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IDE DISCUSSION PAPER No. 848

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Kazunobu HAYAKAWA* and Hiroshi MUKUNOKI

March 2022

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Keywords: Music; International trade; Additive manufacturing
JEL classification: F15; F53

* Senior Research Fellow, Bangkok Research Center, IDE (kazunobu_hayakawa@jetro.go.jp)

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INSTITUTE OF DEVELOPING ECONOMIES (IDE), JETRO
3-2-2, WAKABA, MIHAMA-KU, CHIBA-SHI
CHIBA 261-8545, JAPAN

How Does Additive Manufacturing Change Trade?: Evidence from Trade in Sound Recordings[§]

Kazunobu HAYAKAWA[#]
Bangkok Research Center, Institute of Developing Economies, Thailand

Hiroshi MUKUNOKI
Faculty of Economics, Gakushuin University, Japan

Abstract: Additive manufacturing (AM), known as three-dimensional printing, has the potential to drastically change the mode of production and trade in goods. However, it is challenging to investigate the effects of AM on trade because existing AM production patterns are still immature. To get a clue on the impacts of AM, this study investigates the effects of internet distribution on trade in sound recordings, which has changed after the emergence of online shops or streaming services. Specifically, we estimate the gravity equation in the bilateral trade in sound recordings among 197 countries in 2003–2017 and examine the interaction term of internet diffusion rates between exporting and importing countries. Results show that internet penetration significantly decreases trade in sound recordings. Furthermore, the strong protection of intellectual property rights in importing countries weakens the trade-reducing effect, whereas that in exporting countries magnifies such effect.

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1. Introduction

Additive manufacturing (AM), known as three-dimensional (3D) printing, has the potential to drastically change the mode of production and trade in goods. Except for some specific goods, such as agricultural goods or the materials used for AM, goods may not need to be traded across countries. As a result of the development of "digitalization," which refers to the process of using digital technologies and data to replace or transform business processes (Bloom et al., 2018), only 3D data might need to be exchanged across countries in cyberspace in the future. With 3D data, a wide variety of products are produced/printed

[§] We would like to thank Kyoji Fukao, Shujiro Urata, Miki Hamada, Takeshi Honjo, and seminar participants in the Institute of Developing Economies for their invaluable comments and suggestions. We gratefully acknowledge financial support from the JSPS under KAKENHI Grant Number 19H00594. All remaining errors are ours.
[#] Corresponding author: Kazunobu Hayakawa; Address: JETRO Bangkok, 127 Gaysorn Tower, 29th Floor, Ratchadamri Road, Lumphini, Pathumwan, Bangkok 10330, Thailand; Tel: 66-2-253-6441; Fax: 66-2-254-1447; E-mail: kazunobu_hayakawa@ide-gsm.org.

without incurring any manufacturing costs through "automation," which is the process of making a task or procedure executable without human assistance (Weller et al., 2015). Therefore, we expect the development of AM to reduce the traditional production and international trade in goods. Such a decrease in production will change the spatial distribution of production and the labor market. Meanwhile, a decrease in trade will have a huge impact on the international freight industry. In particular, tariff revenues from trade in goods may disappear. Hence, industry and trade policies would need to be modified completely.

At present, it is challenging to investigate the effects of AM on trade because AM production patterns are still immature. Naturally, most existing social science studies on AM are in the management or business field. Only a few studies have been conducted in the area of economics. One example is the work of Abeliansky et al. (2020), which empirically examined the adoption of AM rather than its effects on trade. Specifically, they first theoretically demonstrated that 3D printers are introduced in areas with high economic activity and thus face high transport costs. Then, they estimated the gravity equation for trade in machinery for working rubber or plastics and found empirical evidence that supports their hypothesis. Freund et al. (2019) used a difference-in-differences method and found that the adoption of 3D printing increases trade in hearing aids. Other studies, such as those of Kleer and Piller (2019) and Weller et al. (2015), aimed to conceptually discuss the effects of 3D printing on cost efficiency and market structure rather than quantitatively investigate those effects.

Against this backdrop, the current study aimed to understand the impacts of AM by investigating the effects of internet distribution on trade in sound recordings. Until a few decades ago, consumers commonly purchased records or compact discs (CDs) in nearby shops to enjoy music. With the emergence of online shops and streaming services (e.g., iTunes), consumers today purchase music online instead of visiting physical stores. This lifestyle change has exerted a huge impact on the music industry. Moreover, file sharing/internet piracy has become another major issue in this industry because it shrinks offline and online markets by increasing the illegal transfer of music. As a result, international trade in music CDs has also experienced a dramatic decrease. These changes in the music industry seem to show a glimpse of the future where AM is the standard mode of production. Both cases do not require the physical transportation of goods for consumption. By investigating the current status of the music industry, we could predict the effects of AM on international trade in the future.

Specifically, in this study, we estimate the gravity equation in international trade in sound recordings. Our data include bilateral trade in sound recordings among 197 countries in 2003–2017. As the main independent variable, the interaction term of internet diffusion rates between exporting and importing countries is introduced. Following the standard exercise in gravity, we control for exporter–year, importer–year, and country pair fixed

effects. Thus, the coefficient for the interaction term represents approximately how much the internet penetration in a trading pair changes trade in sound recordings. The results indicate that internet penetration significantly decreases trade. Furthermore, we investigate how this effect varies according to the degree of protection of intellectual property rights (IPRs) in importing and exporting countries. The results reveal that strong IPR protection in importing countries weakens the decreasing effect of internet penetration on trade, whereas that in exporting countries magnifies this effect.

On the basis of the empirical results on the effects of internet distribution on trade in sound recordings, we discuss the implications on the effects of AM on trade. Conceptually, AM can either increase or decrease trade because it not only promotes local production and substitutes physical trade but also increases exporters' productivity and expands the scope of products produced and exported by multiproduct firms. If the fixed cost of adopting AM is low and the transport costs are high, AM will lead to dispersed production close to customers and reduce trade in goods. If the fixed cost is high and the transport costs are low, AM will enhance the production in the home country and increase trade in goods. Unlike the results of Freund et al. (2019) on hearing aids, our estimation results on sound recordings imply that the trade-reducing effect of AM can dominate the trade-increasing effect. We argue that this disparity comes from the difference in the fixed cost of establishing an online channel: hearing aids need a large investment for 3D printing, whereas sound recordings do not require such an investment. We also argue how the protection of IPRs is related to the trade effect of AM.

In addition to the existing investigations on AM, our study is related to some strands of literature. The first strand includes studies on the economic effects of introducing new production technologies such as automation (or robots). Unlike the studies on AM, the empirical studies on automation are broad perhaps because of the subject's relatively long history (e.g., Antony and Klarl, 2020; Bloom et al., 2018; Lankisch et al., 2017; 2019; Prettner and Strulik, 2017). These studies mainly examine the effects of automation on wage inequality or skill premium and show the expansion of the inequality and premium. By contrast, our study is focused on the effects of new technology on trade. The second strand relates to the research on the relationship between trade in goods and trade in services (e.g., Nordås, 2010; Ariu, 2016; Breinlich et al., 2018; Ariu et al., 2019; Ariu et al., 2020). These studies suggest that trade in goods and trade in services can be either substitutes or complements. Cross-border streaming services are recorded in audiovisual and related services in the statistics of services trade. Thus, our result in the context of the music industry implies that trade in goods substitutes trade in this category of services. The third strand is the literature on music economics (e.g., Michel, 2006; Cameron, 2016; Waldfogel, 2017). These studies report that digitalization and file sharing software decrease CD sales and the revenue of recording companies. In the current study, we examine this issue from the viewpoint of trade.

It is noteworthy to mention two more related strands. One is the studies on e-commerce. Several studies have compared online transactions with offline transactions. For example, Anson et al. (2019) estimated the exchange rate pass-through in e-commerce imports. Cavallo (2017) examined the differences between online and offline prices. Lendle et al. (2015) compared the distance elasticity in gravity between online and regular trade. Online and offline transactions are different in terms of how orders are placed, but they are the same in terms of the physical transaction of goods. In our case, the online order does not accompany the physical transactions of goods (i.e., CDs). The services embedded in goods are transferred in cyberspace.[1] The possible future picture of AM also does not require goods to be physically traded. The other strand includes the studies on the effects of the internet on trade (e.g., Clarke and Wallsten, 2006; Freund and Weinhold, 2004; Rauch and Trindade, 2003; Tang, 2006), with a focus on the role of the internet as a component of communication costs. By contrast, our study is aimed at the role of the internet as a new distributional channel of goods between countries.

The rest of this study is organized as follows: Section 2 presents our empirical framework for investigating the impacts of internet distribution on international trade in sound recordings. Section 3 discusses the estimation results. Section 4 describes the implications of the effects of AM on trade on the basis of the empirical results. Section 5 provides the conclusion of the study.

2. Empirical Framework

This section presents our empirical framework for investigating the impacts of internet distribution on international trade in sound recordings. We specify the trade model as follows:

$$Trade_{ijt} = \exp\{\alpha_1 Internet_{it} \times Internet_{jt} + \alpha_2 RTA_{ijt} + \delta_{ij} + \delta_{it} + \delta_{jt}\} + \epsilon_{ijt} \qquad (1)$$

$Trade_{ijt}$ denotes the export values of sound recordings from countries i to j in time t. Our main variable is the interaction term of internet diffusion rates (*Internet*) between exporting and importing countries.[2] As a control variable defined at a country pair–year level, we introduce a regional trade agreement (RTA) dummy variable that takes a value of 1 if two

[1] In this sense, the research target of Hellmanzik and Schmitz (2015) is close to ours. They examined the role of cultural proximity in trade in audiovisual services. Specifically, they focused on online transactions, whereas we examine offline transactions because we are interested in the possible impacts of AM on trade in goods.

[2] To avoid omitted variable bias at exporter–year and importer–year levels, we control for fixed effects defined at corresponding levels. Thus, we do not investigate the internet diffusion rates in exporting and importing countries separately.

countries are members of the same RTA and a value of 0 otherwise (RTA_{ijt}). δ_{ij} denotes the country pair fixed effects, which control for the time-invariant country pair characteristics (e.g., the geographical distance or the similarity of music preference between two countries). δ_{it} and δ_{jt} are the exporter–year and importer–year fixed effects, respectively. These fixed effects control for the importer's demand size and the exporter's productivity and factor prices, in addition to multilateral resistance terms. ϵ_{ijt} is the disturbance term. We estimate this equation by using the Poisson pseudo maximum likelihood (PPML) method.

The internet exerts various effects on the market of sound recordings. For example, if nearby recording shops in a country establish websites for online ordering, consumers in that country can easily order foreign music CDs through their websites. This case will increase the international trade of music CDs. In our proposed framework, this effect of the development of the internet in importing countries is captured by the importer–year fixed effects. By contrast, internet development in exporting countries may shrink the market of music CDs through the switch to online distribution, which results in a decrease in CD production. This effect decreases the trade of music CDs and is captured by the exporter–year fixed effects. As for the current study, we are interested in the case where the internet develops in both exporting and importing countries. In this case, consumers may order or download foreign music through the websites established by recording companies in foreign countries. This online transaction decreases the international trade of music CDs. We expect this effect to be captured by the coefficient for the interaction term of internet diffusion rates.

Our data sources are as follows. We obtain the trade data from Centre d'Études Prospectives et d'Informations Internationales, which are an updated version of the data (BACI) provided by Gaulier and Zignago (2010).[3] Specifically, we use trade in code 8524 of the harmonized system (1992 version) as trade in sound recordings. Although the database originally includes the data on trade in 1995–2017, we focus on the trade from 2003, when the iTunes Store services were established, to 2017. In other words, although we do not intend to focus on online shopping only through the iTunes Store, we study the period when this online store was launched. The data on internet diffusion rates (individuals using the internet in terms of percentage of population) are obtained from the World Development Indicator.[4] The RTA dummy variable is drawn from Egger and Larch (2008), and its version is updated to 2017 by using the information on RTAs available on the website of the World Trade Organization. The basic statistics for our variables are shown in Table 1.

=== Table 1 ===

[3] http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=37

[4] According to the metadata, internet users are individuals who have used the internet from any location in the last 3 months. The internet can be used via a computer, mobile phone, personal digital assistant, gaming machine, or digital television.

3. Empirical Results

This section reports our estimation results. We cluster the standard errors by country pairs. Although this section presents various estimation results, the number of observations varies depending on the availability of the variable data. The estimation result of equation (1) based on PPML is presented in column (I) of Table 2. The interaction term of internet diffusion rates has a significantly negative coefficient, which is consistent with our expectation. That is, the penetration of internet services in exporting and importing countries decreases the trade of sound recordings perhaps because more music is transferred online between these two countries. The coefficient for the RTA dummy is estimated to be insignificant.

=== Table 2 ===

We conduct two types of robustness checks on the result above. In one robustness check, we use an alternative measure on the extent of online access. We use the number of fixed broadband subscriptions per 100 people, the data on which are obtained from the World Development Indicator.[5] To normalize this number, we divide it by 100 and create the interaction term of these numbers between exporting and importing countries (*Broadband*). The estimation result is shown in column (II) and indicates the negatively significant coefficient for this interaction term. The larger absolute value of the coefficient in comparison with that of the interaction term of internet diffusion rates may indicate that high-speed internet access is important for the online exchange of music.

In the other robustness check, we exclude a large country in terms of the numbers of music contents and online service providers, that is, the US, from our study observations. This exclusion is to show that our results are not driven solely by the services provided by the US. The estimation results for the trade among countries except for the US are shown in columns (III) and (IV). The coefficients for the two interaction terms are again estimated to be significantly negative. Thus, the international trade of sound recordings decreases as the extent of online accessibility develops in exporting and importing countries. Meanwhile, the coefficients for the RTA dummy variable are again estimated to be insignificant, indicating that the entry of RTAs into force does not have significant effects on the trade of sound recordings.

Next, we extend our equation to examine the relation between the effect of online

[5] According to the metadata, fixed broadband subscriptions refer to fixed subscriptions to high-speed access to the public internet (a transmission control protocol/internet protocol connection) at downstream speeds equal to or greater than 256 kbit/s.

purchase and IPRs. Specifically, we further interact the importer's or exporter's extent of protecting intellectual property rights (*IPR*) with the interaction term of internet diffusion rates. The extended equation is given as follows:

$$Trade_{ijt} = \exp\{\alpha_1 Internet_{it} \times Internet_{jt} + \beta_1 Internet_{it} \times Internet_{jt} \times IPR_{it} + \beta_1 Internet_{it} \times Internet_{jt} \times IPR_{jt} + \alpha_2 RTA_{ijt} + \delta_{ij} + \delta_{it} + \delta_{jt}\} + \epsilon_{ijt} \quad (2)$$

IPR ranges from 1 to 7, and the higher score indicates that IPRs are protected to a greater extent. The data on *IPR* are obtained from the Global Competitiveness Index in the World Economic Forum. As the data available cover the period starting in 2007, we focus our study on the period of 2007–2017. The stronger IPR protection in importing and exporting countries will encourage online business and transactions in the music industry. That is, we expect that the triple interaction terms have negative coefficients.

The results are shown in Table 3. Whereas the coefficient for the interaction term with the importer's IPR is estimated to be positive, that for the interaction term with the exporter's IPR is estimated to be significantly negative. These results indicate that the trade-reducing effect of online services is larger in exporting countries with stronger IPR protection and in importing countries with weaker IPR protection. Thus, our expectation holds for exporters' IPR protection but not for importers' IPR protection. We discuss these results at a more detailed level in the next section.

=== Table 3 ===

4. Discussion

Our empirical results show that the bilateral trade of music CDs decreases as internet diffusion rates of exporting and importing countries rise perhaps because of the increase of online distribution and purchases. Furthermore, such a decrease becomes more pronounced in exporting countries with stronger IPR protection and weakens in importing countries with stronger IPR protection. These results are helpful in considering the potential effects of AM on trade. This section discusses the implications of the trade effects of AM drawn from our empirical results.

Conceptually, the spread of 3D printing can either increase or decrease trade in goods. On the one hand, it shrinks the technology gap between exporting and importing countries and helps develop the local manufacturing of goods that used to be imported before the introduction of 3D printing. This development is due to 3D printing enabling manufacturers to produce and supply goods in destination countries. This effect reduces trade in goods. Firms' incentives to localize production increase with a decrease in the cost of establishing

a foreign subsidiary or that of searching and contracting a local producer that uses 3D printing technology. Moreover, the localization of manufacturing expands more for goods whose transportation costs and trade barriers are higher. Therefore, as Abeliansky et al. (2020) suggested, 3D printing is more likely to replace exports when the fixed cost of adopting 3D printing is low and the transportation cost is high. The spread of 3D printing also increases the entry of factoryless goods producers because firms can more easily outsource production processes to other firms by adopting 3D printing technology.[6] An increase in factoryless goods producers promotes the localization of production and thereby reduce trade in goods.

On the other hand, the spread of 3D printing can widen the technology gap and enhance the exports of goods. If the fixed cost of setting up a local base of AM in destination countries is high and the transport cost is low, firms will use the new technology only in their home countries. As Freund et al. (2019) suggested, the introduction of 3D printing reduces production cost and increases productivity.[7] The cost reductions in exporting countries decrease their export prices, thus stimulating the demand in importing countries. This effect increases trade in goods. In addition, AM gives firms the ability to produce more varieties with lower additional costs because they can easily customize goods according to customers' needs. As Eckel and Neary (2010) proposed, multiproduct firms incur a higher production cost for products farther from their core competency, and therefore, their exports tend to be focused on their core products. A smaller cost of producing additional varieties expands the scope of exported products and increases trade in goods if these additional varieties are produced in the exporting countries.

Thus, 3D printing can either weaken or strengthen countries' comparative advantage in producing goods, and its effect on trade in goods is ambiguous. AM promotes local productions close to customers and reduces trade in goods when the fixed cost of adopting AM is low and transport costs are high. Meanwhile, AM leads to the concentration of production when the fixed cost is high and transport costs are low. Thus, the introduction of AM exhibits the standard proximity concentration trade-off of production locations (Brainard, 1997). Our empirical results on music CDs suggest that the trade-reducing effect dominates the trade-enhancing effect, thus implying that developing an online distribution channel between exporting and importing countries reduces trade in goods. As AM is another way to develop an online channel to produce and distribute goods, our empirical result implies that the spread of 3D printing is likely to reduce trade in goods.

This result differs from that of Freund et al. (2019) for hearing aids. As Freund et al.

[6] Bernard and Fort (2015) examined the characteristics of factoryless goods producers in the US. Morikawa (2016) showed that factoryless goods producers in Japan have higher productivity and wages than ordinary producers.

[7] Some anecdotal evidence is available in the following: https://www.ge.com/additive/additive-manufacturing/industries/aviation-aerospace.

(2019) suggested, the transport cost of hearing aids is low, but the fixed cost of adopting 3D printing is high because it requires a large investment to transform data files into products. Therefore, the exporting countries of hearing aids are relatively concentrated even after the spread of 3D printing, thus limiting the trade-reducing effect of AM. For sound recordings, however, the cost of transforming data to products is low because the process only requires downloads of music data and does not incur a high fixed cost. This low cost could explain why establishing online channels replaces the trade of music CDs despite the low transport costs of the latter. Our estimation results are useful in predicting the trade effects of AM for products whose cost for introducing 3D printing is low.

The trade effect of AM is also related to IPRs, especially those in digital model data.[8] The extant literature on the trade effect of IPR protection, which does not consider the effect of 3D printing, suggests that a lower risk of imitation increases trade in goods by securing the demands for authorized products. For instance, Maskus and Penubarti (1995), Smith (1999), and Ivus (2010) empirically found that a stronger IPR protection promotes trade in goods when the threat of imitation is serious. Similarly, strong IPR protection would encourage transactions using AM. For example, if unauthorized manufacturers obtain digital model data to produce goods, they can easily produce counterfeit products with the necessary materials and 3D printers. That is, AM lowers the cost of product imitation.

Our estimation results for sound recordings suggest that a stronger protection of IPRs in exporting countries magnifies the trade-reducing effect of online services. The stronger IPR protection in exporting countries helps develop an online distribution channel to provide music, which can also be used for online sales in foreign countries. Similarly, a stronger protection of IPRs in exporting countries prevents imitation in their domestic market and promotes firms' adoption of 3D printing there. Once firms adopt 3D printing, they will consider using the same technology in their foreign affiliates or outsourcing the production to other foreign firms on a contract basis. Thus, stronger IPR protection in exporting countries is supposed to reduce the fixed cost of adopting 3D printing, which magnifies the trade-reducing effect of AM. The existing literature mainly focuses on the trade effect of IPR protection in importing countries, but our results suggest that IPR protection in exporting countries is also important in developing online channels (including 3D printing) to provide goods.

By contrast, our results unexpectedly reveal that the weaker protection of IPRs in importing countries promotes the trade-reducing effect. However, this result may indicate an important message. The weak protection of IPRs encourages the illegal distribution of downloaded music among consumers in importing countries. Specifically, online streaming services have the potential to dramatically shrink the market size of authorized music due to the spread of illegally copied products. This effect leads to the decrease of cross-border online services and trade in CDs. In other words, although exporting countries with strong

[8] Brown et al. (2016) discussed the legal aspects of protecting IPRs in AM.

IPR protection and importing countries with weak IPR protection decrease trade in CDs, the former increases cross-border online services while the latter does not.[9] Thus, if the imitation cost in AM is low, the weak IPR protection in the market diminishes not only trade in goods but also the officially made, cross-border transfer of production data.[10]

This conjecture for importing countries may be more valid in business-to-consumer (B2C) transactions than in business-to-business (B2B) transactions. The imitation cost is higher in B2B transactions because these transactions deal with more customized products according to individual buyers (e.g., specific machinery parts and components). By contrast, products tend to be less customized in B2C transactions. Indeed, consumers' preferences are mostly homogenous at a musician–song level. Consumers are satisfied if they can copy the music data that other consumers have or are illegally available on the web. They do not need to customize those data. Thus, our empirical results suggest that the trade-reducing effect of AM in importing countries with weaker IPR protection may be stronger in homogenous goods than in heterogeneous goods.[11]

5. Concluding Remarks

We studied the effects of internet distribution on trade in sound recordings or CDs to understand the impacts of AM. Specifically, we estimated the gravity equation in the bilateral trade in sound recordings among 197 countries in 2003–2017. As a main independent variable, the interaction term of internet diffusion rates between exporting and importing countries was introduced. The results revealed that internet penetration significantly decreases trade. Furthermore, this trade-reducing effect is weakened by the strong protection of IPRs in importing countries and magnified by that in exporting countries.

Digital technologies have drastically changed the ways goods are produced and consumed. AM and the development of online supply channels reflect such changes. This study is one of the first attempts to evaluate the effects of digital transformation in the

[9] Indeed, we also regress audiovisual services with a specification in column (III) in Table 3. The data on audiovisual services trade from 2010 to 2017 are drawn from OECD.Stat. As expected, we obtain a negative coefficient for the interaction with the importer's IPR and a positive coefficient for the interaction with the exporter's IPR, but they are estimated to be insignificant. This insignificant result may be due to our use of data in OECD countries (i.e., a small variation in IPR variables and a small number of observations). See Appendix for details.

[10] Another channel is that a stronger IPR in importing countries may decrease trade because exporters exert their monopoly power and have incentive to reduce exports to raise their export prices. See Smith (1999) for details.

[11] Meanwhile, one of the advantages of adopting AM is that it enables producers to provide prototype products or customized products more easily. Thus, producers are likely to adopt AM in producing heterogenous goods.

context of international trade. Our empirical results imply that the spread of AM worldwide reinforces the shift of international transactions from commodity trade to services trade and cross-border data flows. Nevertheless, there remains room for further research. Although AM reduces trade in goods, it may increase the trade of materials used for AM, such as metal, plastic, and paper. Moreover, policy discussions are open. For establishing efficient global supply chains in the digital era, it is worth examining the effects of restrictions on services and data flows, protection of IPRs in data, and digital taxes.

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Table 1. Basic Statistics

	Obs	Mean	Std. Dev.	Min	Max
Trade	152,411	2032	20427	0	1386604
Internet	152,411	0.22	0.22	0	0.98
Broadband	137,307	0.02	0.03	0	0.26
Internet * Importer IPR	79,327	1.39	1.24	0.00	5.90
Internet * Exporter IPR	79,327	1.45	1.25	0.00	5.90
RTA	152,411	0.33	0.47	0	1

Sources: Authors' computation.

Table 2. Baseline Estimation Results

	(I)	(II)	(III)	(IV)
Internet	-1.544**		-2.179***	
	[0.697]		[0.839]	
Broadband		-6.416**		-7.348**
		[3.147]		[3.200]
RTA	0.046	0.044	0.235	0.221
	[0.131]	[0.118]	[0.155]	[0.158]
Number of observations	152,411	137,307	147,073	132,492
Log pseudolikelihood	-2.99E+07	-2.90E+07	-2.71E+07	-2.64E+07
Pseudo R-squared	0.9736	0.9736	0.9703	0.9703

Notes: This table reports the estimation results based on the PPML method. ***, **, and * respectively indicate the 1%, 5%, and 10 % levels of statistical significance. The standard errors reported in parentheses are those clustered by country pairs. In all specifications, we control for exporter–year, importer–year, and country pair fixed effects.

Table 3. Extended Specification

	(I)	(II)	(III)
Internet	-4.667**	2.88	-0.468
	[1.964]	[1.844]	[2.705]
Internet * Importer IPR	0.575*		0.610*
	[0.349]		[0.351]
Internet * Exporter IPR		-0.713**	-0.730**
		[0.289]	[0.286]
RTA	0.122	0.126	0.124
	[0.184]	[0.179]	[0.182]
Number of observations	79,327	79,327	79,327
Log pseudolikelihood	-17,726,807	-17,698,138	-17,677,565
Pseudo R-squared	0.9753	0.9753	0.9753

Notes: This table reports the estimation results based on the PPML method. ***, **, and * respectively indicate the 1%, 5%, and 10 % levels of statistical significance. The standard errors reported in parentheses are those clustered by country pairs. In all specifications, we control for exporter–year, importer–year, and country pair fixed effects.

Appendix. Impacts of AM on Services Trade

In this appendix, we examine the impacts of internet distribution on international trade in audiovisual services. For the dependent variable, we simply replace trade in sound recordings with trade in audiovisual services. The data on audiovisual services trade from 2010 to 2017 are drawn from OECD.Stat. The data are available for trade between 27 reporting countries and their 62 partner countries. The PPML estimation results are reported in Table A. All coefficients are estimated to be insignificant.

Table A. PPML Estimation Results: Impacts on Trade in Audiovisual Services

	(I)	(II)	(III)	(IV)
Internet	-0.012	6.490	-7.142	-0.359
	[3.678]	[5.829]	[5.850]	[7.772]
Internet * Importer IPR		-0.905		-0.825
		[0.739]		[0.742]
Internet * Exporter IPR			0.939	0.859
			[0.751]	[0.758]
RTA	-0.096	-0.101	-0.098	-0.103
	[0.253]	[0.252]	[0.253]	[0.253]
Number of observations	9,321	9,211	9,211	9,211
Log pseudolikelihood	-23,014	-22,915	-22,915	-22,904
Pseudo R-squared	0.964	0.964	0.964	0.964

Notes: This table reports the estimation results based on the PPML method. ***, **, and * respectively indicate the 1%, 5%, and 10 % levels of statistical significance. The standard errors reported in parentheses are those clustered by country pairs. In all specifications, we control for exporter–year, importer–year, and country pair fixed effects.