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How ICT-enabled offshoring transformed services trade with the U.S. : Before and after the global financial crisis in 2008

Akihiko SHINOZAKI, Shigehiro KUBOTA

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How ICT-enabled offshoring transformed services trade with the U.S.[1]: Before and after the global financial crisis in 2008

Akihiko SHINOZAKI[2], Shigehiro KUBOTA[3]

Abstract

This study demonstrates how information and communications technology (ICT)-enabled offshoring, driven by the cross-border movement of skilled labor, has transformed international services trade since the global financial crisis of 2008. For this purpose, we first conducted panel data analysis based on network theory to verify the determinants of U.S. services trade with 31 countries from 1999 to 2015. Our dataset includes each country's services exports to the U.S., the number of H-1B and L-1 visas issued, gross national income (GNI) per capita, network readiness index, and an English dummy for the official language. We, then, illustrated how these factors interact with each other based on graphical modeling analysis. Finally, we examined how the determinants and their interactions were transformed before and after the 2008 global financial crisis. Our analysis yields three observations. First, higher-income nations traditionally have more robust services trade links with the U.S. due to income level proximity. Second, skilled labor in lower-income countries tend to desire H-1B or L-1 visas and create intensive human resource networks, which leads to the expansion of services trade with the U.S. Third, our study clarifies how these trade links have changed recently. Skilled labor networks and ICT networks have had the most direct and positive impact on U.S. services imports since 2008, while the impact of income level proximity has become weak and indirect.

JEL Classification: F20 international factor movements, F01 globalization, F14 multilateral trade and developing countries, O10 economic development.

Keywords: offshoring, services trade, graphical modeling, skilled labor network, ICT-network

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[2] Kyushu University, Japan.
[3] Tohoku Bunka Gakuen University, Japan.

1. Introduction

This study aims to demonstrate how information and communications technology (ICT)-enabled offshoring, driven by cross-border movements of skilled labor, has transformed international trade in services with the United States (U.S.) before and after the global financial crisis in 2008.

International services trade with the U.S., the world's largest services importer, expanded 2.5 times from $193 billion in 1999 to $489 billion in 2015 (Figure 1). The growth momentum was especially strong in the offshoring segment, which includes telecommunications, business, professional, and technical services such as computer and data processing services. It expanded 3.6 times from $37 billion in 1999 to $136 billion in 2015. Consequently, the offshoring segment accounted for 27.8% of the total services imported in the U.S. in 2015, an 8.5 percentage point increase from 1999. This segment's share in the total services' imports (27.8%) exceeded that of traditional services, such as travel (23.1%), cargo and transportation (19.9%), and financial and insurance (14.9%).

(Figure 1)

According to UNCTAD (2009), offshoring is a cross-border service trade categorized into two types of businesses (Table1). One is the ICT business, which includes programming, software development, and data processing. The other includes ICT-enabled services, such as call centers, customer contact, financial analysis, accounting, research and development (R&D), and a variety of knowledge-based services in back-office jobs.

(Table1)

Traditionally, physical goods used to dominate international trade because non-physical services were mainly on-site businesses, such as face-to-face transactions. Therefore, services were considered non-tradable businesses. However, certain types of service transactions, like offshoring, became tradable in the late 1990s owing to innovations in ICT, and its global penetration. Offshoring represents a new type of international trade, along with the global spread

of ICT.

In addition, global ICT and ICT-enabled businesses are highly dependent on skilled laborers, such as programmers, engineers, analysts, specialists, and consultants, who create intensive human networks across the transnational job market. Therefore, this study focuses specifically on skilled labor networks as well as ICT networks.

With this background, we first review the recent trend in offshoring, best represented by the growth in cross-border services trade, by applying network theory as an analytical framework and model specification. We, then, verify the factors that determine trade in services between the U.S. and developed as well as developing countries, based on the specified model. We also conduct a graphical modeling analysis to illustrate the trajectories and interactions between determinants. Finally, we examine how international services trade with the U.S. transformed *before* and *after* the global financial crisis in 2008.

2. Literature review

2.1 Economic impact of ICT and trade in services

During the last three decades, various studies were conducted on the global spread and economic impact of ICT innovations. Most of these studies demonstrated that investment in ICT accelerated productivity and economic growth (Jorgenson et al., 2008; Adams et al., 2008). In addition, the global penetration of ICT has generated a variety of ICT-enabled businesses, leading to massive potential for economic prosperity in both developed and developing countries (Baldwin, 2016; Shinozaki and Urakawa, 2017).

Offshoring is regarded as a representative sector with a positive impact on the economy (UNCTAD, 2009; Takagi, 2017). The import of services in the U.S. expanded rapidly, only to be interrupted by a decline in the late 2000s due to the global financial crisis triggered by the Lehman Brothers' bankruptcy (Figure 1). The growth momentum was particularly strong in the offshoring segment. It grew without any decline, even during the financial crisis. By 2008, the offshoring

segment's imports exceeded that of traditional services, such as cargo and transportation, travel, and financial and insurance services. Since 2008, its share in total services' imports in the U.S. has exceeded that of traditional services, reaching 27.8% in 2015.

During this phase, India emerged as a leading services trade partner of the U.S. It ranked below the top 20 largest service providers in 1999 and progressed to the tenth and sixth positions in 2008 and 2015, respectively. With this dynamic change, the volume of India's services exports to the U.S. increased by more than 17 times, from $1.4 to $24.7 billion (Table 2). One of the driving forces that made India a major provider was the Y2K (year 2000) programming issue at the turn of the millennium.[4] A former chief executive officer (CEO) of Tata Consultancy Services, India's largest information services company, stated, the "Y2K problem created an enormous opportunity for us to scale up our operations" (Ramadorai, 2013, p.95). Consequently, India has emerged as one of the most competent and promising service providers in the world.

(Table 2)

Here, we find three contradictions with the results of previous studies. The first is geographical distance. India is geographically located at a considerable distance from the U. S., whereas some empirical studies, such as Van der Marel and Shepherd (2013), indicated that geographical distance has a negative impact on services trade. The second factor is the income level. Traditionally, international services trade was considered intensive among high-income countries because their volume and variety of services expanded, in terms of both demand and supply, as their economies developed. Kimura and Lee (2006) estimated a gravity equation model and found that per capita income has a statistically positive effect on the growth of services trade. However, India's per capita income was only $1,640 in 2015, whereas that of the U.S. was $56,770, indicating a large income disparity between them.

The third contradiction concerns the development path. Traditional development theories

[4] Many computer programs had to patch their year code bugs because early software programs allocated only two digits rather than four to save memory space.

adopted Petty–Clark's law, explaining major productivity shifts sequentially from agriculture to manufacturing, and then to services. The U.S. is a typical case, which progressed "from the Industrial into the Information Age in the last decade of the twentieth century" (Chandler, 2000, p. 3). Likewise, the concepts of the "flying geese" or "catching-up" model are explained in the international trade theories (Kojima, 2000). Based on this, services trade was considered intensive among advanced economies.

However, India's development path seems quite different. It has leapfrogged straight from an agriculture-centric economy[5] to the software-intensive information age and somehow bypassed the manufacturing-based industrial age. [6] Therefore, previous studies and traditional theories have not sufficiently captured and described this development trajectory.

2.2 Offshoring and the network theory

One of the key factors that resolves these contradictions is active human networks in high-tech business communities in the U.S. and India. Several case studies on offshoring refer to the importance of cross-border human networks in addition to ICT networks. Highly skilled Indian engineers and experts play a vital role in the fast growth of high-tech firms in the U.S., such as Microsoft, IBM, Intel, and many other start-ups in the Silicon Valley (JETRO, 2008; Atkinson, 2004).

Foreign engineers usually require H-1B or L-1 visas, which are non-immigrant visa categories for workers in specialty occupations. Offshoring business models, therefore, rely heavily on H-1B and L-1 visas (Kirkegaard, 2005; Economic Policy Institute, 2016). In addition, English is a common language in India's advanced education system, and Indian students consider math and algebra to be promising subjects, which creates favorable conditions for business with

[5] According to the Government of India (2018), the share of agricultural workers in total workers was more than half over the last few decades. It was 59.0% in 1991, 58.2% in 2001, and 54.6% in 2011 respectively.

[6] Fong (2009) provided a comprehensive review of the leapfrogging phenomenon, and Singh (1999) adopted this view to illustrate the Indian telecommunications industry.

the U.S. (Blinder, 2006).

With this background, Suenaga et al. (2014) employed “network theory” as the analytical framework with a specific focus on cross-border networks of skilled labor as well as information networks to examine the rapid expansion of offshoring according to the concept of “leapfrogging” development. The key concepts of network theory involve three items that are of value to our study: regular networks, small-world networks, and multi-level networks. A regular network structure contains highly ordered and proximity-based features, whereas a small-world network has a few random links to a distant node via the re-wiring of regular networks (Figure 2).

(Figure 2)

In general, individuals and organizations, illustrated as nodes in Figure 2, create a regular network based on proximity with limited and close links to each other. If they randomly rewire some of their links to a distant node, they can create a small world and benefit from the new links. In other words, rewiring provides a proximity effect between distant nodes, which leverages and revitalizes the entire network. Furthermore, the economy consists of several layers of networks, such as personal networks (friendships), organizational networks (relations between firms), and cross-country networks (international trade), referred to as multi-level networks. These networks sometimes affect each other across layers. For example, personal-level relations influence those of an affiliated organization or country; likewise, a country- or organizational-level relationship influences individual-level behavior and performance (Hitt et al., 2007).

These network theory concepts are useful in analyzing offshoring as follows. Based on the theory, a large number of H-1B and L-1 visa holders (competent students, professionals, and technical experts) emigrate to the U.S. from their home countries. This triggers rewiring and then they then create a small-world network by joining U.S. multinational firms or starting their own businesses, consequently creating greater cross-border business networks between countries. Finally, these networks promote service trade expansion between their countries and the U.S. at the national level. Thus, we can now observe the interaction between different layers of networks,

that is, a multilevel network.

Adopting network theory, a small world is understood to be generated by cross-border human networks of skilled labor, in addition to global ICT networks, even though there are large geographical distances and huge income discrepancies across the countries.

2.3 Scope and purpose of this study among previous studies

Based on this theoretical framework, Shinozaki and Kubota (2018) investigated the expansion of offshoring between 1999 and 2008, when offshoring took off worldwide. The study concluded that network theory is a robust and significant framework for investigating international trade in services, particularly ICT-enabled businesses, and that the cross-border movement of skilled labor has a positive effect on services trade with the U.S.

However, the study covered a limited period, from 1999 to 2008, which was the initial stage of offshoring. Since then, the global economy has experienced a disruptive change due to the global financial crisis triggered by the Lehman Brothers' bankruptcy because this event had a strong impact on the global economy and transformed international trade in services. Thus, verification of whether the fundamental momentum of offshoring and its determinant factors continue to promote international services trade is significant.

In this study, we expand the scope of these analyses to demonstrate how ICT-enabled offshoring, driven by cross-border movements of skilled labor and information networks, has transformed international services trade since the global financial crisis of 2008. For this purpose, we first conduct a panel data analysis based on network theory to verify the determinants of U.S. services trade with 31 countries between 1999 and 2015. We, then, illustrate how these factors interact based on graphical modeling analysis. Finally, we examine how the determinants and their interactions were transformed *before* and *after* the 2008 global financial crisis.

3. Model and dataset

Our study adopts model (1) specified by Shinozaki and Kubota (2018) to verify whether human resource networks with the U.S. contributed to growth in offshoring businesses and consequent national-level exports of services to the U.S between 1999 and 2015.

$$usaimp_{ij} = C + \beta_1 visa_{ij} + \beta_2 networkreadiness_{ij} + \beta_3 nipercap_{ij} + \beta_4 englishdummy_{ij} \ldots (1)$$

In model (1), the dependent variable is the value of services exports from each country (*i*) to the U.S. (*usaimp*), with the following independent variables: the number of H-1B and L-1 visas issued (*visa*), IT network availability (*networkreadiness*), income level or development stage (*nipercap*); the English proficiency dummy variable equals "1" if English is an official or subsidiary official language, and "0" otherwise (*englishdummy*).

The sources of the dataset in this study are as follows: 1) the value of each country's exports of services to the U.S. from the U.S. Department of Commerce; 2) the number of H-1B and L-1 visas issued for highly skilled technical workers, from the U.S. Department of State, as a proxy for highly skilled labor networks; 3) the World Economic Forum Network Readiness Index as a proxy for IT network availability; and 4) Gross National Income (GNI) per capita from the World Bank database as a proxy for each country's income level or development stage (Table 3).

(Table 3)

Owing to limited data availability, this study focused on the 31 countries listed by Shinozaki and Kubota (2018). They include 19 Organization for Economic Co-operation and Development (OECD) member countries or developed countries and 12 non-member countries or developing countries, such as India (Table 4). Our dataset period (*j*) covers 1999 to 2015, extending the final period from 2008 to 2015 for analysis of *before* and *after* the global financial crisis in the late 2000s.

(Table 4)

4. Results

4.1 Panel data analysis

Based on the above-mentioned dataset, we estimate model (1) and conduct a panel data analysis for three categories: the entire period from 1999 to 2015, term I from 1999 to 2008, and term II from 2009 to 2015. The estimation results are presented in Table 5.

(Table 5)

[*visa*]

In the model for the *entire period* from 1999 to 2015, the coefficient of *visa* is confirmed as statistically positive, and models with *visa* show better results than those without *visa*. Thus, skilled labor networks are a determinant factor in the growth of services trade with the U.S. By comparing the models of term I (*before* 2008) with term II (*after* 2008), we find that the coefficient of *visa* is statistically positive in both terms, as in the *entire period*. However, ${}_{\text{Adj}}R^2$ in the models of term I represents no significant differences between the model with *visa* and the model without *visa*, while ${}_{\text{Adj}}R^2$ in the models of term II represents a better fit in the model with *visa* than in the model without *visa*. Moreover, the coefficient of *visa* in term II is larger (0.23) than that in term I (0.13). Thus, it is concluded that the impact of *visa* became more significant after 2008.

[*nipercap*]

The coefficient of *nipercap* is statistically positive in every category, implying that international trade in services with the U.S. consistently tends to become intensive among high-income countries. In other words, income proximity is proven to have a positive impact on international services trade with the U.S., as in Kimura and Lee (2006). By comparing the models of term I (*before* 2008) and term II (*after* 2008), we find that the coefficient of *nipercap* is statistically positive in both terms, as in the *entire period*. However, the coefficient of *nipercap* in term II is smaller (0.13) than that in term I (0.36). Thus, it is concluded that the impact of *nipercap* became less significant *after* 2008, a clear contrast to the impact of *visa*.

[*networkreaadiness*]

The coefficient of *networkreadiness* is statistically positive in every period: the *entire period*, *before*, and *after* 2008. In addition, the coefficient of *networkreadiness* in term II is higher (2196.35) than that in term I (1205.43). Thus, it is concluded that the impact of ICT networks became more significant after the recent expansion of services trade with the U.S. post 2008, as did the impact of *visa*.

[Summary]

Our panel data analysis finds that skilled labor networks, income level proximity, and ICT networks have shown statistically positive effects on the expansion of services trade with the U.S. In addition, *after* the financial crisis of 2008, skilled labor networks and ICT networks have had a more powerful impact on services trade with the U.S. In contrast, income level proximity has had a smaller impact on services trade with the U.S. since the late 2000s.

4.2 Graphical modeling analysis

Using the panel data analysis's results, we clarify how individual variables interact and affect services trade with the U.S., addressing why and how low-income countries, such as India, expanded their service exports to the U.S. For this, we employ a graphical modeling methodology to examine the mutual effects between the variables and illustrate a clear trajectory in their effects on the services trade with the U.S. Figure 3 illustrates the results of the graphical modeling analysis.

(Figure 3)

[*entire period*]

In the entire period from 1999 to 2015, *nipercap*, *visa*, and *networkreadiness* had direct and positive relationship with the services trade with the U.S. Among these three factors, a negative

relationship appears between *nipercap* and *visa*, despite their positive effects on services trade. Thus, we can conclude that income proximity creates regular networks in the services trade among developed countries, whereas in developing countries with income levels lower than the U.S., H-1B or L-1 visas are desirable to achieve more prosperity and create intensive human resource networks.

These cross-border skilled labor networks, spanning from low-income countries to the U.S., generate a "re-wiring effect" and create "small networks" resulting in the expansion of services trade with the U.S. Furthermore, *networkreadiness* has a direct and positive relationship with both services trade and *nipercap*, which verifies that the ICT network is a significant factor to improve income levels and promote international trade in services.

[*before* and *after* 2008]

From 1999 to 2008, a period considered as the commencement of offshoring, *nipercap* and *visa* had a positive and direct relationship with the services trade with the U.S., while *networkreadiness* had a positive but indirect relationship. However, from 2009 to 2015, *nipercap* had no direct relationship with the services trade with the U.S., whereas *networkreadiness* had a direct relationship. Thus, skilled labor networks and ICT networks emerge as two significant factors in the expansion of recent services trade with the U.S.

[Summary]

The graphical modeling analysis clarifies that *before* 2008, high-income countries had a direct impact on the services trade with the U.S., whereas skilled labor in low-income countries desired H-1B or L-1 visas that generated a rewiring effect and shaped "small-world network," promoting the services trade with the U.S. At the same time, ICT networks were closely associated with income levels and had an indirect impact on the services trade with the U.S. *before* 2008.

After 2008, however, these relationships have transformed. Income proximity has no direct

impact on the services trade with the U.S., whereas ICT networks and skilled labor networks display more direct and larger impacts *after* 2008.

5. Conclusions and implications

In this study, we demonstrate how ICT-enabled offshoring, driven by cross-border movements of skilled labor, has transformed international trade in services since the 2008 global financial crisis. For this purpose, we employed network theory as an analytical framework and conducted a panel data analysis to verify the determinants of the services trade between the U.S and 31 countries in the period 1999-2015. We, then, illustrated how these factors interact based on graphical modeling analysis. Finally, we examined how the determinants and their interactions transformed *before* and *after* the 2008 global financial crisis.

Our analysis yields three observations. First, high-income nations traditionally have stronger services trade links with the U.S due to income level proximity. Second, H-1B and L-1 visas appeal to skilled labor in low-income countries and create intensive human resource networks, leading to the expansion of services trade with the U.S. Third, cross-border human networks of skilled labor, as well as ICT networks, have become more significant driving forces to expand international services trade since 2009, while the impact of income level proximity has become less significant and indirect.

Traditionally, higher-income nations have had more robust services trade links with the U.S. Our study clarifies how these trade links were recently rewired. Our study expands existing research by verifying the transformation of the determinants of services trade between 1999 and 2015. It contributes to further research and policy implications by demonstrating the vital role of cross-border networks of skilled labor. The services trade model needs to account for the movement of labor, and policymakers need to recognize the importance of cross-border human networks of skilled labor, in addition to ICT networks, in promoting economic growth and development.

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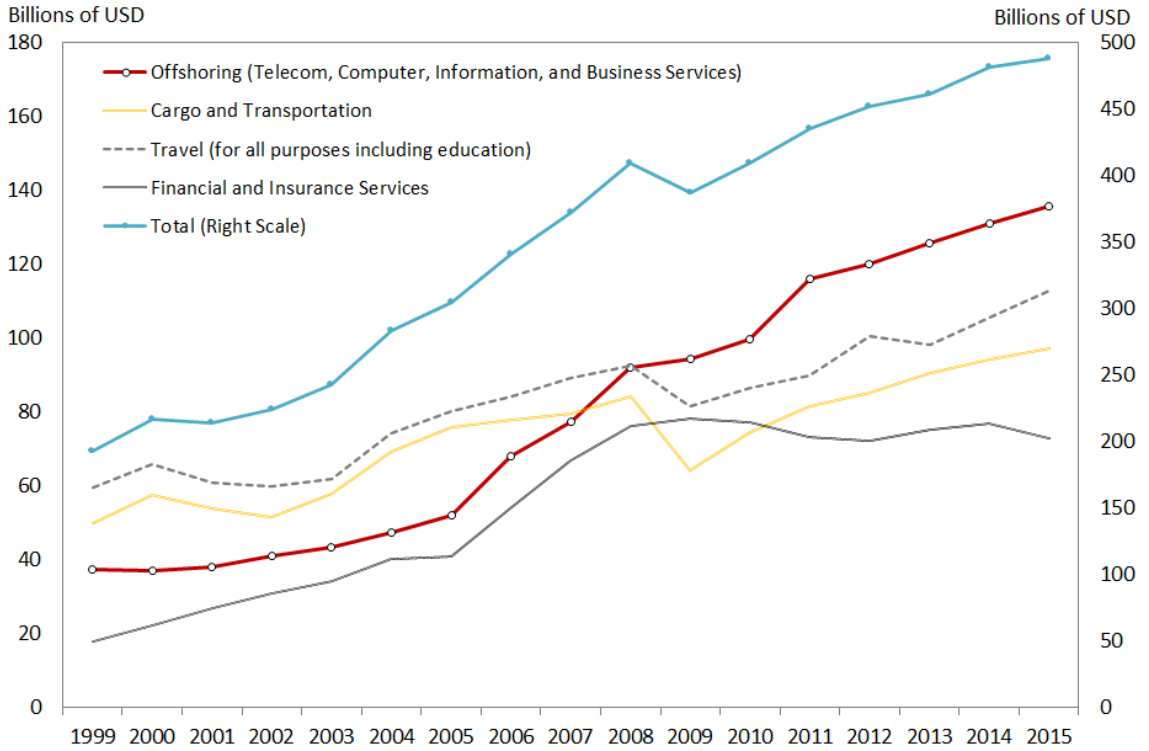
Tables and Figures

Figure 1. U.S. Service imports by major category



Source: Bureau of Economic Analysis, U.S. Department of Commerce.

Table 1. Categories of offshoring

Service category	Examples of service activities
IT services	Programming, systems integration, application testing, IT infrastructure management and maintenance, IT consulting, software development and implementation services, data processing and database services, IT support services, data warehousing, and content management and development
ICT-enabled services	
Front office services	Call centres and customer contact centres (inbound and outbound)
Back office services	Data entry, human resources, payroll, finance and accounting, procurement, transcription
KPO	Financial analysis, data mining, engineering, research and development, insurance claims processing, architectural design, remote education and publishing, medical diagnostics, journalism

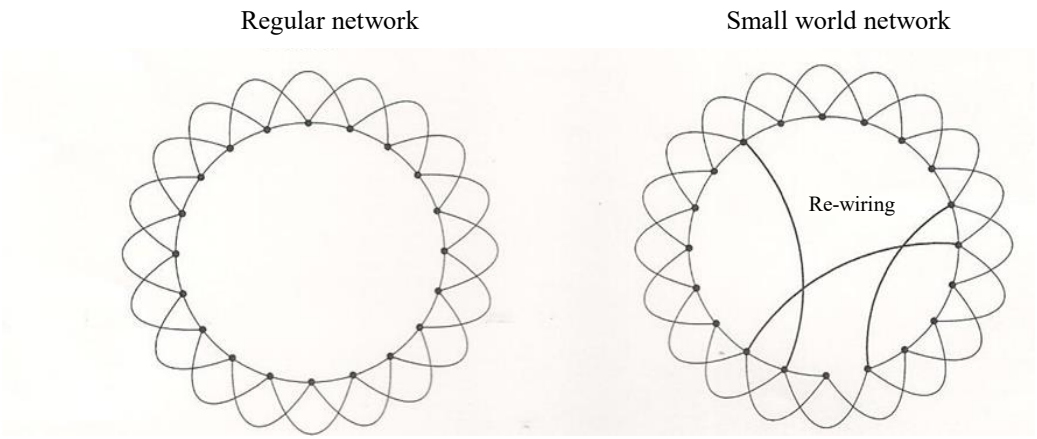
Source: UNCTAD (2009) Information Economy Report 2009, p. 74, Table III.8.

Table 2. U.S. Trade in Services (Imports) by Country (millions of current US$)

	1999		2008		2015	
Rank	Country	Imports	Country	Imports	Country	Imports
1	United Kingdom	26,237	United Kingdom	45,259	United Kingdom	52,891
2	Canada	16,598	Germany	33,372	Germany	31,668
3	Japan	15,284	Canada	25,973	Japan	29,411
4	Germany	13,710	Bermuda	24,675	Canada	28,992
5	Mexico	9,688	Japan	24,609	Bermuda	25,051
6	France	7,975	Switzerland	19,274	**India**	**24,693**
7	Italy	5,845	Mexico	15,904	Mexico	21,930
8	Bermuda	5,363	France	15,148	Switzerland	21,323
9	Korea	5,171	Ireland	13,822	France	16,372
10	Netherlands	4,843	**India**	**12,654**	Ireland	15,882
11	Switzerland	4,378	China	10,924	China	15,108
12	Hong Kong	3,673	Italy	9,913	Korea	11,127
13	Taiwan	3,088	Netherlands	8,708	Italy	10,823
14	China	2,719	Korea	8,079	Netherlands	10,181
15	Australia	2,640	Hong Kong	7,175	Hong Kong	8,775
16	Spain	2,492	Taiwan	6,236	Brazil	7,833
17	Belgium	2,400	Australia	5,505	Taiwan	7,650
18	Israel	2,087	Spain	5,030	United Kingdom Is	7,010
19	Singapore	2,027	Belgium	4,684	Australia	7,008
20	Saudi Arabia	1,724	Brazil	4,514	Singapore	6,770
21	**India**	**1,439**	Israel	4,405	Israel	6,060

Source: Bureau of Economic Analysis, U.S. Department of Commerce.

Figure 2. Regular and small world networks



Source: Nishiguchi (2009), with some modifications.

Table 3. Dataset and Sources

Variable	Abbreviation	Source
Service exports to the U.S. (millions of USD)	usaimp	Service imports from the statistics section of Private Services Trade by Area and Country, International Services, U.S. Department of Commerce, Bureau of Economic Analysis.
Total number of H-1B and L-1 visas issued (person)	visa	H-1B and L-1 visas from the Visa Statistics, U.S. Department of State, Bureau of Consular Affairs, Nonimmigrant Visa Issuances by Visa Class and by Nationality.
Network readiness index	networkreadiness	Networked Readiness Index from *The Global Information Technology Report* issued by the World Economic Forum.
GNI per-capita (current international dollar: PPP)	nipercap	GNI per capita, PPP (current international $) provided by the World Bank.
English proficiency factor (Dummy variable)	englishdummy	"1" if English is an official or subsidiary official language and "0" otherwise

Table 4. Country group categories

Region	Countries and economies
America	United States*, Canada*, Mexico*, Brazil, Argentina, Chile*, Venezuela
Europe	Ireland*, United Kingdom*, Italy*, Netherlands*, Switzerland*, Sweden,*, Spain*, Germany*, Norway*, France*, Belgium*
Asia and Oceania	Japan*, Australia*, New Zealand*, Singapore, Hon Kong, South Korea*, Indonesia, Thailand, Philippines, Malaysia, China, India
Other region	Israel*, South Africa

Note: OECD member counties are marked with *.

Table 5. Results of panel data analysis

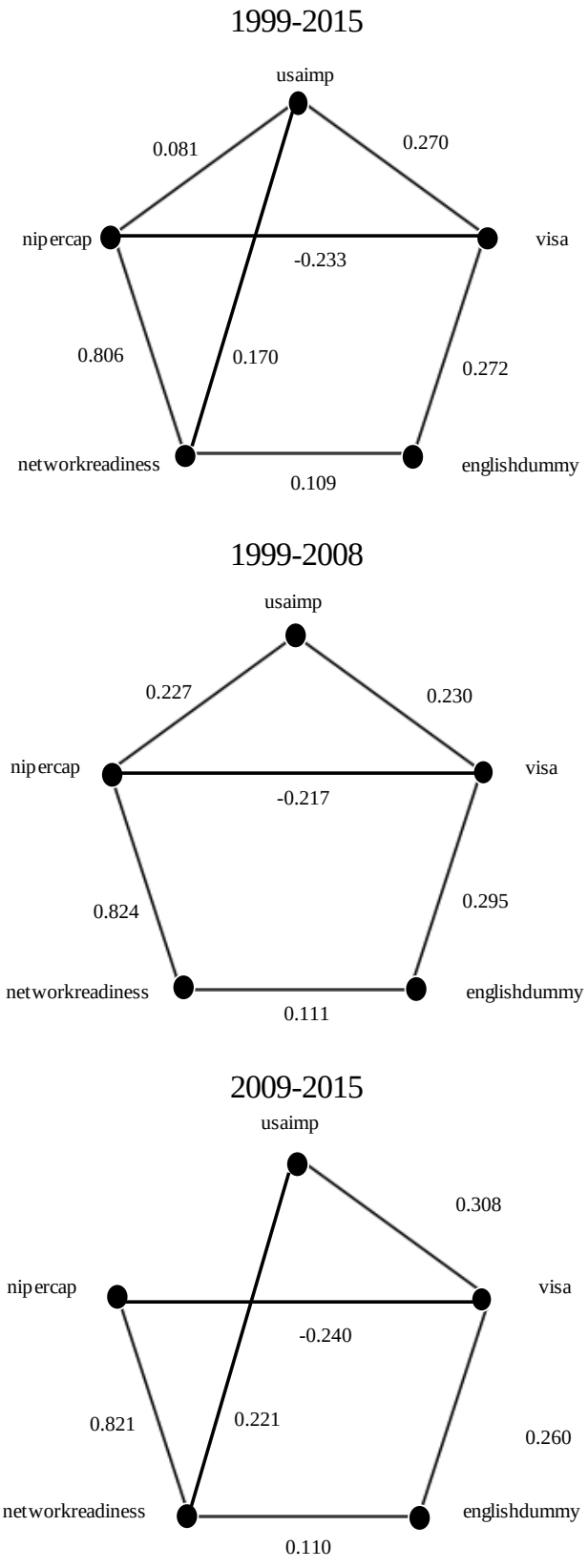
	[1999-2015 (*entire period*)]			
	fixed effect model		random effect model	
networkreadiness	2313.37	1830.36	2234.01	1808.40
	[4.085]***	[3.402]***	[3.994]***	[3.414]***
nipercap	0.27	0.28	0.26	0.27
	[11.260]***	[12.380]***	[11.090]***	[12.331]***
englishdummy			2091.34	288.51
			[0.603]	[0.084]
visa		0.22		0.22
		[7.574]***		[7.799]***
_cons	-9291.58	-8580.74	-9452.44	-8465.53
	[-3.877]***	[-3.791]***	[-3.109]***	[-2.889]***
Adj-R-squared				
within	0.34	0.41	0.34	0.41
between	0.09	0.16	0.11	0.16
overall	0.11	0.18	0.12	0.19
N	490	490	490	490

Notes: * p<0.1, ** p<0.05, *** p<0.01.

	[1999-2008 (*before*)] random effect model		[2009-2015 (*after*)] random effect model	
networkreadiness	1428.54	1205.43	1047.35	2196.35
	[2.714]***	[2.342]**	[1.321]	[3.235]***
nipercap	0.35	0.36	0.19	0.13
	[10.251]***	[10.764]***	[3.814]***	[3.127]***
englishdummy	1256.05	320.26	3753.76	1437.40
	[0.415]	[0.106]	[0.891]	[0.349]
visa		0.13		0.23
		[3.998]***		[8.320]***
_cons	-7907.95	-7445.78	-1317.59	-5634.25
	[-2.761]***	[-2.648]***	[-0.352]	[-1.659]*
Adj-R-squared				
within	0.36	0.39	0.22	0.46
between	0.13	0.17	0.08	0.17
overall	0.14	0.17	0.08	0.18
N	273	273	186	186

Notes: * p<0.1, ** p<0.05, *** p<0.01.

Figure 3. Results of graphical modeling analysis



Note: Figures represent partial correlation coefficient.

A list of back numbers

No.1 Deta de yomu jouhou tsuushin gijutsu no sekaiteki na fukyu to hensen no tokuchou (How does a global ICT indicator illustrate the long-run changes of the international community?), Masato NOGUCHI, Yusuke YAMAMOTO, Akihiko SHINOZAKI, January 2015, pp.1-25, in Japanese.

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ICR InfoCom Research, Inc. 株式会社情報通信総合研究所

Urban Net Nihonbashi Bldg., 2-14-10, Nihonbashi Ningyo-cho, Chuo-ku,
Tokyo 103-0013, Japan
For further information, mail to ict-me@icr.jp