Network Externalities, Competition, and Trade: East Asian Perspectives

Toru Kikuchi (kikuchi@econ.kobe-u.ac.jp)[1]

and

Chiharu Kobayashi (ckobayas@mail.doshisha.ac.jp)

Abstract

There are large deviations in access to telecommunications infrastructure and trading patterns within the East Asian region. We examine how the network externalities of communication activities and trading opportunities interact to determine the structure of comparative advantage. These interactions are examined by constructing a simple two-country, two-good model of trade involving a country-specific communications network sector. The role of competition of network service providers, which allows users of a network easier access to other networks, is also explored. (JEL Classification: D43, F12, L13)

1. Introduction

As economic integration in East Asia progresses, trade patterns within the region are displaying an ever-greater complexity: Though intra-industry trade is growing in importance, the share of inter-industry trade still accounts for majority. In other words, trade and production structures vary widely within East Asian countries.[2] Related to such phenomena, it is widely recognized that the growing connectivity of individuals and organizations achieved through new types of communications networks (e.g., the Internet

[1] We would like to thank Michael Gilroy, Masami Imai, Fukunari Kimura, Takeo Nakao, Elaina Rose, Kang Shi, Ryuhei Wakasugi and the participants of *Korea and the World Economy IV* conference for their kind suggestions. This paper has also benefited from comments by the editor and two anonymous referees. The first author is grateful for financial support provided to the 21st Century Center of Excellence Project by MEXT (Ministry of Education, Culture, Sports, Science and Technology). The second author is grateful for financial support provided to "Academic Frontier" Project, 2004–2008, by MEXT.

[2] In this respect, Fukao *et al.* (2003, pp. 475–6) conclude that, in East Asia, there exist much higher barriers against intra-regional trade and FDI than in other regions (e.g., EU), which are likely to reduce intra-industry trade. They also suggest that there is a high income gap among East Asian countries, which is likely to reduce horizontal specialization because of the differences in the industrial structure and preferences.

and satellite communications networks) and a consequent increase in the information flow play an important role as a determinant of trade structures.[3] East Asian countries have become increasingly aware that both the quality and the scale of their communications infrastructure have become crucial factors determining their comparative advantage.[4]

There are large deviations in development levels of telecommunications infrastructure and computer technology within East Asian countries. There are several reasons for these deviations, such as lack of infrastructure. The cost of using telecommunications and accessing the Internet is one of the most obvious barriers. Related to this, Hargittai's (1999) analysis of Internet connectivity concludes that the regulatory environment and its influence on competition have the largest impact on Internet penetration, that is, the competition between telecom service providers increases Internet connectivity. Thus, we can say that competition between service providers is a key feature of communications networks. The worldwide trend toward deregulation and privatization in telecommunications began in the 1980s and accelerated in the 1990s. Until late in the 1990s, however, this trend lagged in East Asian countries. In 2000, only half of the telecommunications operators in the Asia-Pacific region were privately owned, compared with 63% in Europe and 74% in the Americas.[5] Furthermore, just under 40% of local telephone service providers in the region experienced any competition. However, in recent years, East Asian countries have undergone dramatic regulatory and policy changes, including introducing competition into the sector, establishing a separate regulatory agency and privatizing incumbent carriers (Table 1).

Table 1: Level of Competition in Selected East Asian Economies
For Selected Telecommunication Services, 2004

Economy	Local Services	Int'l	Separate Regulator	Status of Main Fixed-Line Operator
China	Partial	Partial	No	State-Owned and Partially Privatized
Hong Kong	Yes	Yes	Yes	Privatized
Indonesia	Partial	Partial	Yes	Partially Privatized
Japan	Yes	Yes	No	Fully Privatized
Korea	Yes	Yes	Yes	Fully Privatized

[3] See Cairncross (1997), Sidorenko and Findlay (2001).

[4] According to this line, Matoo *et al.* (2001) find that countries with the fully liberalized telecommunications sector can grow up to 1.5% per year faster than those with more restrictive policies. See, also, Li and Xu (2002).

[5] See, ITU (2000). According to this, Yusuf and Evenett (2002, ch. 5) conclude that East Asia still has much catching up to do.

Philippines	Yes	Yes	Yes	Fully Privatized
Singapore	Yes	Yes	Yes	Partially Privatized
Taiwan	Yes	Yes	No	Partially Privatized

Source: ITU (2004)

There is another key feature of communications networks: the existence of strong *network externalities*. Network externalities occur if the value of the good (or the service) to a user depends on the number of users using the same or similar good (service).[6] Although network externalities are often regarded as 'consumption externalities,' recent literature on communications networks emphasizes the role of network externalities *in the production sectors*: due to an increased information flow, each worker's productivity depends on the size of the network.[7] Given that there are strong network externalities in the production sectors, it is important to capture a certain number of users to attain a favorable size of networks. In other words, the size of one country's network plays an important role as a determinant of trade structures. The world's broadband success stories, such as one in Korea, share such key factors (e.g., pro-competitive telecommunications policies and regulations, special incentives for the provision of broadband to rural areas and those population groups with less attractive economic characteristics, and so on). The seminal contribution to emphasizing the importance of competition between service providers (and network externalities) is Katz and Shapiro (1985).[8] However, as their model is based on a single (or closed) market for one consumption good, the role of competition between providers as a determinant of comparative advantage is downplayed in the analysis. Since the role of competition between *domestic* service providers is emphasized in the *globalized* world, it seems important to explore the roles of both (*a*) network externalities in production and (*b*) competition between service providers in the trading-economies setting.

As its primary contribution, we examine how the network externalities of communication activities, competition between service providers, and trading opportunities interact to determine the structure of comparative advantage between countries, which also

[6] There is an important concept related to network externalities – *interconnectivity* –which allows users of a network to communicate with users of other networks. Cremer *et al.* (2000) explore the role of interconnectivity between Internet Service Providers (ISPs) in the closed economy setting. Kikuchi (2003, 2004) explores the role of interconnectivity using a monopolistically competitive trade model.

[7] For example, David (2000) argues that the development of Internet technology has opened the door to an entirely new class of organization-wide data-processing applications and has standardized the potential for collective and cooperative forms of work organization. Also, he has emphasized the role of network externalities in the production sectors.

[8] See Katz and Shapiro (1994), Economides (1996), Shy (2001) for surveys of the relevant literature. Liebowitz and Margolis (1994) distinguish between network effects and network externalities, questioning the validity of the latter concept.

helps to understand the role of communications networks in East Asian trade patterns. For these purposes we construct a simple two-country, two-good model of trade with country-specific communications networks. It will be shown that a comparative advantage in the good that requires network services is held by the country with competitive service providers (i.e., a larger number of providers). It is also emphasized that, given that there are strong network externalities, differences in competitive environment of service providers work as a catalyst for international specialization. In other words, there is a circular process between network expansion and trade creation.

In the next section we present the basic model. The role of competition between network service providers as a determinant of trade patterns is considered in Section 3, followed by concluding remarks presented in Section 4.

2. The Model

Consider a world economy consisting of two countries, Home and Foreign.[9] There are two goods: a primary commodity which is produced only by labor and a high-tech product which is produced with both labor and communications services. Communications services are assumed to be provided by country-specific *network service providers*. There are n (n*) identical providers in Home (Foreign):[10] they are playing a Cournot competition. Providers will be indexed by label i (i = 1, ..., n). Let x_i denote the size of the i-th provider (i.e., the number of subscribers), y_i the size of the network with which the i-th provider is associated, and let z be the total number of network users. For example, when n providers are fully interconnected, $z = y_i = x_1 + ... + x_n$ holds.

Let the high-tech product be the numeraire and p indicate the relative price of the primary good. The primary good is produced under constant returns technology; units are chosen such that its unit input coefficient is unity.

Each country is populated by a continuum of workers with population L. Each worker is endowed with one unit of labor and some level of human capital for the production of the high-tech product, which is measured by index r. r is uniformly distributed over the interval [0, L]. Each worker's productivity is also affected by the level of network externalities, vy_i^e, where v ($v \leq 1$) is a valuation parameter and y_i^e is the worker's expectation of the size of the (i-th) network. The v term captures gains through increased information flow between individuals: if more workers join the communications

[9] The structure of this model is based on Kikuchi (2005), which emphasizes the role of interconnectivity as a determinant of trade patterns. However, in this paper, we emphasize the role of competitive environment of service providers as a determinant of trade patterns.

[10] To keep matters simple, we assume that the number of providers is exogenously determined. Government regulation could be a major factor. Differences in the level of entry fixed cost could also be an important factor. These kinds of extension need further consideration.

network, each worker can collect information more efficiently. It is simply assumed that a type-r worker can produce $r + vy_i^e$ units of the high-tech product.

Workers have the choice of either supplying labor for the production of the primary good or becoming a supplier of the high-tech product, and workers will become the latter only if they connect to a communications network. To connect to the i-th provider's network, each worker must pay a connection fee, f_i, in exchange for unlimited access up to the maximum throughput of their particular connection. A type-r worker chooses to connect to the network for which

$$r + vy_i^e - (f_i + p) \qquad (1)$$

is largest. This can be interpreted as follows. If $r + vy_i^e - f_i \geq p$ holds for a particular worker, that worker pays the connection fee and starts to produce the high-tech product. However, if $r + vy_i^e - f_i < p$ holds, that worker chooses not to connect to the network and produces the primary good instead. As p rises, more workers choose not to connect to the network. Thus, one can interpret $(f_i + p)$ as a connection fee including the outside option.

In equilibrium, providers i and j will both have a positive number of subscribers only if

$$(f_i + p) - vy_i^e = (f_j + p) - vy_j^e \ , \qquad (2)$$

where $(f_i + p) - vy_i^e$ is the connection cost adjusted for network size.[11] Let Φ denote the common value of this cost. For a given value of Φ, only those workers for whom $r > \Phi$ become producers of the network good. Given the uniform distribution of r, there are $L - \Phi$ workers who choose to connect to the networks. Thus, if the total number of network users is z, $z = L - \Phi$ holds. Then, by substituting $\Phi = (f_i + p) - vy_i^e$ into this, we obtain the condition for the connection fee

$$f_i = L - p + vy_i^e - z. \qquad (3)$$

To simplify the analysis, we assume that the production cost for each provider is equal to zero. Thus the i-th provider's profits are

$$\pi_i = x_i f_i = x_i(L - p + vy_i^e - z). \qquad (4)$$

Now consider the equilibrium supply level of the high-tech product. By Equations (1) and (3), a type-r worker can produce $r + z + f + p - L$ units of product. Furthermore,

[11] (2) implies that all the existing networks in equilibrium provide necessarily the same 'surplus,' which is defined as (1).

only those workers for whom r is greater than $L-z$ join the network, while the others choose to produce the primary good. Integrating all workers who do connect to the networks, we can obtain the total output of the high-tech product:

$$S(z) = \int_{L-z}^{L} (\rho + z + f + p - L) d\rho = (z^2/2) + (f + p)z. \quad (5)$$

We can interpret this as the supply function of the high-tech product. This function is represented by *OS* in Figure 1(b). As the total number of network users becomes larger, the average productivity of each high-tech product supplier rises (this is shown as lines *OA* and *OA'* in Figure 1(b)). The economy thus has a supply function that exhibits increasing returns to the size of the networks. More noteworthy is that, in terms of income inequality between sectors, as the size of the networks becomes larger, income inequality between sectors increases.

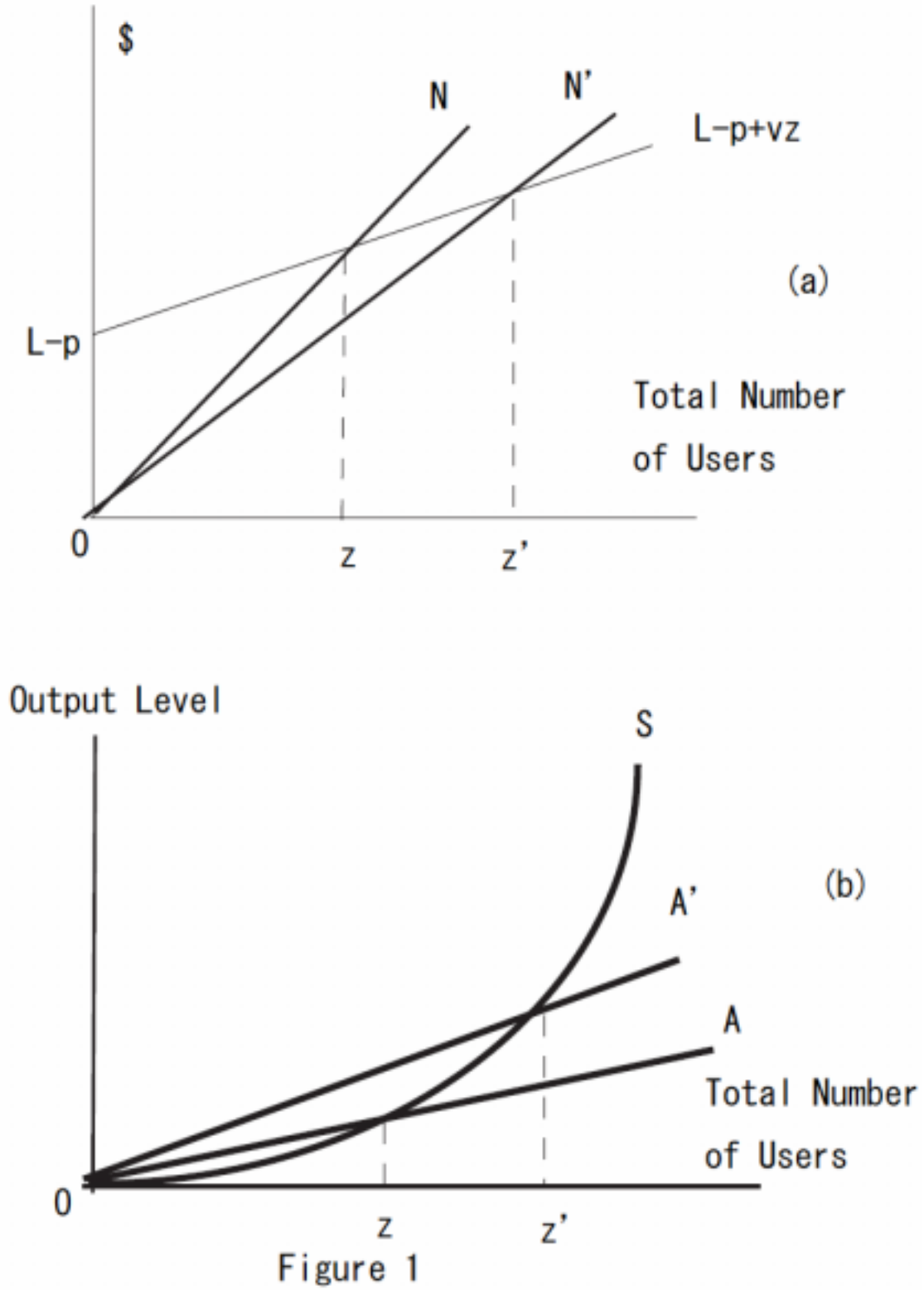
$
N
N'
L-p+vz
(a)
L-p
Total Number
of Users
0
z
z'
Output Level
S
A'
(b)
A
Total Number
of Users
0
z
z'

Figure 1

Depending on the interconnectivity between providers, several cases can emerge as the production equilibrium. For simplicity, let us assume that n providers are fully interconnected (i.e., $y_i = x_1 + \ldots + x_n = z$).[12] A user who connects to one network can communicate with users of other networks. Interconnectivity expands the size of each network to the total membership of all providers. This raises the productivity gains enjoyed by a worker who subscribes to only one provider's network because network externalities depend on the total size of the network. Thus, maximizing (4) with respect to x_i, we obtain

$$x_i = L - p + vz^e - z.$$

Imposing the requirement that in equilibrium workers' expectations are fulfilled (*Fulfilled Expectation Equilibrium*), $z^e = z = nx$ holds. Then we obtain the equilibrium sales level for each provider

$$x = (L - p)/(n + 1 - nv). \qquad (6)$$

By summing Equation (6) over all providers, we obtain the total network as a function of the relative price of the high-tech product ($1/p$).

$$z(1/p) = [n(L - p)]/(n + 1 - nv). \qquad (7)$$

The equilibrium is depicted in Figure 1(a). The horizontal axis shows the total size of the network, z, while the vertical axis shows the values of $L-p+vz$ and $[(n + 1)z]/n$. Equilibrium is obtained at an intersection of two curves: Line ON represents $[(n+1)z]/n$ while the other line represents $L-p+vz$. As p becomes smaller, the line will shift upward, which results in a larger total size of the network.

Now turn to the impact of an increased competition between providers. An increase in the number of service providers can be shown as a clockwise shift of line ON (e.g., ON'), which also results in a larger size of the network. As the total number of network users becomes larger, the average productivity of each worker in the high-tech product sector rises.

There are two sources of these gains: (1) as the market of network services becomes more competitive, each provider chooses to set a lower connection fee, which attracts more workers and (2) as more workers join the networks and the total number of subscribers increases, each infra-marginal worker can attain higher productivity.

3. Competition between Providers and the Impact of Trade Integration

[12] As space is limited, we concentrate on the nature of the equilibrium and pay scant attention to the factors that determine interconnectivity.

Suppose that the only difference between two countries is the number of network service providers. Without loss of generality, Home is assumed to have more providers than Foreign (i.e., $n > n^*$). Note that an increase in the number of providers shifts the supply curve of the high-tech product to the right (Figure 2). Also, let each country have the same demand function for the high-tech product, $D(1/p)$, which is shown as a downward sloping curve in Figure 2.[13] In this case, from Figure 2, Home has the lower autarky price of the high-tech product (i.e., $(1/p) < (1/p^*)$).

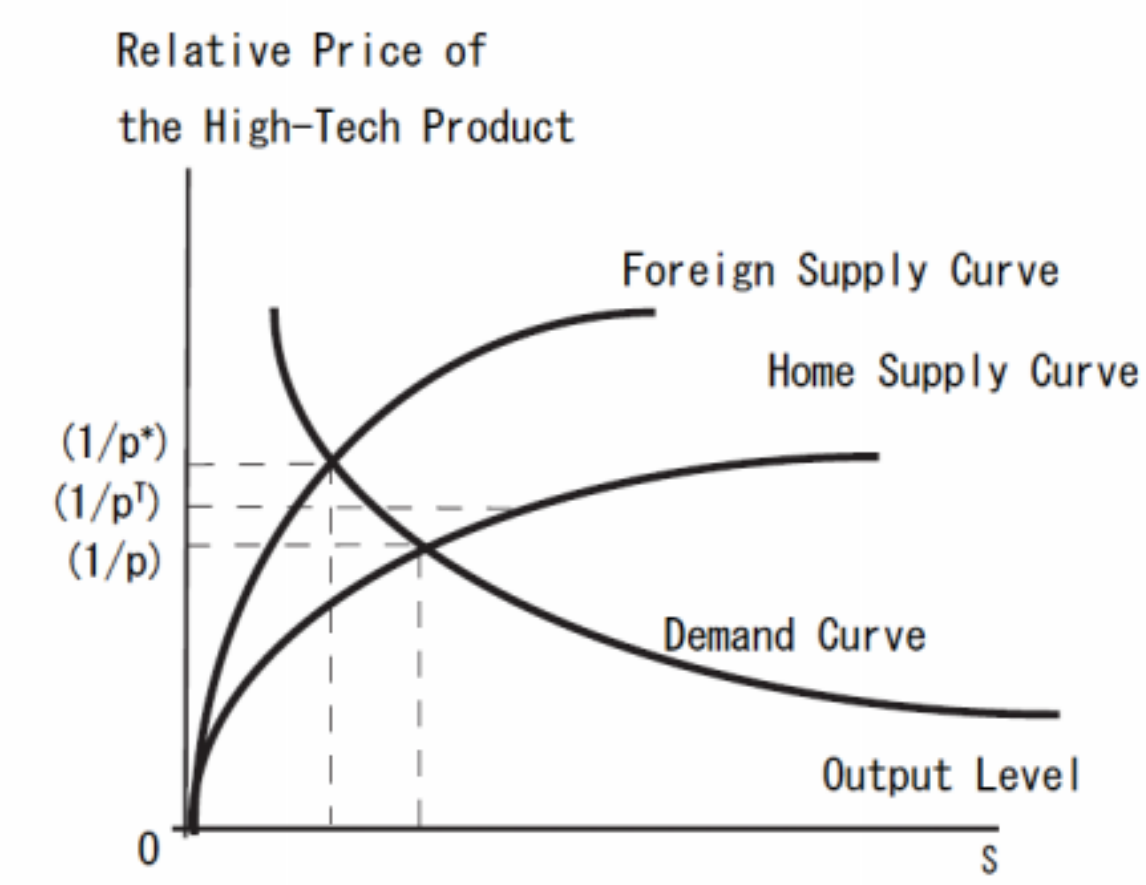

Figure 2

Now suppose that two countries (Home and Foreign) open their goods markets and

[13] Note that we assume away any income effect.

have a trade relationship. The opening of trade provides an opportunity for entry into Home's high-tech product sector because, with expanded network size, the average productivity of Home workers is much higher than that of Foreign workers. On the other hand, marginal workers in Foreign's high-tech product sector stop producing the high-tech product due to the reduced relative price. Thus the size of Home networks with competitive providers will expand, while Foreign ones with less competitive providers contract. The differences in the network sizes will be reinforced by this entry-exit process. That is, there will be a *cumulative process* in which trading opportunities bring an opportunity for larger networks, and the increased sizes of the networks promote (through intensified network externalities) exports. This process will continue until the price differential between countries disappears ($(1/p^T)$ in Figure 2). Superscript T indicates the trading equilibrium value.

Proposition 1: *A comparative advantage in the high-tech product is held by a country with competitive service providers. If the two countries commence free trade from autarky, the country with more competitive providers incompletely specializes in the high-tech product and the country with less competitive providers incompletely specializes in the primary good.*

[Proof]
In the trading equilibrium, the following conditions must be held:
$S(z(1/p^T)) > S^*(z^*(1/p^T))$ and $D(1/p^T) = D^*(1/p^T)$.
This implies that, due to intensified network externalities, Home becomes an exporter of the high-tech product: $S(z(1/p^T)) - D(1/p^T) > 0$. (Q. E. D.)

Proposition 1 implies, given that there are strong network externalities, differences in the number of service providers (i.e., the level of competition) result in a large variation in specialization patterns. This may help to explain large deviations in both the development of communications infrastructure and trading patterns within the East Asian region. This proposition also emphasizes the importance of competition policy for the *domestic* communications sector to survive in the *globalized* world economy.

Since the size differential between country-specific networks is magnified through international trade, we also obtain the following proposition.

Proposition 2: *Opening international trade increases inequality in the country that exports the high-tech product and reduces inequality in the country that exports the primary good.*

[Proof]
Since $(1/p) < (1/p^T) < (1/p^*)$ holds, the size of the country-specific network changes as follows: $z(1/p^T) > z(1/p)$ and $z^*(1/p^T) < z^*(1/p^*)$. This implies that Home's income inequality becomes greater while Foreign's becomes smaller. (Q.E.D.)

4. Concluding Remarks

In this study, we examine how the network externalities of communication activities, competition between service providers, and trading opportunities interact to determine the structure of comparative advantage between countries, which also helps to understand the role of communications networks in East Asian trade patterns. It should be emphasized that differences in competitive conditions among country-specific network service providers determine the comparative advantages of countries: although each country is endowed with equal amount of labor, the country with competitive providers can attain higher productivity through increased information flow. More noteworthy is that there is a circular process between network expansion and trade creation which further affects income inequalities within each country. Although these results are derived under the assumption that communications networks are purely country-specific, it appears that something similar to this will occur in more general settings.

The present analysis must be regarded as very tentative. Hopefully it provides a useful paradigm for considering how communications infrastructure works as a driving force for the development of the East Asian region.

References

[1] Cairncross, F. *The Death of Distance,* Boston, Mass.: Harvard Business School Press, 1997.

[2] Cremer, J., P. Rey, and J. Tirole. "Connectivity in the Commercial Internet," *Journal of Industrial Economics,* 48, 2000, pp. 433–72.

[3] David, P. A. "Understanding Digital Technology's Evolution and the Path of Measured Productivity Growth," in *Understanding the Digital Economy*, edited by E. Brynjolfsson and B. Kahin. Cambridge, Mass.: MIT Press, 2000, pp. 49–95.

[4] Economides, N. "The Economics of Networks," *International Journal of Industrial Organization,* 14, 1996, pp. 673–99.

[5] Fukao, K., H. Ishido, and K. Ito. "Vertical Intra-Industry Trade and Foreign Direct Investment in East Asia," *Journal of the Japanese and International Economies,* 17, 2003, pp. 468–506.

[6] Hargittai, E. "Weaving the Western Web: Explaining Differences in Internet Connectivity among OECD Countries," *Telecommunications Policy,* 23, 1999, pp. 701–18.

[7] ITU (International Telecommunications Union). *Asia-Pacific Telecommunications Indicators 2000,* Geneva, 2000.

[8] ITU (International Telecommunications Union). *Asia-Pacific Telecommunications Indicators 2004,* Geneva, 2004.

[9] Katz, M. L., and C. Shapiro. "Network Externalities, Competition, and Compatibility," *American Economic Review,* 75, 1985, pp. 424–40.

[10] Katz, M. L., and C. Shapiro. "Systems Competition and Network Effects," *Journal of Economic Perspectives,* 8(2), 1994, pp.93–115.

[11] Kikuchi, T. "Interconnectivity of Communications Networks and International Trade," *Canadian Journal of Economics,* 36, 2003, pp. 155–67.

[12] Kikuchi, T. "Communications Networks and Regional Economic Development," *The Journal of the Korean Economy,* 5 (1), 2004, pp. 125–39.

[13] Kikuchi, T. "Network Externalities as a Source of Comparative Advantage," *Economics Bulletin,* 6 (7), 2005, pp. 1–9.

[14] Li, W., and L. C. Xu. "The Political Economy of Privatization and Competition: Cross-Country Evidence from the Telecommunications Sector," *Journal of Comparative Economics,* 30, 2002, pp. 439–62.

[15] Liebowitz, S. J., and S.-E. Margolis. "Network Externality: An Uncommon Tragedy," *Journal of Economic Perspectives,* 8 (2), 1994, pp. 133–50.

[16] Matoo, A., R. Rathindran, and A. Subramanian. "Measuring Services Trade Liberalization and Its Impact on Economic Growth: An Illustration," Working Paper 2655, World Bank, Washington D. C., 2001.

[17] Sidorenko, A., and C. Findlay. "The Digital Divide in East Asia," *Asian-Pacific Economic Literature,* 15 (2), 2001, pp. 18–30.

[18] Shy, O. *The Economics of Network Industries,* Cambridge University Press, 2001.

[19] Yusuf, S., and S. J. Evenett. *Can East Asia Compete? Innovation for Global Markets,* World Bank, Washington D. C., 2002.