goods trade, this study adopts the commodity version of the gravity model. This model has been proven to be a flexible general equilibrium framework consistent with a variety of trade models (Bergstrand 1985, 1989). We follow the literature in estimating a gravity equation to determine the impact of IPR protection on the manufacturing goods to specify the empirical specification of information goods trade. While the exact specification of the gravity equation can vary, our equation includes the core variables, GDP, population, the distance between the exporter and importer, and other factors that may enhance or distort information goods trade. In particular, the strength of IPR protection is the key variable of interest that may increase or decrease trade flow. Adopting the specification by indexing the U.S. as the source country to examine bilateral trade, the starting point for our analysis is the following:

$$\begin{aligned}\ln \mathrm{TRADE}_{ijt} = {} & \beta_0 + \beta_1 \ln \mathrm{PGDP}_{it} + \beta_2 \ln \mathrm{POP}_{it} + \beta_3 \ln \mathrm{DIS}_{ij} + \beta_4 \mathrm{TARIFF}_{it} \\ & + \beta_5 \mathrm{NAFTA}_i + \beta_6 \mathrm{LANG}_i + \beta_7 \mathrm{RELIGION}_{ij} + \beta_8 \mathrm{IPR}_{it} + \gamma T + \varepsilon_{it}\end{aligned} \tag{1}$$

Here, i denotes the importing country, j denotes the U.S., t denotes the time period, ε is a normally distributed error term, and ln is a logarithm. TRADE is the sum of information goods exported from the U.S. to country i at time t. The core explanatory variables include the per capita GDP of country i in US dollars (PGDP) and the population of the importing country i in thousands (POP). These two variables are used to capture the concept of marginal propensity to import and market size in the importing country, respectively. Both the PGDP and POP are obtained from the IMF World Economic Outlook Database. We expect that, in line

[11] It can easily cost over US $100 million to produce a Hollywood movie, while the illegal copy of DVD movie can cost just under US $1 and take only few minutes.

with the existing trade literature, both per capita GDP and population will have positive impacts on trade, reflecting a positive marginal propensity to import and a positive relationship between market size and volume of trade.

The geographical distance between country *i* and the U.S. (DIS) is also included. It represents a natural rather than a policy-driven distortion, because the transport cost increases as the distance is longer. It is expected to have a negative impact on trade flows. The terms TARIFF and NAFTA are two variables regarding trade barriers. TARIFF denotes the average tariff imposed on imported goods by country *i*. It is expected to have a negative impact on imports, because a higher tariff causes imported goods to be more expensive. NAFTA is a dummy variable that takes one if the importing country is a member of the North American Free Trade Agreement (NAFTA). The establishment of a free trade zone is widely recognized to prompt trade creation across member countries within the zone. We expect NAFTA to have a positive impact on the information goods trade.

As discussed in the previous section, information goods are culturally relevant to the destination market. Therefore, two cultural variables, LANG and RELIGION, are taken into account. The term LANG is a dummy variable that equals one if the importing country shares a common language with the U.S.[12] In the existing literature, a common language is thought to facilitate communication between trade partners and reduce the search costs of international trade. It is therefore used as a proxy for information channels about profitable trade opportunities between the two countries (Schulze 1999). In this study, this variable is used to represent the "cultural distance" or "cultural proximity" between the two countries. A shorter cultural distance implies a lower transaction cost and a more similar taste, and therefore the trade in information goods increases. Another proxy of cultural proximity is similarity in the religion. The term RELIGION denotes the religious similarity between the importing country and the U.S. Following the measure used in Marvasti and Canterbery (2005), religious similarity is measured by the percentage of population that is Judeo-Christian in the importing country, because about 80% of the population is of the Judeo-Christian faith in the U.S.[13]

The term IPR is the key variable investigated in this study. It is an index of IPR protection in the importing country. The IPR index developed by Rapp and Rozek (1990) and Ginarte and Park (1997) is widely adopted to measure the degree of patent protection in existing studies, but this index cannot be adopted in this study. This index is available for years before 1990 and 1995, and 2000; however, the period we examine is 1997–2005. In order to overcome this limitation, this study adopts two consecutive and consistent IPR indices surveyed by WEF and IMD, respectively. The WEF and IMD indices have been adopted in Nunnenkamp and

[12] Centre D'etudes Prospective Et D'infornational Internationals (CEPII) defines the language variable as one if a language is spoken by at least 9% of the population in both countries.

[13] In fact, a country's cultural policy also has impacts on imports. In order to protect domestic cultural goods producers, some countries have their own cultural policies to hinder sales in the domestic market. For example, cinemas in South Korea are required to show films made in South Korea at least 146 days per year (Cooper and Manyin 2007). Such a cultural policy reduces U.S. exports of cultural goods to South Koreans. This article does not take cultural policy into account since we are short of importers' cultural policy data.

Spatz (2003) and have proven to be highly correlated with the Ginarte–Park index. The WEF survey is related to IPR protection in general. The question of the WEF survey is whether "intellectual property protection [is] in your country" and the respondents give a score from "weak or non-existence (score 0)" to "equal to the world's most stringent (score 7)." Thus, this index ranges from 0 to 7 and a higher value of the index indicates a stronger level of protection. For analogous presentation, the IPR index of IMD ranges from 0 to 10 by giving a score on the following question: "Intellectual property rights are not adequately enforced or are adequately enforced." A positive and significant coefficient for the IPR variable in Eq. 1 implies the existence of a market expansion effect, whereas a negative coefficient indicates that firms exert their market power and decrease trade flows.

The above two measures have both limitations and strengths. The major limitation of these indices is that they are obtained from the subjective scoring of respondents, although most respondents are entrepreneurs, experts, and scholars.[14] Moreover, IPR indices and per capita GDP are highly correlated, implying that GDP variable can capture the effect of IPR protection on trade and vice versa. However, we cannot distinguish both effects from them clearly. On the other hand, they have two major advantages. First, the longitudinal data coincide with the need of examining the trade–IPR nexus for the post-TRIPs period. Moreover, the use of these excellent alternative indices enables us to obtain more insightful analyses on the dynamic relation between IPR and information goods trade. Second and importantly, the limitation mentioned above alternatively induces an advantage that there is a significant time variation across countries during the sample years, meeting the need of panel data analyses. As shown in Fig. 1, both average IPR scores surveyed by WEF and IMD of the 48 sampled countries do not present a significant increasing or decreasing trend, while it fluctuated across years. In terms of WEF's IPR index, its score ranges from a low of 4.563 in 2005 to a high of 5.073 in 2002. On the other hand, the average score of IMD's IPR index is from a low of 5.576 in 1998 to a high of 6.745 in 2000.

A series of annual time dummies (T) are included in the empirical equation. The estimates of these dummies can be employed to indicate the overall change in U.S. information goods trade during the period. The common shift in a time trend might be attributed to a number of other macro shocks and the development of internet technology and content which have impact on the information goods trade.

As is well known, most economic time series are non-stationary, including the time series data of trade volume, implying there is a potential problem of autocorrelation. It is noteworthy that information goods are culturally relevant, implying that most information goods belong to the broad concept of culture goods. As Schulze (1999) pointed out, the consumption of cultural goods can be thought to be addictive (or habitual)—that is, information goods trade is possibly influenced by the past. The most common approach in the empirical trade literature to test for such

[14] For example, the Executive Opinion Survey of IMD is sent to executives in top and middle management in all the economies and the sample represents a cross section of business community in each country or region. The distribution reflects a breakdown of industry by sectors. In order to be statistically representative, IMD selects a sample size which is proportional to the GDP of each economy. In 2006, there were 4055 responses from the 61 economies worldwide.

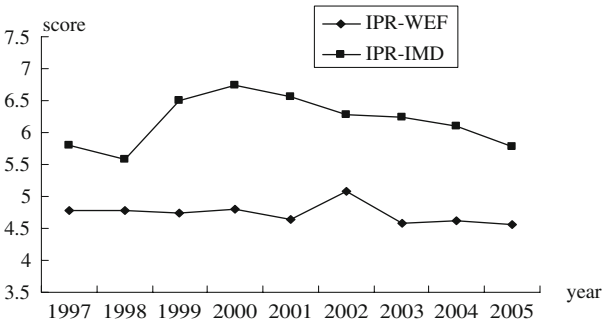

Fig. 1 Time trend of average IPR-WEF and IPR-IMD scores, 1997–2005

a hysteresis effect is adding lagged trade (TRADE(−1)) to the specification. A positive and significant estimated coefficient on this lagged one-year trade variable can lend support to the presence of a habitual behavior. Therefore, Eq. 1 can be augmented as the following:

$$\begin{aligned}\ln \mathrm{TRADE}_{ijt} = {} & \beta_0 + \alpha \ln \mathrm{TRADE}_{ij,t-1} + \beta_1 \ln \mathrm{PGDP}_{it} + \beta_2 \ln \mathrm{POP}_{it} + \beta_3 \ln \mathrm{DIS}_{ij} \\ & + \beta_4 \mathrm{TARIFF}_{it} + \beta_5 \mathrm{NAFTA}_i + \beta_6 \mathrm{LANG}_i + \beta_7 \mathrm{RELIGION}_{ij} \\ & + \beta_8 \mathrm{IPR}_{it} + \varepsilon_{it}\end{aligned} \tag{2}$$

In order to deal with the appearance of a lagged one-period variable and get rid of the possible endogeneity for IPR strength, we employ the instrumental variable approach for the dynamic panel data model to estimate Eq. 2. In order to consolidate the results obtained by the instrumental variable approach, this study adopts various instrumental variables.[15]

The information goods trade we focus on in this study is U.S. exports to 48 countries for 1997–2005. The information goods include mainly audio-visual products. Detailed information concerning these products is displayed in Appendix Table 8.[16] The choice of the sample and the time frame is worth noting. Indeed, the United States is the largest exporter of information goods, especially for audio-visual products.[17] Therefore, this study focuses on information goods exported from the U.S. In order to harmonize with the availability of IPR indices, 48 countries are included in the sample. The value of exports to the sample countries accounted for

[15] The GMM method for the panel dynamic model provides an alternative approach. However, the results obtained by GMM are inconsistent when the number of observations is not large enough and they are very sensitive to instrumental variables used. Therefore, this study does not employ this technique to estimate the regressions. Actually, the instrumental variable (IV) method serves as a good alternative strategy for GMM, depending on selecting appropriate instruments.

[16] Although previous literature has provided definitions of information goods (Varian 1999), so far there have not been HS or SITC codes used to define information goods. Therefore, we establish our own criteria and select products that are more likely to be considered as information goods. Since this article mainly focuses on cross-border trade, we exclude the trade classified as service via licensing and Internet downloads.

[17] http://portal.unesco.org/culture/.

Table 1 Variable definitions, basic statistics, and data sources

Variable	Definition (unit)	Mean	S.E.	Min.	Max.	Source
TRADE	Value of information goods export from U.S. to country *i* (US $ million)	20.651	37.871	0.080	247.245	(1)
PGDP	Per capita gross domestic product of destination country (US $)	16,279	14,153	432	80,288	(2)
POP	Population of destination country (million)	84.861	228.282	0.421	1,307.56	(2)
DIS	Geographic distance between U.S. and country *i* (km)	8,614	621.97	6,394	11,159	(3)
TARIFF	Average tariff rate of country *i* (%)	5.645	5.635	0	47.80	(2)
OPEN	Openness degree: ratio of the sum of imports and exports to GDP (%)	74.78	55.84	14.25	367.96	(2)
NAFTA	Dummy variable: NAFTA = 1 if the importing country *i* is a member of the North American Free Trade Agreement (none)	0.042	0.200	0	1	(4)
LANG	Dummy variable: LANG = 1 if English is spoken by above 9% of the population in country *i* (none)	0.396	0.489	0	1	(3)
RELIGION	Religious similarity: percentage of population that is Judeo-Christian in the importing country (%)	62.172	35.818	0	100	(5)
IPR-WEF	Degree of IPR protection of destination country. It ranges from 0 to 7 and a higher value denotes a stronger protection (none)	4.731	1.102	1.9	6.7	(6)
IPR-IMD	Degree of IPR protection of destination country. It ranges from 0 to 10 and a higher value denotes a stronger protection (none)	6.178	1.651	1.77	9.153	(7)
TIMPORT	Value of total export from U.S. to country *i* (US $ million)	12875.7	25668.3	68.439	188204.5	(1)
PIRACY	Piracy rate of software (%)	51.137	18.251	23	96	(8)

Notes: Figures in columns *Mean* and *S.E.* represent means and standard errors, respectively, of pooled data for the 1997–2005 period. The statistics of each variable are calculated by 432 observations

Data sources: (1) World trade atlas (WTA); (2) IMF world economic outlook database; (3) Centre D'etudes Prospective Et D'informational Internationals (CEPII), http://www.cepii.fr; (4) http://www.trade.gov.tw; (5) The World Factbook 2005, Central Intelligence Agency, United States; (6) The global competitiveness report, World Economic Forum; (7) World competitiveness yearbook, International Institute for Management Development; (8) Business software alliance

about 90% of U.S. exports of audio-visual products during the sample period, indicating that the sample countries chosen in this study are a representative sample. In order to assess the importance of copyright on information goods trade after the implementation of TRIPs in 1995, we therefore cover the 1997–2005 time span. Table 1 displays the definitions, basic statistics, and data sources of the variables.[18]

[18] The correlation matrix of explanatory variables is displayed in Appendix Table 9.

4 Empirical estimates for the information goods Trade–IPR nexus

4.1 Estimating results of the panel data model

Table 2 displays a series of estimates of IPR's impact on information and manufacturing goods trade. Estimates in columns (1) and (2) are obtained by the random effect of the panel data model and the estimates are specified as the basic model.[19] On the other hand, columns (3) and (4) display estimates by adopting U.S. exports of manufacturing goods as the dependent variable. It is interesting to compare the influences of information goods trade with those observed for trade in manufacturing goods.

The statistics of the Hausman test shown in columns (1) and (2) are not significant at a conventional statistical level, indicating that the random effect is appropriate for the estimates on information goods trade. The results obtained from the panel data model are broadly as anticipated and are quite similar to the previous studies by focusing on manufacturing sectors and that for U.S. manufacturing goods trade in columns (3) and (4). The coefficients of per-capita GDP and population are both positive and significant at the 1% statistical level in all specifications, implying that a country that has a higher per capita income and a larger population imports more information goods from the U.S. In particular, the estimated coefficient on lnPGDP is also significantly larger than unity, indicating that information goods can be treated as luxury goods. We find a negative coefficient on distance, but not statistically significant. Increased shipping distance represents a higher transportation cost of trade and it might decrease the volume of trade. The insignificant effect of geographic distance is possibly attributed to the minor role transportation cost serves in information goods trade.

As for the effects of tariff and free trade zone on trade, the coefficient on the TARIFF variable exhibits an unexpected positive sign, but it is not statistically significant. The possible interpretation is that the information on tariff we use is the average tariff rate of all imported goods rather than the distinct tariffs on information goods, preventing us to clarify the actual tariff effect on information goods trade. On the other hand, the impact of NAFTA is significantly positive in both estimates as expected, indicating that the establishment of a free trade zone can raise the level of trade flow across member countries.

Turning to the culture-related variables, the linguistic similarity appears to exhibit a trade-enhancing effect of raising the trade flow of information goods. This finding is consistent with the recent literature on the determinants of cultural goods, such as Marvasti and Canterbery (2005) and Disdier et al. (2007). Alternatively, the coefficient on religious similarity RELIGION is in contrast with the expectation to have a negative and significant impact on the trade flow of information goods imported from the U.S., indicating that a country with a higher percentage of Judeo-Christian faith population imports less information goods from the U.S., *ceteris paribus*. This result may arise from excluding the strong negative impact caused by

[19] Since the culture-related variable LANG and the variables of distance and free trade zone are time invariant, we adopt a random effect (RE) rather than a fixed effect (FE) model.

Table 2 Determinants of trade in information goods and manufacturing goods

Dep. variable	Panel data model (RE) Information goods		Panel data model (RE) Manufacturing goods	
	(1)	(2)	(3)	(4)
Constant	−11.539*** (2.575)	−11.846*** (2.568)	−0.625 (3.157)	−0.505 (3.118)
lnPGDP	1.185*** (0.090)	1.227*** (0.092)	0.662*** (0.055)	0.648*** (0.056)
lnPOP	0.950*** (0.063)	0.949*** (0.063)	0.724*** (0.076)	0.732*** (0.076)
lnDIS	−0.068 (0.244)	−0.041 (0.242)	0.046 (0.327)	0.048 (0.322)
TARIFF	0.001 (0.011)	0.001 (0.012)	−0.011** (0.005)	−0.012** (0.005)
NAFTA	1.097* (0.577)	1.148** (0.574)	2.230*** (0.774)	2.226** (0.764)
LANG	1.023*** (0.167)	1.017*** (0.166)	0.921*** (0.224)	0.910*** (0.221)
RELIGION	−0.0055** (0.0027)	−0.0055** (0.0027)	−0.008** (0.004)	−0.007** (0.0036)
IPR-WEF	0.101* (0.055)		0.069*** (0.023)	
IPR-IMD		0.029 (0.040)		0.052** (0.017)
Year 98	0.012 (0.088)	0.020 (0.088)	0.040 (0.033)	0.050 (0.034)
Year 99	0.024 (0.088)	0.002 (0.093)	−0.003 (0.033)	−0.044 (0.036)
Year 00	−0.050 (0.089)	−0.073 (0.098)	0.066* (0.034)	0.017(0.038)
Year 01	−0.266*** (0.090)	−0.299*** (0.096)	0.048 (0.034)	−0.002 (0.037)
Year 02	−0.298*** (0.091)	−0.281*** (0.093)	−0.106*** (0.035)	−0.112*** (0.035)
Year 03	−0.663*** (0.091)	−0.702*** (0.091)	−0.121*** (0.035)	−0.158*** (0.035)
Year 04	−0.877*** (0.094)	−0.913*** (0.093)	−0.068* (0.038)	−0.092** (0.037)
Year 05	−0.972*** (0.098)	−1.008*** (0.096)	−0.030 (0.040)	−0.041 (0.040)
R^2	0.836	0.836	0.770	0.769
Hausman test	3.525	4.187	14.853***	17.248***
D-W test	0.521***	0.513***	0.045***	0.044***
Observations	432	432	432	432

Notes: Figures in parentheses are standard errors. RE represents random effect model estimation

***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively

other religions (Helble 2007). Moreover, some countries have a very low ratio of Judeo-Christian faith population, such as China and Japan, but they import a large amount of information goods from the U.S.

The main concern of this study is to assess whether information goods trade is sensitive to the national differences in IPR protection. We have a significantly positive coefficient for the IPR-WEF variable, while an insignificantly positive coefficient for IPR-IMD is found. Why is there a difference in significance for estimated coefficients on both variables? The possible cause is the difference in the content on variable construction as discussed previously. Does stronger IPR protection induce more trade on information goods? The above estimates on IPR variables seem to provide limited evidence that the market expansion effect prevails for information goods trade when the degree of threat-of-imitation is not controlled. As discussed previously, there are some econometric problems needed to be fixed, especially for the endogenous choice of the degree of IPR protection.

The estimates on the IPR variable obtained by the panel data model on information goods trade provide only very preliminary evidence. However, the result tends to be consistent with the results of the previous studies, which find a positive impact of IPR protection on manufacturing goods trade.

The two sets of estimates for the year dummies obtained by panel data model and their 95% confidence intervals are plotted in Figs. 2 and 3. Both figures show a similar trend and depict an apparent trend of a substantial decrease, especially since 2001, in the amount of U.S. information goods trade during 1997–2005 after controlling for other variables. The decreasing rates of U.S. information goods exports are at an overall average rate of 12.1% and 18.4% per year during 1997–2005 and 2000–2005, respectively. It implies that, given that other positive influences are fixed, the exports of U.S. information goods in 2005 were only as a half large as that in 1997. Why did trade flows of information goods decrease substantially? As a consequence of the rapid change in Internet technology and content, many information goods, such as music and movies, can be easily and rapidly downloaded at a very low cost. As indicted in McCalman (2004), when IPR protection alters, exports may be substituted by FDI or licensing, causing a declining trend on U.S. exports of feature films and videos exports.[20] This is also the possible reason causing the decreasing time trend on U.S. information goods exports. On the other hand, as argued by developed countries, the piracy rate of information goods seems to remain at a higher level in many developing countries. All the factors mentioned above cause the serious drop in trade flows of information goods over time.

It is interesting to compare the potential differences in determinants of trade for information goods and manufacturing goods. Comparing results in columns (1) and (2) for information goods and results in columns (3) and (4) for manufacturing goods, there are several interesting findings worth noting. First, as shown in Table 2, the tariff has a significantly negative impact on the trade flow of manufacturing goods rather than information goods, because the tariff variable used is the average tariff rate. Second, the influence of free trade zone (NAFTA) on promoting regional trade is much higher for manufacturing goods. In contrast, whether two countries share the common language is much relevant to information goods trade. Third, and importantly, comparing the estimated magnitudes of IPR variable in columns (1) and (3) (0.101 vs. 0.069), the estimated trade-enhancing effect of IPR seems to be stronger for information goods, highlighting the importance of IPR protection on information goods trade.

[20] Using Hollywood feature film and video firm level data, McCalman (2004) empirically examines the choice between FDI and licensing to serve foreign markets when the host country's IPR strength is taken into account. The article shows that the non-monotonic relationship between IPR and FDI exists, demonstrating that Hollywood studios prefer taking FDI rather than licensing to serve foreign markets when the IPR standards are low or high. However, a licensing agreement is taken if the IPR strength is moderate.

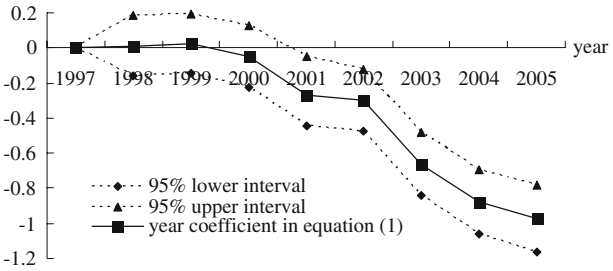

Fig. 2 Estimated year effects, from Eq. 1 of Table 2

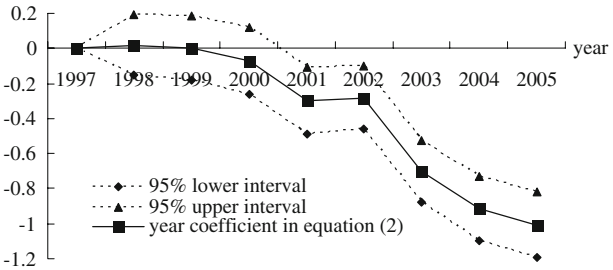

Fig. 3 Estimated year effects, from Eq. 2 of Table 2

4.2 Dynamic perspectives of the relationship between IPR and information goods trade

The above analyses provide preliminary evidence that IPR protection has a positive impact on information goods trade, in line with previous studies that the market expansion effect is widespread. However, it is noteworthy that the Durbin–Watson statistics shown in the bottom of Table 2 reveals that there exists a first-order autocorrelation problem. Moreover, the estimates for the trade effect of IPR might be inconsistent when the importing country's IPR protection is assumed to be an exogenous rather than an endogenous variable—that is, two econometric problems emerge with regard to the panel data model. First, the time dimension of the panel data might be non-stationary due to the existence of a unit root. Second, the potential of an endogeneity between trade flows and the measure of IPR protection may exist, because the enforcement of IPR is probably influenced by other factors such as economic development and technological specialization.

Concerning the first problem, we now resort to the formal panel unit root test developed by Im et al. (2003) and the ADF-Fisher test for the dependent variable of exports. Table 3 shows that the statistics for both tests are smaller than the critical value at the 10% statistical level, indicating that the null hypothesis, that there is a panel unit root, is not rejected. Thus, adopting the dynamic panel data model is more appropriate to examine the relationship between IPR and information goods trade. More importantly, the estimated coefficient on the lagged trade variable can be used to test the existence of the hysteresis effect on the consumption of information goods.

Table 3 Panel unit root tests of information goods trade

Method	Statistic	Probability
Im et al. (2003) *W*-statistic	1.982	0.976
ADF-Fisher χ^2	79.534	0.888

Note: The null hypotheses assume that panel unit root prevails

In order to deal with the problem of the endogenous decision on IPR strength, the instrumental variable (IV) estimates for the dynamic panel data model is adopted in this subsection. The first-stage estimation relates IPR strength to a vector of determinants, including the importing country's real per capita GDP (PGDP), total imports (TIMPORT), tariff rate (TARIFF), and the degree of openness (OPEN).[21] The predicted IPR variable then enters to the second stage estimation of the dynamic panel data model. Table 4 summarizes the results.[22]

It is apparent to see that the results obtained by adopting instrumental variables are quite similar compared with those obtained by the panel data model shown in Table 2. However, there are several important points worth noting. First, the estimated coefficient on the lagged exports of information goods from the U.S. is positive and significant at the 1% statistical level, validating the presence of a habitual behavior in information goods consumption. Such a hysteretic effect is important since it will lead to reinforce long-established market positions in information goods exports. Second, the estimated coefficients on per capita GDP and population remain positive and significant, while the impact of tariff turns to be significantly positive in column (6), contradicting the theoretical argument. A possible reason is the tariff rate we use is the average rate rather than particular rates for information goods, inducing a confusing result. Third, the effects of a free trade zone and culture-related variables weaken substantially. This change is also found in Disdier et al. (2007) and it seems to be largely a consequence of the inclusion of the hysteretic effect.

Most importantly, the coefficient for the IPR variable in various specifications is positive and statistically significant at the 1% or 5% statistical level after controlling for potential econometric problems. Specifically, the estimated magnitude of the coefficient on the IPR variable becomes much larger than that in Table 2, implying that the impact of IPR on information goods trade is underestimated without controlling for the endogenous choice of IPR strength. In contrast to previous panel data studies, such as Co (2004) and Yang and Woo (2006), we find discernible impact of IPR protection on trade, especially for information goods. This finding

[21] Please see Table 1 for variable definitions.

[22] The *F* statistics for the test of weak IV in the bottom of Table 4 are larger than 10, rejecting the null hypothesis. It indicates that the IV used in this study is effective. We did not run the estimations of the dynamic panel data model for manufacturing trade. The reason is twofold: first, it is not sure whether there is the hysteresis effect on consumption of manufacturing goods. Second, we adopt the piracy rate as one of criteria to classify groups of threat-of-imitation. This variable is distinct for the information goods and it does not apply to manufacturing trade.

Table 4 Determinants of trade in information goods: test of the hysteresis effect

	(5)	(6)
Constant	−1.006 (0.935)	−1.629* (0.949)
lnTRADE(−1)	0.662*** (0.037)	0.717*** (0.037)
lnPGDP	0.028 (0.080)	0.238*** (0.068)
lnPOP	0.264*** (0.038)	0.224*** (0.039)
lnDIS	0.036 (0.080)	0.041 (0.082)
TARIFF	0.012 (0.007)	0.017** (0.007)
NAFTA	0.550*** (0.197)	0.555*** (0.202)
LANG	0.211*** (0.064)	0.178*** (0.066)
RELIGION	−0.0014* (0.008)	−0.0015* (0.0009)
IPR-WEF	0.515*** (0.106)	
IPR-IMD		0.117** (0.057)
R^2	0.735	0.768
F (first stage)	66.33***	55.78***
Observations	384	384

Notes: Figures in parentheses are standard errors. The first-stage estimation of IPR variables (IPR-WEF and IPR-IMD) is assumed to be related to lnPGDP, ln(TIMPORT), TARIFF, and OPEN

***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively

overall supports the market expansion effect from the dynamic standpoint and it contributes new insights on the dynamic relation between IPR and trade. It implies also that the TRIPs agreement to strengthen and harmonize national IPR seems to be relevant to the trade flow of information goods, because stronger IPR protection induces more trade.

5 Threat-of-imitation and information goods trade

Smith (1999) argues that the effects of patent protection on trade flow could vary, depending on the importing nation's economic development level and related threat-of-imitation that is correlated to the degree of economic development. By defining a set of development dummy variables to split the sample into various degrees of threat-of-imitation or adopting an R&D intensity of 0.5% as the critical value to group high and low imitative abilities, she assesses the IPR interactions effect and suggests that the relative power of the market expansion effect and market power effect will strengthen across different regimes (Table 5). The empirical literature to date has also found evidence of both effects, depending on the degree of threat-of-imitation of importing countries.

The grouping standard of threat-of-imitation defined according to the degree of economic development or R&D ratio is ad hoc and is not suitable for the degree of threat-of-imitation for information goods. One reason is that the degree of economic development and R&D intensity is usually highly correlated with IPR

Table 5 Relationship between threat of imitation and market expansion and market power effects

	Weak patent rights	Strong patent rights
Weak imitative abilities	3. Moderate threat of imitation; ambiguous effect (±)	1. Weak threat of imitation; market power effect (−)
Strong imitative abilities	4. Strong threat of imitation; market expansion effect (+)	2. Moderate threat of imitation; ambiguous effect (±)

Data source: Smith (1999, p. 156)

protection, resulting in only a few observations that will be classified into groups 1 and 4 as displayed in Table 5. For example, when the strong imitative ability is defined as GDP per capita higher than US $8,356 and strong IPR protection is defined as above the mean of the WEF index, there is no country belonging to group 1 and only four countries belonging to group 4. The estimates of a few observations do not provide reliable results. Moreover, the distinct feature of low imitation technology and cost for reproduction of information goods may differentiate the role of threat-of-imitation on the trade–IPR nexus from that suggested by Smith (1999).

The estimates in Sect. 4 can be thought of treating all importing countries as the same group of imitative abilities. However, law is one thing and enforcement is another. Even though all importing countries have the ability to replicate imported information goods, their degree of imitation threat should be quite different. This section will re-examine the hypothesis concerning threat-of-imitation.

How does one measure the imitative ability of importing countries? The software piracy rate surveyed by Business Software Alliance (BSA) provides an excellent alternative measure for information goods, because the replication method of information goods is nearly the same as that of software.[23] We therefore adopt piracy rate as the imitation degree to displace the imitative ability. According to the study methodology adopted by BSA, the software piracy rate is calculated following the steps below. First, BSA determines how much PC packaged software was deployed in one country based on the global sale information on PCs and laptop PCs in each year. The second step determines how much PC packaged software was paid for and legally acquired in each year. According to the above information, one can subtract the first one from the second figure to get the amount of pirated software. The piracy rate can be found as the ratio of the pirate software to PC packaged software.[24] Therefore, the piracy rate

[23] The BSA defines software piracy as "the unauthorized copying or distribution of copyrighted software." This can be done by copying, downloading, sharing, selling, or installing multiple copies onto personal or work computers.

[24] For a detailed description on the survey methodology, please refer to the annual report of BSA/IDC Global Software Piracy Study. See http://www.bsa.org.

ranges between 0% and 100%. For example, a 60% piracy rate denotes that 60% of computers install illegal software in that country. Therefore, a country with a higher piracy rate indicates a weak enforcement of IPR protection. Relating to the measurement of threat-of-imitation, a higher piracy rate implies a stronger imitation degree. The technological level of pirating is extremely low, preventing us to differentiate the imitative ability across countries. The utilization of the piracy rate as a proxy variable of imitation degree is more relevant to information goods and it seems to be more appropriate than those used in previous studies, such as the degree of economic development and R&D intensity.[25]

We now divide the importing countries into four categories as suggested by Smith (1999) by using the means of the piracy rate and IPR indices in each year. These four groups are denoted by threat-of-imitation dummies G1, G2, G3, and G4, respectively. The countries we select and the degree of threat-of-imitation are summarized in Appendix Table 10. This classification enables more observations to locate in groups 1 and 4, which are more appropriate for testing the hypothesis.[26]

In order to examine the relationship between threat-of-imitation and information goods trade, the following equation is the empirical model modified from Eq. 2 by replacing the IPR variable by four threat-of-imitation dummies and their interactive terms with the IPR variable.

$$\begin{aligned}\ln \mathrm{TRADE}_{ijt} = {} & \beta_0 + \alpha \ln \mathrm{TRADE}_{ij,t-1} + \beta_1 \ln \mathrm{PGDP}_{it} + \beta_2 \ln \mathrm{POP}_{it} + \beta_3 \ln \mathrm{DIS}_{ij} \\ & + \beta_4 \mathrm{TARIFF}_{it} + \beta_5 \mathrm{NAFTA}_i + \beta_6 \mathrm{LANG}_i + \beta_7 \mathrm{RELIGION}_{ij} \\ & + \beta_8 G1_{it} \mathrm{IPR}_{it} + \beta_9 G2_{it} \mathrm{IPR}_{it} + \beta_{10} G3_{it} \mathrm{IPR}_{it} + \beta_{11} G4_{it} \mathrm{IPR}_{it} + \varepsilon_{it}\end{aligned} \tag{3}$$

According to Smith's (1999) predictions, the sign for coefficient β_8 should be negative and the sign for coefficient β_{11} should be positive. On the other hand, the estimated interaction effects for groups 2 and 3 (β_9 and β_{10}) are undetermined, depending on the relative strength of market expansion and market power effects. We implement similar econometric techniques of IV for the dynamic panel model used in obtaining Table 4 and report the estimates on the new interaction variables in Table 6.

Compared with estimates in Table 4, the estimates on variables (except for IPR variables) are very similar. Specifically, the variable of religious similarity turns out to be statistically insignificant. We now focus on discussing the impact of interaction terms between IPR protection and threat-of-imitation on information goods trade. According to the theoretical predictions, the market power effect should be found in group 1 and the market expansion effect will be exhibited in

[25] American pirated products (e.g., pirated American movie DVDs) produced in foreign countries (e.g., China or Brazil) and exported to third markets (e.g., Japan or EU) are prevalent. Although this article does not explicitly take it into account, the U.S. export data used in this article implicitly consider it since the U.S. information goods exports are confronted with U.S. pirated products in the foreign markets.

[26] One alternative method employs the technique of the panel threshold model, while this approach is difficult to be extended to the dynamic panel data model to our knowledge.

Table 6 Determinants of trade in information goods: the effects of threat-of-imitation

	(7)	(8)
Constant	−0.927 (0.966)	−1.485** (0.972)
lnTRADE(−1)	0.662*** (0.037)	0.712*** (0.038)
lnPGDP	0.026 (0.082)	0.229*** (0.070)
lnPOP	0.266*** (0.039)	0.229*** (0.040)
lnDIS	0.035 (0.081)	0.038 (0.083)
TARIFF	0.012 (0.007)	0.016** (0.008)
NAFTA	0.564*** (0.199)	0.562*** (0.204)
LANG	0.201*** (0.066)	0.177*** (0.067)
RELIGION	−0.001 (0.009)	−0.001 (0.009)
IPR-WEF		
Group 1 (β_8) strong IPR, weak imitation degree	0.506*** (0.107)	
Group 2 (β_9) strong IPR, strong imitation degree	0.504*** (0.111)	
Group 3 (β_{10}) weak IPR, weak imitation degree	0.516*** (0.108)	
Group 4 (β_{11}) weak IPR, strong imitative ability	0.497*** (0.110)	
IPR-IMD		
Group 1 (β_8) strong IPR, weak imitation degree		0.120** (0.057)
Group 2 (β_9) strong IPR, strong imitation degree		0.110* (0.058)
Group 3 (β_{10}) weak IPR, weak imitation degree		0.123** (0.059)
Group 4 (β_{11}) weak IPR, strong imitation degree		0.111* (0.058)
R^2	0.734	0.770
Observations	384	384

Notes: Figures in parentheses are standard errors. In model I, the instrumental variable is one-year lagged IPR variable. In model II, the first-stage estimation of IPR variables (IPR-WEF and IPR-IMD) is assumed to be related to lnPGDP, ln(TIMPORT), TARIFF, and OPEN

***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively

group 4. In other words, the estimated coefficients on β_8 and β_{11} should be significantly negative and positive, respectively. Existing studies focusing on manufacturing exports, such as Smith (1999), Rafiquzzaman (2002), and Liu and Lin (2005), find evidence of both effects. As shown in Table 6, the estimates by adopting the IMD or WEF index as a measure of IPR protection are similar, showing a positive coefficient in all groups. As for theoretical predictions, the market expansion effect prevails for countries with a high level of threat-of-imitation and weak IPR protection. While one can expect the effect of IPR to be ambiguous for importers in groups 2 and 3, our estimates obtain a consistent result of a positive impact, tending to support the hypothesis of the market expansion effect.

The most important and interesting finding is that the coefficient of the interactive term with group 1 is positive and statistically significant. More specifically, the estimated magnitude attached on the coefficient is quite large, compared with the coefficient for the other three groups. This outcome contradicts earlier theoretical and empirical evidence that expects to observe a

market power effect for countries with a weak imitative ability and strong IPR protection. Different from the manufacturing trade, IPR protection appears to have a trade-enhancing effect in each regime of threat-of-imitation, because the essential feature of imitation threat that information goods encounter is quite different from manufacturing goods. Since every importing country possesses the ability to reproduce imported information goods, firms should choose to adopt the low-price strategy to expand markets rather than exercise their market power.

Our results seem to confirm the prevalence of the market expansion effect and there is no market power effect for information goods trade as previously thought. What implications about TRIPs and the imports of developing countries are inspired from this study? As observed from Appendix Table 10, most countries within group 4 are developing countries with a high-piracy rate. In recent years, developed countries have claimed the serious problem of piracy on information goods as well as cultural goods in developing countries that caused them to lose billions of dollars. They have also expressed concern over the issue of strengthening IPR protection on the imports of developing countries. Drawn from our results, strengthening IPR protection across developing countries is particularly relevant to the trade flow of information goods.

6 Concluding remarks

The theoretical ambiguity concerning the effects of strengthening IPR on trade has been much emphasized in the literature. An emerging amount of empirical works has contributed evidence on the sensitivity of trade flow to national differences in IPR and concludes that imitative ability serves important roles in the trade–IPR nexus. However, the existing literature concentrates on the manufacturing sector rather than information goods. More importantly, IPR protection is inherently a dynamic process, meaning that the clarification about the dynamic relation between IPR and trade is worth exploring, while is more poorly investigated due to the availability of a longitudinal IPR index. On the other hand, the above-established outcomes have often relied on classifying countries into threat-of-imitation cohorts on the degree of economic development or R&D activity, which are not appropriate for information goods.

As a consequence of the emerging importance of information goods trade, we use a commodity version of the gravity equation to examine the impact of IPR protection on information goods trade, but our approach differs from most previous examinations in several respects. First, we focus on information goods rather than manufacturing. Due to the serious problem of pirated information goods in many developing countries, how IPR protection affects trade flow of information goods is more topical than ever and attracts widespread concern among developed countries. Second, we utilize panel data rather than the more usual cross-section data, thus allowing us to control for unobserved heterogeneity across both countries and time. By adopting longitudinal and consistent IPR

indices conducted by IMD and WEF and employing the technique of instrumental variables for the dynamic panel data model, this study provides insightful results for the dynamic relationship between IPR protection and trade. Third, due to the essential differences in the technological as well as pecuniary requirement of reproductions between information goods and manufacturing, this study uses an alternative measure of threat-of-imitation (piracy rate) to investigate the role of threat-of-imitation on the relationship between IPR protection and information goods trade.

Based on the data of information goods exports from the U.S. to 48 countries during 1997–2005 and employing the technique of dynamic panel model, the empirical results find that overall the national differences in IPR protection do have a significantly positive influence on U.S. information goods exports after controlling other country characteristics, validating the presence of market expansion effects. Moreover, the consumption of information goods is found to exhibit an additive behavior, supporting the existence of a hysteresis effect—that is, current consumption of information goods is influenced by past consumptions.

We then examined the role of threat-of-imitation emphasized in theoretical arguments. We found, in contrast with existing literature, widespread evidence of market expansion effects in each group of imitative ability. No evidence of market power effects is found in this study, because the imitation threat that information goods encounter is essentially different from the manufacturing trade. Our findings suggest that the existing theories on the imitation ability may not apply to the information goods trade.

One key policy implication is inspired from the results. Under the circumstance of a declining trend of U.S. exports in information goods, the prevalence of software piracy in many countries is widely recognized as one of the main causes. Since with information goods it is extremely easy to replicate illegal products with a similar quality, exporting firms can only choose to exercise market expansion effects rather than market power effects in countries with strong as well as low threat-of-imitation. This sheds light on the importance of copyrights and IPR on information goods trade. Therefore, the agreement of TRIPs, aiming to harmonize the mean of IPR protection, is particularly relevant to information goods trade from the dynamic point.

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Appendix

See Tables 7, 8, 9 and 10.

Table 7 Selected empirical studies of intellectual property rights–trade relationship

Study	Exporting country, period (T), industry, and number of importing countries (N)	Model	IPRs protection index	IPRs effect (+, −, or no)
Maskus and Penubarti (1995)	U.S., $T = 1984$, 28 ISIC 3-digit industries, $N = 77$	Helpman–Krugman model	Rapp–Rozex index	+
Smith (1999)	U.S., $T = 1992$, 19 SIC 2-digit industries, $N = 95$	Gravity model	Rapp–Rozex index	+, −
Smith (2001)	U.S., $T = 1989$, manufacturing sectors, $N = 50$	Gravity model	Rapp–Rozex index	+, −
Smith (2002)	U.S., $T = 1972$, 1977, 1982, 1987, 1992, biological products, medical chemicals and botanical products, and pharmaceutical preparations, $N = 105$	Gravity model	Ginart–Park index	+, −
Co (2004)	U.S., $T = 1970$–1992, 34 manufacturing industries, $N = 71$ Taiwan,	Gravity model	Ginart–Park index	No if R&D intensive + if non-R&D intensive
Liu and Lin (2005)	$T = 1989$–2000, semiconductor, information, and communication equipment, $N = 54$	Gravity model	Ginart–Park index	+, −
Fink and Primo-Braga (2005)	89 countries, $T = 1989$, high-tech exports, $N = 88$	Gravity model Probit model	Ginart–Park index	No
Falvey et al. (2006)	Five advanced countries, $T = 1970$–1999, manufacturing exports, $N = 69$	Gravity model	Ginart–Park index	+ if developed countries no if less developed
Yang and Woo (2006)	U.S., $T = 1990$–2000, planting seed, $N = 60$	Gravity model	Adheres to IPRs agreements	No

Notes: "+", "−" and "no" denote that the IPR effects confirm the market expansion effect, monopoly power effect, and indetermination, respectively

Table 8 Inclusion of information goods

HS Code	Description
8524100020	PHONOGRAPH RECORDS, 33-1/3 RPM STEREO, QUADRAPHONI
8524100040	PHONOGRAPH RECORDS, NESOI
8524320000	LASER DISC FOR REPRODUCING SOUND ONLY
8524511000	NEWS SOUND RECORDINGS RELATING TO CURRENT EVENTS
8524513040	SOUND RECORDINGS ON CASSETTE TAPES, WIDTH LE 4MM
8524513080	OTHER MAGNETIC TAPE RECORDINGS LE 4 MM, NESOI
8524521040	VIDEO TAPE RECORDNG (4–6.5 MM), IN CASSETTES
8524521080	VIDEO TAPE RECORDINGS (4–6.5 MM), EXCEPT CASSETTE
8524522000	OTHER MAGNET TAPE RECORDNG (4–6.5 MM), EXCEP VIDEO
8524531040	VIDEO TAPE RECORDING, WIDTH LE 16 MM, IN CASSETTES
8524531080	VIDEO TAPE RECORDINGS (6.5–16 MM), NOT IN CASSETT
8524532000	OTHER MAGNET TAPE RECORDING GT 6.5 MM, EXCEPT VIDEO
8524990000	RECORDED MEDIA, NESOI
3706103000	SOUND REC., MOTION PICT FLM, FOR EXHIBIT GE 35 MM
3706106030	POSITIVE RELEASE PRINTS FOR FEATURE FILMS GE 35 MM
3706106060	FEATURE FILM, EXCEPT POS. RELEASE PRINT GE 35 MM
3706106090	MOTION-PICTURE FILM, EXPSD&DEVLP., GE 35 MM, NESOL
3706900000	OTHER MOTION-PICTURE FILM, EXPOS&DEVLP, LT 35 MM

Source: World trade atlas

Table 9 Correlation matrix of explanatory variables

	lnPGDP	lnPOP	lnDIS	TARIFF	NAFTA	LANG	RELIGION	IPR-WEF	IPR-IMD
lnPGDP	1								
lnPOP	−0.593	1							
lnDIS	−0.262	0.095	1						
TARIFF	−0.714	0.526	0.152	1					
NAFTA	0.041	0.125	−0.659	−0.091	1				
LANG	−0.124	0.042	−0.057	0.197	0.258	1			
RELIGION	0.321	−0.326	−0.497	−0.242	0.119	0.063	1		
IPR-WEF	0.775	−0.431	−0.097	−0.506	0.033	−0.073	−0.303	1	
IPR-IMD	0.728	−0.432	−0.117	−0.480	0.035	−0.033	−0.307	0.856	1

Table 10 Importing countries grouped by four different threat of imitation, 2005

		IPR protection					
		Weak			Strong		
Imitation degree	Weak	**G3:** 3 countries			**G1**: 21 countries		
		Chile			Australia	Hungary	Singapore
		Hong Kong			Austria	Ireland	Sweden
		Jordon			Belgium	Israel	Switzerland
					Canada	Japan	Taiwan
					Denmark	Luxembourg	United Kingdom
					Finland	Netherlands	
					France	New Zealand	
					Germany	Norway	
	Strong	**G4**: 18 countries			**G2**: 6 countries		
		Argentina	Malaysia	Turkey	Czech		
		Brazil	Mexico	Venezuela	Portugal		
		China	Philippines		Slovakia		
		Columbia	Poland		South Africa		
		Greece	Romania		South Korea		
		India	Russia		Spain		
		Indonesia	Solvenia				
		Italy	Thailand				

Notes: This table classifies the 48 importing countries into four groups, G1, G2, G3 and G4, based on the data in 2005. The critical values of the piracy rate and IPR-IMD index are 48.87 and 5.785%, respectively. The country distributions of various groups by using either the IPR-IMD or IPR-WEF index in each year are quite similar. The countries located in each category differ each year

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