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Shinozaki, Akihiko
Faculty of Economics, Kyushu University

Kubota, Shigehiro
InfoCom Research, Inc.

Suenaga, Yudai
Nagasaki Prefectural Government

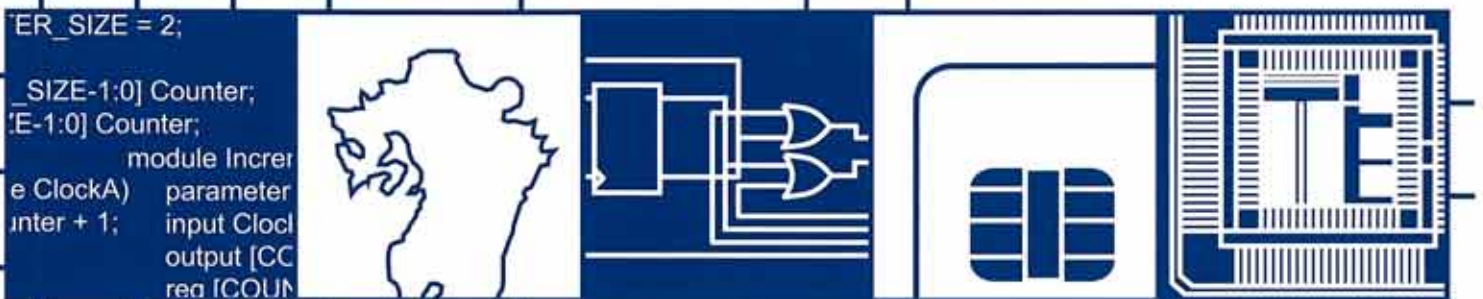
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Akihiko Shinozaki, Shigehiro Kubota, Yudai Suenaga

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Abstract

In this study, we analyze the growth trajectory of service exports from developing countries to the U.S. based on the network theory. We first conducted a panel data analysis covering 31 countries from 1999 to 2008, the decade right before the 2008 global financial crisis. The study uses data for each country's service exports to the U.S., number of H-1B visa holders, GNI per-capita, network readiness index, and English proficiency factors. We then use graphical modeling analysis to illustrate the trajectory and interaction among these factors. The analyses yield two observations. First, per-capita income and H-1B visa holders have the most direct effect on service exports to the U.S. Second, the lower a country's income level is, the more intensively cross-border personal networks are fabricated through H-1B visas. The results of this study suggest that international human resource networks were a catalyst for low-income economies such as India to expand service exports to the U.S., although service trade is traditionally the domain of high-income countries.

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

¹ This paper represents a consolidated study by Suenaga, et al. (2014) and Kubota, et al. (2016) based on a revised model and updated dataset in English to aid international discussions.

1. Introduction

The recent trend in outsourcing best symbolizes the growth in cross-border service trade, which includes business, professional, and technical services such as computer and data processing services. This study aims to clarify the impact and interactions between the various contributing factors such as income levels, IT network availability, cross-border networks of human resources, and English language skills.

According to UNCTAD (2009), the global offshoring market expanded 2.6 times between 1998 and 2008, approximately the decade that followed the Asian currency crisis. During this period, the U.S., the largest service trade market in the world, witnessed growth in international service imports by a factor of 2.2. The growth momentum was especially strong in the offshoring segment, which expanded by 3.7 times. Consequently, this segment's share of overall service imports jumped from 18% in 1998 to 25% by 2008. Its volume exceeded travel services, cargo and transportation services, and even financial and insurance services by 2008.

Such trends in the U.S. have a significant ripple effect on the economies of the trade partner countries 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, with the contribution to aggregate economic growth accelerated by 2.8%, from 3.0% in the 1980s to 5.8% in the 2000s.

It is worth noting that there are some limits to interpreting this expansion in the trade in services

through the traditional theory of international economics, such as the flying geese pattern of development, which deals mainly with the trade of goods such as automobiles or electronic devices. To address this gap, we employ network theory in this study for an empirical analysis of the enabling factors of service trade, focusing on the strength of cross-border human resource networks. Specifically, we conduct a panel data analysis using a dataset of service exports to the U.S., the number of H1-B visa holders, network readiness index, GNI per-capita, and an English proficiency dummy for 31 countries during 1999-2008. Moreover, we investigate and illustrate the mutual links between the five independent variables with a graphical modeling analysis. We hope to contribute some empirical analyses to clarify the framework of factors influencing the expansion in service exports to the U.S.

2. Theoretical framework

In this study, we focus on human resource networks in knowledge-based business such as the information service industry as a driving force to expand cross-border trade. As Chandler (2000) notes,² the U.S. economy transformed, “from the Industrial into the Information Age in the last decade of the twentieth century,” and traditional development theories often adopt the basis underlying Petty-Clark’s law, i.e., that major productivity shifts from the agriculture to the manufacturing industry, and from then on to the services industry. In India’s case, however, the economy appears to be “leapfrogging” straight from an agriculture-centric economy into a

² See Chandler (2000), p.3.

software-intensive Information Age, somewhat bypassing the manufacturing-based Industrial Age.³

Likewise, concepts such as the “flying geese” or “catch-up” model of development are a familiar feature of international trade theories (Kojima, 2000). In contrast, offshoring, which best exemplifies the international services trade model between the U.S. and India, is a new phenomenon in the Information Age. Therefore, it seems reasonable that traditional theoretical frameworks do not sufficiently capture and describe this development trajectory.

We thus employ network theory as the theoretical framework to understand this “leapfrogging” development, with a special focus on cross-border human resource networks.⁴ This theory is popular in recent management studies and contains three major concepts of value to our study: small world, re-wiring, and multi-level networks. A regular network has highly-ordered and proximity-based features in its structure, while a “small world” network has a few random links in addition to the regular network.

(Figure 1)

In general, individuals and organizations usually create a regular network with limited and close links with each other. If they randomly “re-wired” some of their links to a distant node, they can make a “small world” and benefit from new links. In other words, “re-wiring” provides a proximity effect between distant and different entities, which leverages and revitalizes the entire network.

The economy consists of several layers of networks such as personal networks, organizational

³ Fong (2009) represents a comprehensive review of the leapfrogging development. Singh (1999) illustrates Indian telecommunication industry from the viewpoint of leapfrogging development.

⁴ Blinder (2006) points out that in modern economies where production and jobs shift towards services, “much comparative advantage derives from human effort rather than natural conditions.”

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, country or organizational-level relationship building influences individual-level behavior and performance (Hitt et al., 2007).

These network theory concepts are useful to analyze the offshoring business model in U.S. firms. Based on re-wiring, small world, and multi-level networks, one could argue that a large number of H1-B visa holders, i.e., competent students, professionals, and technical experts, emigrate from many countries to the U.S. (re-wiring). They then join U.S. multinational firms or start their own businesses, consequently creating greater cross-border business networks with their home 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).⁵

To empirically investigate this “leapfrogging” development based on network theory, the following section reports the panel data and a graphical modeling analyses covering 31 countries from 1999 to 2008, the decade in which offshoring began to take off worldwide.

4. Empirical analysis

4-1. Dataset

Table 1 summaries the countries and data in this study. These include: (1) value of service exports from each country to the U.S., U.S. Department of Commerce (usaimp); (2) number of H1-B

⁵ Suenaga et al. (2014) employed this framework.

visas issued for highly-skilled technical workers, U.S. Department of State (visa) as a proxy for human resource networks; (3) the World Economic Forum network readiness index (networkreadiness) as a proxy of IT network availability; (4) per-capita GNI from the World Bank database (nipercap) as a proxy for each county's income level or development stage; and (5) English dummy variables equal to 1 if English is an official or subsidiary official language and 0" otherwise, as a proxy of English proficiency.

(Table 1) (Table 2)

Due to data availability limitations, this study focuses on 31 countries from 1999 to 2008, a decade between right after the currency crisis in Asia and Russia and the global financial crisis triggered by the Lehman Brothers bankruptcy, when offshoring coincidentally grew significantly worldwide. Table 3 presents a summary of the basic statistics and correlation matrix of the variables.

(Table 3)

4-2. Panel data analysis

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

$$usaimp = \alpha + \beta \cdot visa + \gamma \cdot networkreadiness + \delta \cdot nipercap + \varepsilon \cdot englishdummy \dots(1)$$

In this model, the dependent variable refers to the value of service exports from each country to

the U.S. (usaimp), with the following independent variables: the number of U.S. H-1B visa issued as a proxy for highly skilled human resource networks (visa), IT network availability (networkreadiness), income level or development stage (nipercap), and the English proficiency dummy variable (englishdummy).

We estimate model (1) for three categories: the pooling model, the fixed effects model, and the random effects model. Table 4 reports the results of the estimations. 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 the model without the visa variable. In other words, the results strongly verify that highly skilled human resource networks with the U.S. have statistically significant effects on the growth of service exports to the U.S. Additionally, per-capita income shows a similarly positive effect on service trade with the U.S.; service trade with the U.S. is more intensive among higher income countries.

(Table 4)

This leads to a 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 (Table 3) is more puzzling. It appears to show a negative correlation between human resource networks (visa) and income level (nipercap), despite their positive effects on the service trade (usaimp). To address these questions, we must clarify how individual variables interact and affect service exports to the U.S. We do this by employing a graphical modeling methodology to clarify the mutual affects between variables and to illustrate the clear trajectory of their effects on service exports to the U.S.

4-3. Graphical modeling analysis

One problem with multivariate model estimates is that the coefficients of independent variables include not only the direct impact of independent variables on dependent variables, but also that of other various factors. Therefore, we must remove pseudo-correlations and rigorously distinguish between direct and indirect relationships for a detailed examination. One way to do this is by observing the partial correlation coefficient matrix in Table 5.

(Table 5)

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

In this study, we employ a reduced model methodology, starting with a full model with relationships established between all combinations of variables, and then systematically remove relationships in which the partial correlation coefficient between variables is extremely small. We then finally select an optimal model based on the Bayesian information criterion, or BIC. Table 6 presents the resulting partial correlation matrix and Figure 2 illustrates the results of the graphical modeling analysis.

⁶ See Dempster (1972) for theoretical background.

(Table 6) (Figure 2)

Table 6 and Figure 2 reveal the structural relationship between the variables. First, per-capita GNI and H-1B visa have a positive and the most direct effect on service exports to the U.S. Second, we observe a negative relationship between per-capita GNI and H-1B visa. Third, networkreadiness has an indirect effect on service exports to the U.S., through per-capita GNI or H-1B visa. Fourth, the English factor has a positive relationship with both networkreadiness and H-1B visa, and an indirect influence on service trade with the U.S. through networkreadiness or H-1B visa.

In terms of network theory, the regular network in Figure 1 illustrates the proximity of income levels to cross-border service trade. In other words, developed countries with high income levels close to the U.S. generally tend to have higher 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. Consequently, these 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.

Incidentally, the English proficiency factor has an indirect effect on service exports through networkreadiness, which has a higher index in high-income countries, or through H-1B visa, which the U.S. issues more frequently to individuals from low-income countries. It is likely that English, which is the most dominant language in the internet community, provides a platform for active information flows and interpersonal communication.

5. Conclusion

We adopted network theory in this study for an empirical analysis of the growth trajectory of service exports from developing countries to the U.S., with a special focus on cross-border human resource networks. We conducted a panel data analysis covering 31 countries from 1999 to 2008 using dataset of service exports to the U.S., number of U.S. H-1B visa holders, GNI per capita, network readiness index, and English proficiency factors. In addition, we explored and illustrated the interconnections between the five independent variables using graphical modeling analysis. Our study yielded two findings: first, income level and the number of H-1B visa holders have the most direct and positive effect on service exports to the U.S., second, individuals in developing countries tend to desire H-1B visa 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. Traditionally, higher-income economies had more robust service trade with the U.S. The significance of our research results lies in the fact that it traced a clear path of how these trade links changed via re-wiring in the form of labor movement from developing countries.

In closing, we note that our study leaves several questions unanswered. To begin with, the target period of analysis is limited to a 10-year period between 1999 and 2008, when offshoring had just begun to take off. As UNCTAD (2009) rightly pointed out, the global economy has drastically changed since the late 2000s. Therefore, it is necessary to conduct a further and more detailed examination by extending and grouping the sample period. Furthermore, data availability constraints

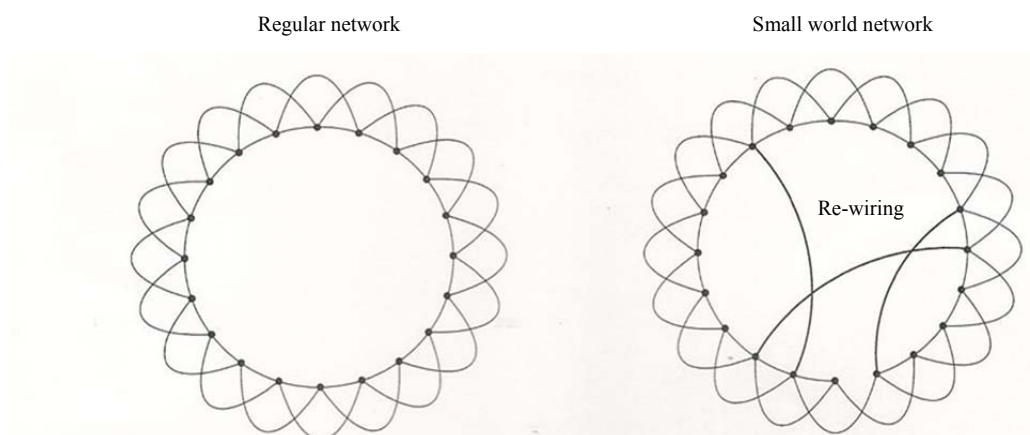
limited the scope of the analysis to just 31 countries. Thus, future studies should collect and build a larger dataset to cover more countries by mining original statistics provided by individual countries in addition to those published by international organizations.

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List of figures and tables

Figure 1. Regular and small world networks



Source: Nishiguchi (2009), with some modifications.

Table 1. Dataset

Variable	Abbreviation	Sources
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 <i>The Global Information Technology Report</i> 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 2. Countries

Region	Countries and economies
America	United States*, Canada*, Mexico*, Brazil, Argentina, Chile*
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 3. Basic statistics of variables and their 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 nipercep	22,645	13,036	0.539	-0.0317	0.861	1.000	
E englishdummy	0.308	0.462	0.128	0.265	0.133	0.075	1.000

Table 4. Panel data analysis results

	pooling model		fixed effect model		random effect model	
	b/t	b/t	b/t	b/t	b/t	b/t
networkreadiness	1863.89 [1.549]	1702.78 [1.426]	1610.98 [3.022]***	1574.90 [2.985]***	1429.58 [2.736]***	1426.60 [2.768]***
nipercep	0.13 [1.827]*	0.17 [2.357]**	0.37 [10.705]***	0.37 [10.838]***	0.35 [10.484]***	0.35 [10.755]***
englishdummy	1619.33 [1.578]	849.50 [0.797]	0.00 [.]	0.00 [.]	1132.68 [0.375]	339.90 [0.111]
visa		0.12 [2.431]**		0.13 [2.461]**		0.14 [2.792]***
_cons	-5007.77 [-1.212]	-5382.91 [-1.313]	-8740.60 [-3.626]***	-9053.81 [-3.790]***	-7910.88 [-2.774]***	-8225.97 [-2.900]***
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
Hauseman test			chi2(2) = 1.72 Prob>chi2 = 0.4228			
N	273	273	273	273	273	273

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

Table 5. Partial correlation matrix

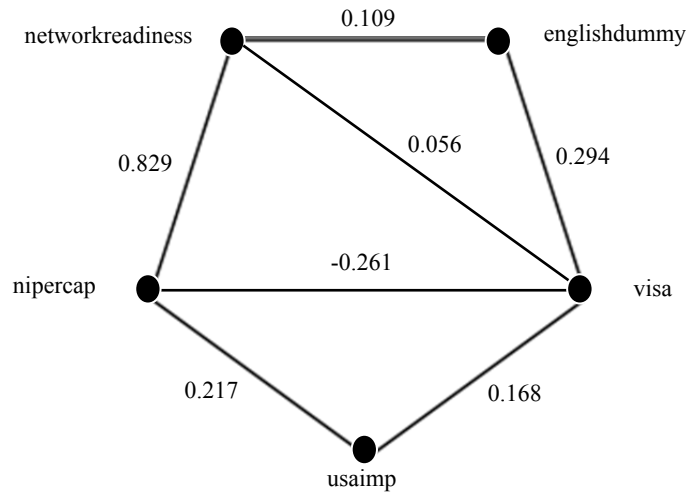
Variables	A	B	C	D	E
A usaimp	—				
B visa	0.147	—			
C networkreadiness	0.087	0.042	—		
D nipercap	0.143	-0.248	0.825	—	
E englishdummy	0.049	0.287	0.108	-0.011	—

Table 6. Covariance selection and partial correlation matrix

Variables	Graphical modeling (BIC : 49.302)				
	A	B	C	D	E
A usaimp	—				
B visa	0.168	—			
C networkreadiness	<u>0.000</u>	0.056	—		
D nipercap	0.217	-0.261	0.829	—	
E englishdummy	<u>0.000</u>	0.294	0.109	<u>0.000</u>	—

Note: Underlined figures are converted to zero based on BIC standard statistics.

Figure 2. Graphical modeling analysis diagram



Note: Figures represent partial correlations between the variables

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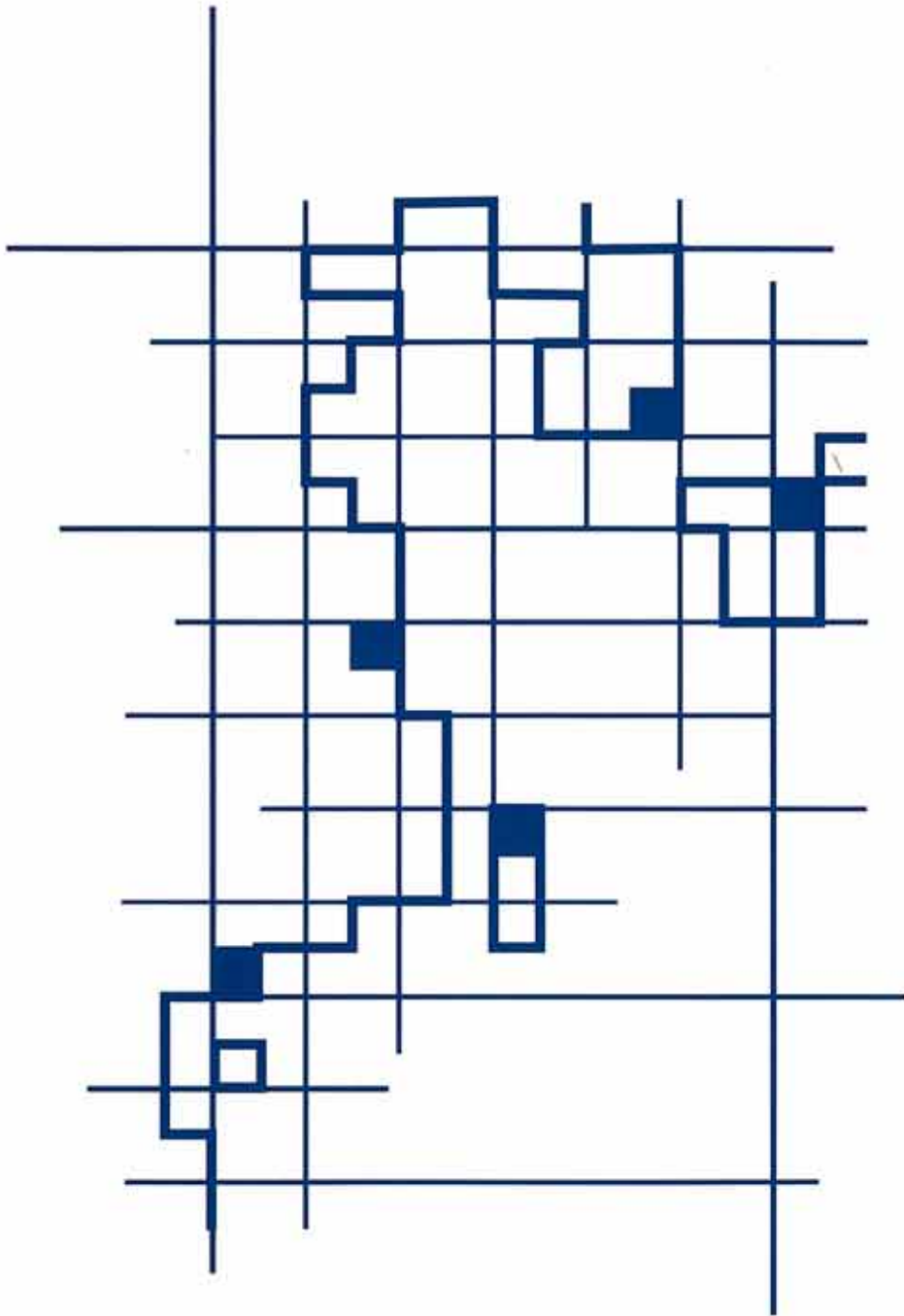
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Sawara-ku, Fukuoka 814-0001

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