The Role of Cross-Border Networks of Skilled Labor in Offshore Outsourcing: Empirical Evidence Based on the Network Theory

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The role of cross-border networks of skilled labor in offshore outsourcing: Empirical evidence based on the network theory

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Abstract

This study investigates the determinant role of the cross-border movement of skilled labor in the expansion of service trade between the U.S. and both developed and developing countries. For this purpose, we employ the key concepts of network theory as an analytical framework and conduct panel data analysis and graphical modeling analysis for 31 countries from 1999 to 2008. In this decade, offshore outsourcing in the service trade took off worldwide. We use data for each country's service exports to the U.S., number of H-1B visas issued, GNI per-capita, network readiness index, and an English dummy for the official language. We illustrate the trajectory and interactions between these factors. These analyses yield three observations. First, service trade with the U.S. is more intensive among higher income countries. Second, the number of H-1B visas issued has a positive effect on service exports to the U.S. Third, individuals in lower-income countries tend to desire H-1B visas and create intensive skilled labor networks with the U.S., the path through which developing countries such as India expanded their service exports to the U.S.

JEL Category: F14 Multilateral Trade and Developing Countries, F01 Globalization, F20 International Factor Movements, O10 Economic Development

Keywords: offshoring, trade in services, graphical modeling, human resource network

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1. Introduction

This study examines the determinants of the service trade from both developed and developing countries to the U.S., with a special focus on cross-border skilled labor networks. The recent trend in offshore outsourcing, or offshoring, best symbolizes the growth in cross-border service trade, which includes business, professional, and technical services such as computer and data processing services. All of these services became tradable in the late 1990s due to innovation in information technology (IT) [1, 2, 3].

The global offshoring market expanded 2.6 times between 1998 and 2008 [4]. During this period, the U.S., the world's largest service trade market, saw an annual growth rate of 8.5% in service imports. The growth momentum was especially strong in the offshoring segment, which expanded 11.3% annually. Such trends in the U.S. have a significant ripple effect on the economies of the trading partner, such as India, a country with a robust trade in services with the U.S. India's economic growth rate since 2000 accelerated by 2.1% to 7.8%, up from an average rate of 5.7% in the 1980s-1990s. Service industries such as software development contributed the most to this increased growth momentum, accelerating aggregate economic growth by 2.8%, from 3.0% in the 1980s to 5.8% in the 2000s.

For interpreting this expansion in the trade in services, there are some limits to the traditional frameworks of economic analysis, such as the well-known "Petty-Clark's law" or "flying geese pattern" of development in international trade. To address this gap, we employ network theory as an alternative framework to investigate the enabling factors of service trade empirically, focusing on the strength of cross-border skilled labor networks.

2. Literature review

Since the early 2000s, offshoring has been a controversial issue in the U.S. [5, 6]. Service imports in the U.S., the world largest service trade market (Table 1), expanded rapidly, roughly during the decade following the late 1990s Asian currency crisis until the global financial crisis in the late

2000s triggered by the Lehman Brothers bankruptcy. In particular, the offshoring segment (telecommunications, computer, information, and other business services) experienced the fastest growth. The segment's volume exceeded traditional service trade such as cargo and transportation services, travel services (for all purposes including education), or financial and insurance services by 2008 (Figure 1).

[Table 1] [Figure 1]

With these dynamic changes in the U.S. market, India emerged as a significant overseas service provider, as Table 2 indicates. India had a very low ranking in 1999, but became one of the top ten service providers in the late 2000s. One of the driving forces that made India a major provider was the Y2K (year 2000) programing issue at the turn of the millennium.[1] A former CEO of Tata Consultancy Services, India's largest information service company, stated, the "Y2K problem created an enormous opportunity for us to scale up our operations" [7, p.95]. Consequently, India emerged as one of the most competent and promising service providers globally.

[Table 2]

Here, we find two contradictions with results from prior studies. The first is distance. India is geographically distant from the U.S., while recent empirical studies, like Van der Marel et al. [8], indicate that geographical distance has a negative impact on the service trade. The second contradiction is in the prior findings on income levels, which relates to the shift to a service economy in economic development. Kimura and Lee [9] estimate a gravity equation model and find that per-capita income shows a statistically positive relationship with the growth of international service trade. India's GDP per capita, however, remains extremely low and a large discrepancy exists between the U.S. and India.

One of the key factors that resolves the contradiction is active human networks in high-tech

[1] 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.

business communities between the U.S. and India [10]. Several case studies of offshoring show that higher skilled Indian engineers and experts had a vital role in the fast growth of high-tech firms in the U.S., such as Microsoft, IBM, Intel, and in particular, many other start-ups in Silicon Valley [11, 12]. However, foreign engineers usually require an H-1B visa, which is a nonimmigrant visa category for workers in specialty occupations. Offshore outsourcing business models therefore rely heavily on H-1B visas [13, 14, 15]. 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 doing business with the U.S. [6, 9].

Unlike the traditional service trade model, we assume that the cross-border movement of skilled labor, income level, English proficiency, and IT network availability are key hidden to investigate the expansion of India's service trade with the U.S. Suenaga et al. [16] focus on these factors in a panel analysis, as do Kubota et al. [17] in a graphical modeling analysis. However, they use older service trade statistics and process the original dataset differently. Therefore, the results of their analyses are neither comparable nor relatable due to the lack of consistency. Furthermore, Kubota et al. [17] employ restricted conditions in the algorithm for technical reasons rather than for the purposes of economic analysis, so the economic implications are ambiguous and confusing.

We take several steps to address these limitations. First, we investigate the two contradictions mentioned above by building an alternative model with a robust theoretical framework, rather than using traditional trade or development models. Second, we employ the new U.S. service trade statistics for further research opportunities. Third, we use identical data processing for both the panel analysis and graphical modeling in the model specifications. Fourth, we employ more generalized conditions in the algorithm for the graphical modeling to provide accurate and appropriate relations between our variables.

3. Theoretical framework

Traditional development theories explain that major productivity shifts sequentially from agriculture to manufacturing, and then to services. The U.S. is a typical case, which moved "from the Industrial into the Information Age in the last decade of the twentieth century" [18, p. 3]. Accordingly, it has been considered that international service trade expands between the higher income countries because the volume and variety of services grow in both demand and supply as the economy develops.

In India's case, however, the economy appears to be "leapfrogging" straight from an agriculture-centric economy to the software-intensive Information Age, somewhat bypassing the manufacturing-based Industrial Age.[2] Likewise, offshoring, which best exemplifies the international services trade model between the U.S. and India, is a new phenomenon.

Therefore, traditional theoretical frameworks, such as the "flying geese" or "catching-up" model of international trade [19], may not sufficiently capture and describe this development trajectory. We thus employ network theory as the theoretical framework to study leapfrogging development, with a special focus on cross-border skilled labor networks. This theory contains three major concepts of value to our study: the re-wiring of regular networks, small world networks, and multi-level networks [16].

A regular network has highly ordered and proximity-based features in its structure, while a small world network has a few random links via re-wiring of the regular network [20]. In general, individuals and organizations, illustrated as nodes in Figure 2, usually create a regular network based on proximity with limited and close links to each other. If they randomly re-wired some of their links to a distant node, they can create a small world and benefit from new links. In other words, re-wiring provides a proximity effect between distant entities, which leverages and revitalizes the entire network.

[2] Fong [21] provides a comprehensive review of leapfrogging development and Singh [22] adopts this view to illustrate the Indian telecommunication industry.

[Figure 2]

The economy consists of several layers of networks, such as personal networks, organizational networks, and cross-country networks, referred to as multi-level networks. Networks sometimes affect each other across different layers. For example, personal-level relations influence those of the affiliated organization or country; likewise, a country- or organizational-level relationship influences individual-level behavior and performance [23].

These network theory concepts are useful to analyze the offshoring business model in U.S. firms. Based on network theory, a large number of H-1B visa holders, or competent students, professionals, and technical experts, emigrate to the U.S. from their home countries (re-wiring). They then join U.S. multinational firms or start their own businesses, consequently creating greater cross-border business networks between both countries (small-world networks). Finally, these networks trigger growth in service trade between their countries and the U.S. at the national-level (multi-level networks).

4. Empirical analysis

4.1 Model and dataset

Based on the theoretical framework, our study specifies model (1) to verify whether human resource networks with the U.S. contributed to growth in offshoring business and the consequent national service exports to the U.S.

$$usaimp = C + \beta_1 visa + \beta_2 networkreadiness + \beta_3 nipercap + \beta_4 englishdummy \ldots (1)$$

In this model, the dependent variable is the value of service exports from each country to the U.S. (*usaimp*), with the following independent variables: the number of H-1B visas issued (*visa*), IT network availability (*networkreadiness*), income level or development stage (*nipercap*), and the English proficiency dummy variable (*englishdummy*).

[Table 3]

Table 3 summarizes the sources of dataset in this study. This includes: 1) the value of each country's service exports to the U.S. from the U.S. Department of Commerce, 2) number of H-1B visas issued for highly-skilled technical workers from the U.S. Department of State as a proxy for high-skilled labor networks, 3) the World Economic Forum network readiness index as a proxy of IT network availability, 4) GNI per-capita from the World Bank database as a proxy for each county's income level or development stage, and 5) an English dummy variable equal to 1 if English is an official or subsidiary official language and 0 otherwise as a proxy of English proficiency.

[Table 4]

Due to limited data availability, this study focuses on the 31 countries listed in Table 4. These include 19 OECD member countries, or developed countries, and 12 non-member countries, or developing countries, such as India. The dataset period covers 1999 to 2008, a decade between the late 1990s currency crisis in Asia and the global financial crisis in the late 2000s triggered by the Lehman Brothers bankruptcy, when offshoring coincidentally grew significantly worldwide.

4.2 Panel data analysis

We estimate model (1) for three categories: the pooling model, the fixed effects model, and the random effects model. Table 5 reports the results of the estimations.

[Table 5]

In each model, the coefficient of H-1B visa shows a significantly positive relationship with service trade with the U.S., and the coefficients of determination are higher than those in the models without the *visa* variable. In other words, the results strongly verify that highly skilled human resource networks with the U.S. (*visa*) have statistically significant and positive effects on the growth of service exports to the U.S. (*usaimp*). Additionally, per-capita income (*nipercap*) shows a similar significant and positive effect, indicating that service trade with the U.S. is more

intensive among higher income countries, as with Kimura and Lee [9].

This leads to a new question: why and how did low-income countries like India expand their service trade with the U.S.? Moreover, a glance at the correlation matrix for the variables in Table 6 is more puzzling. It appears to show a negative correlation between human resource networks (*visa*) and income level (*nipercap*), despite their positive effects on service trade (*usaimp*).

[Table 6]

To address these questions, we must clarify how the individual variables interact and affect service exports to the U.S. We do this by employing a graphical modeling methodology to examine the mutual effects between the variables and to illustrate a clear trajectory in their effects on service exports to the U.S.

4.3 Graphical modeling analysis

One problem with multivariate analyses, such as panel analysis, is that the coefficients of the independent variables include both the direct impact of the independent variables on dependent variables and that of other factors. Therefore, we must remove pseudo-correlations and rigorously distinguish between the direct and indirect relationships for a detailed examination. The partial correlation coefficient matrix in Table 7 addresses this issue.

[Table 7]

Compared to the correlation matrix in Table 6, the partial correlation matrix shows differences in some variables, where some even have different signs. Here, we replace some of the partial correlation coefficients with zero because they are extremely small and we can conclude that there are no direct correlations between those variables. Consequently, we can simplify the inter-variable relationships and construct clear diagrams of the overall structure using the graphical modeling methodology[3].

[3] See Dempster [24] for the theoretical background.

In this study, we employ a reduced model algorithm that starts with a full model with relationships between all combinations of variables, and then systematically remove the relationships with extremely small partial correlation coefficients between variables. We then finally select an optimal model based on the Bayesian information criterion (BIC). Table 8 presents the resulting partial correlation matrix and Figure 3 illustrates the results of the graphical modeling analysis.

[Table 8]

[Figure 3]

4.4 Results and analyses

Table 8 and Figure 3 show the structural relationship between the variables. First, GNI per-capita and H-1B visa have a positive and the most direct effect on service exports to the U.S. Second, there is a negative relationship between GNI per-capita and H-1B visa, despite their positive effects on service exports. Third, network readiness and the English factor have indirect effects on service exports to the U.S. through GNI per-capita or H-1B visas.

Network theory helps us interpret these results. In terms of model (1), the regular network in Figure 1 illustrates the proximity of income levels, that is, economic development stages, to cross-border service trade. In other words, developed countries with higher income levels close to those of the U.S. generally tend to have higher volume services trade with the U.S.

On the contrary, developing countries with income levels very distant from those of the U.S. tend to desire H-1B visas to improve their opportunities and create intensive human resource networks among highly skilled communities. Thus, there is a negative relationship between GNI per-capita and H-1B visa. Consequently, these cross-border human resource networks from developing countries to the U.S. generate a re-wiring effect and promote services trade with the U.S., despite their income level disadvantage.

5. Conclusion and policy implications

This study uses network theory to analyze empirically the growth trajectory of service exports from both developed and developing countries to the U.S. with a special focus on the cross-border movement of skilled labor. We conducted a panel data analysis covering 31 countries from 1999 to 2008 using a dataset of service exports to the U.S., number of U.S. H-1B visas issued, GNI per capita, network readiness index, and English proficiency factors. In addition, we explore and illustrate the interconnections between the five variables using a graphical modeling methodology.

Our study yields three major findings. First, service trade with the U.S. is more intensive among higher income countries. Second, the number of H-1B visas issued have a positive effect on service exports to the U.S. Third, individuals in developing countries tend to desire H-1B visas and create intensive high-skilled human networks with the U.S., the path through which developing countries such as India expanded their service exports to the U.S.

Traditional models, which explain that higher-income and shorter-distance economies have more robust service trade with the U.S., cannot explain the expansion of service trade between the U.S. and India, despite their long distance and huge income disparity. Our research results are significant because they trace a clear path of how traditional trade links changed via re-wiring due to skilled labor movement from distant developing countries. Consequently, this study solves the two issues of distance and income levels that run contrary to prior findings, and clearly describes the fast expansion of offshoring between the U.S. and India, despite their long distance and huge income discrepancy.

This study has several implications. First, the service trade model needs to account for the vital role of cross-border networks of skilled labor, that is, the factor movement of labor. Second, network theory is a robust and significant framework to investigate international service trade, in particular IT-enabled high-tech business. Third, policy makers in both developed and developing countries, who tend to focus on trade balances or capital movements, need to recognize the importance of the movement of skilled labor because it strongly relates to growth in international service trade.

Notes

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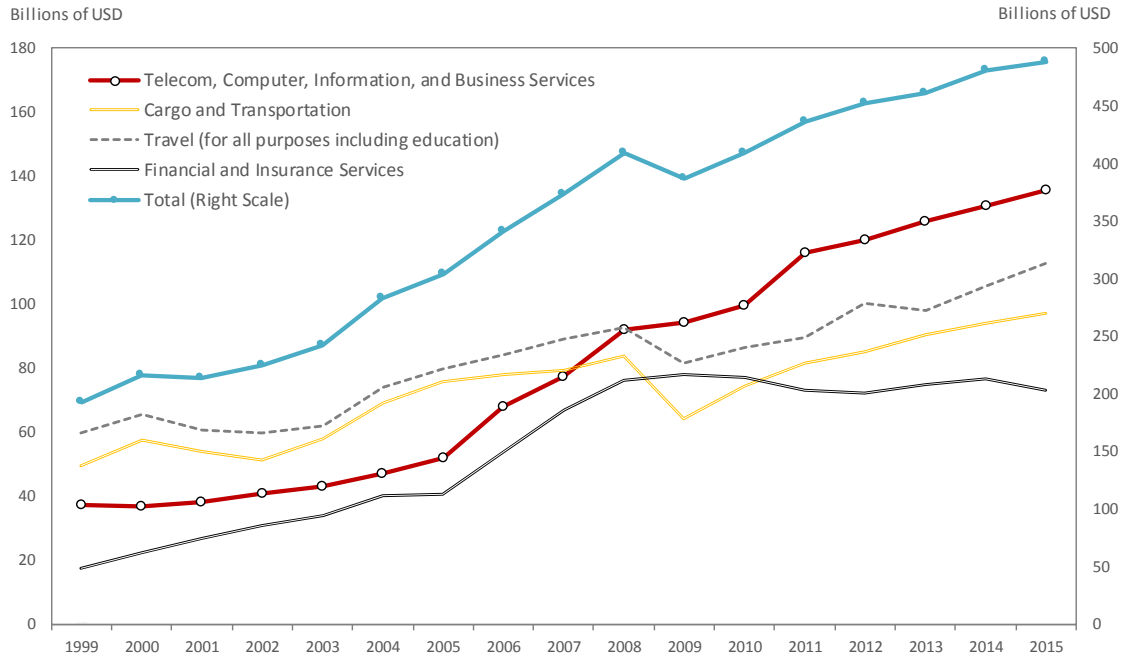
Figures and Tables

Table 1. Trade in Services, top 10 import countries (millions of current US$)

No	2000		2005		2010		2015	
1	U.S.A	216,121	U.S.A	304,451	U.S.A	409,311	U.S.A	491,741
2	Germany	136,740	Germany	209,867	Germany	263,002	China	435,719
3	Japan	118,299	U.K.	174,032	U.K.	184,779	Germany	295,342
4	U.K.	103,997	Japan	139,013	France	181,693	France	230,119
5	France	84,598	France	134,350	Japan	164,880	U.K.	217,335
6	Italy	58,698	Netherlands	101,352	China	140,934	Japan	178,614
7	Netherlands	51,114	Italy	94,795	Netherlands	134,468	Ireland	169,542
8	Hong Kong	44,497	China	83,971	Italy	113,086	Singapore	166,806
9	Canada	42,979	Ireland	71,437	Ireland	107,301	Netherlands	150,988
10	China	36,269	Canada	65,176	Singapore	101,212	Korea	112,647

Source: International Monetary Fund, Balance of Payments Statistics Yearbook and data files.

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



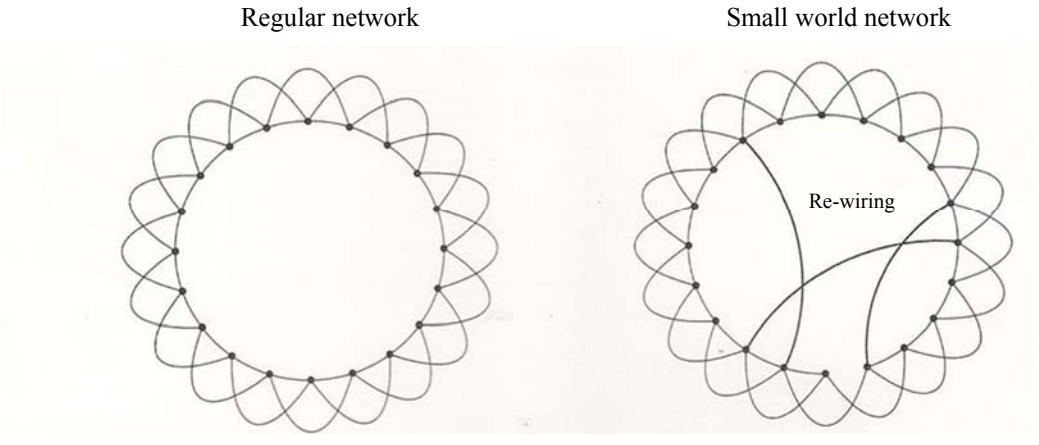
Source: Bureau of Economic Analysis, U.S. Department of Commerce.

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 Isl	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 [20], 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.
Number of H-1B visas issued (person)	visa	H-1B visa 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. Panel data analysis results

	Pooling model		Fixed effect model		Random effect model	
networkreadiness	1863.89	1702.78	1610.98	1574.90	1429.58	1426.60
	[1.549]	[1.426]	[3.022]***	[2.985]***	[2.736]***	[2.768]***
nipercap	0.13	0.17	0.37	0.37	0.35	0.35
	[1.827]*	[2.357]**	[10.705]***	[10.838]***	[10.484]***	[10.755]***
englishdummy	1619.33	849.50			1132.68	339.90
	[1.578]	[0.797]			[0.375]	[0.111]
visa		0.12		0.13		0.14
		[2.431]**		[2.461]**		[2.792]***
_cons	-5007.77	-5382.91	-8740.60	-9053.81	-7910.88	-8225.97
	[-1.212]	[-1.313]	[-3.626]***	[-3.790]***	[-2.774]***	[-2.900]***
N	273	273	273	273	273	273
R-squared	0.15	0.17				
Adj-R-squared	0.14	0.15				
within			0.37	0.38	0.37	0.38
between			0.13	0.15	0.14	0.15
overall			0.13	0.16	0.14	0.16
Model with visa	F test: F(30, 239) = 125.89, p-value = 0.0000 Hausman test: chi2(2) = 1.72, p-value = 0.4228 Breusch and Pagan test: chibar2(01) = 937.86, p-value = 0.0000					

Note: *, **, and *** indicate significance at the 10%, 5%, 1% levels, respectively.

Table 6. Basic statistics and correlation matrix

Variables	Mean	SD	A	B	C	D	E
A usaimp	6,855	8,325	1.000				
B visa	3,624	10,878	0.042	1.000			
C networkreadiness	4.523	0.773	0.360	-0.228	1.000		
D nipercap	22,645	13,036	0.359	-0.317	0.861	1.000	
E englishdummy	0.308	0.462	0.128	0.265	0.133	0.075	1.000

Table 7. Partial correlation matrix

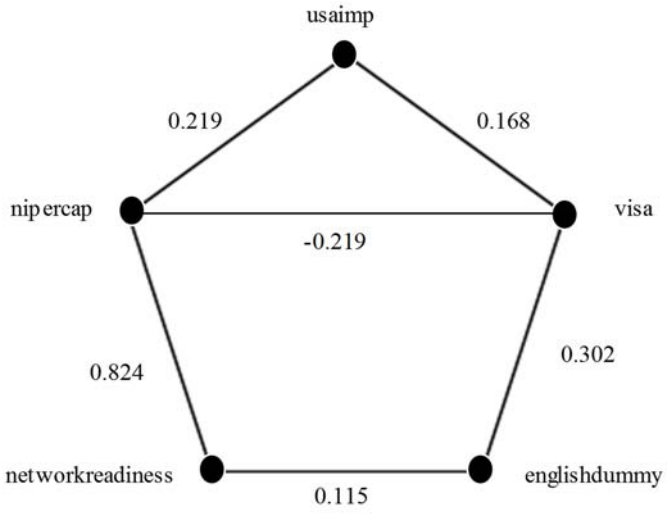
Variables	A	B	C	D	E
A usaimp	—				
B visa	0.147	—			
C networkreadiness	0.087	0.042	—		
D nipercap	0.143	-0.248	0.825	—	
E englishdummy	0.049	0.287	0.108	-0.011	—

Table 8. Covariance selection and partial correlation matrix

Variables	Graphical modeling (BIC : 37.580)				
	A	B	C	D	E
A usaimp	—				
B visa	0.168	—			
C networkreadiness	0.000	0.000	—		
D nipercap	0.219	-0.219	0.824	—	
E englishdummy	0.000	0.302	0.115	0.000	—

Note: Underlined figures converted to zero based on the BIC.

Figure 3. Graphical modeling analysis results



Note: Represents the partial correlations between the variables