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Co-evolutionary Dynamism between Japan and China in Software Outsourcing

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Abstract

Outsourcing from Japan to China has increased dramatically in recent years, resulting in increased mutual benefit. Japan's dependency on outsourcing of software development to China will lead to the most efficient information and communication technology (ICT) development in Japan, which in turn will induce China's ICT development. Software outsourcing leads to a co-evolutionary dynamism between both countries and such a co-evolution can be enabled by a co-evolutionary dynamism between advancement of economy, ICT and software in both countries. This paper attempts an empirical analysis of Japan's outsourcing of its software development to China by utilizing the concept of substitution dynamism between Japan's own software development and the development by software-leading countries, China, USA and India.

1. Introduction

1.1 Background

With progress in ICT, outsourcing (supply by an external entity of a service previously provided in-house) has become feasible. In fact, the international outsourcing has been growing rapidly. Software development outsourcing from USA to India is a typical example. Similar to USA, Japan is making use of outsourcing to overseas to promote its ICT development. In recent years, outsourcing to China has been becoming focused. **Table 1-1** demonstrates scale of outsourcing from Japan to overseas over the period 2002 to 2004 which demonstrates that the share of outsourcing to China greatly increased from 48% in 2002 to 63% in 2004.

Table 1-1 Scale of Outsourcing from Japan to Overseas *(02-04): ¥ millions*

Country/Year	2002	2003	2004	% of total in 2004
China	9,833	26,280	33,241	**63.08**
US	3,260	4,988	5,147	9.78
India	1,908	6,312	4,255	8.07
Australia	0	2,626	3,133	5.95
UK	20	1,827	2,126	4.03
Philippines	1,864	2,494	2,117	4.02
Korea	1,952	1,817	1,415	2.69
France	0	834	548	1.04
Canada	496	616	262	0.50
Vietnam	30	30	216	0.41
Others	888	1,082	237	0.43
Total	20,251	48,960	52,697	100

Source: An investigation from surveys by Japan Information Technology Services Industry Association (JTSA), Japan Electronics and Information Technology Industries Association (JEITA) and Japan Personal Computer Software Association (JPSA).

1.2 Hypothesis

The foregoing observations suggest the following hypothetical views with respect to the co-evolutionary dynamism of software development between Japan and China triggered by outsourcing:

(i) Pursuing the most qualified software resources available in the world market is indispensable for nation's competitiveness.

Japan's dependency on outsourcing of software development to China can lead to the most efficient ICT development in Japan, which in turn induces China's ICT development.

(ii) Software outsourcing can lead to a co-evolutionary dynamism between both countries.

Such a co-evolution can be enabled by a co-evolutionary dynamism between advancement of economy, ICT and software in both countries. The hypothetical view can be postulated as **Figure 1-1**.

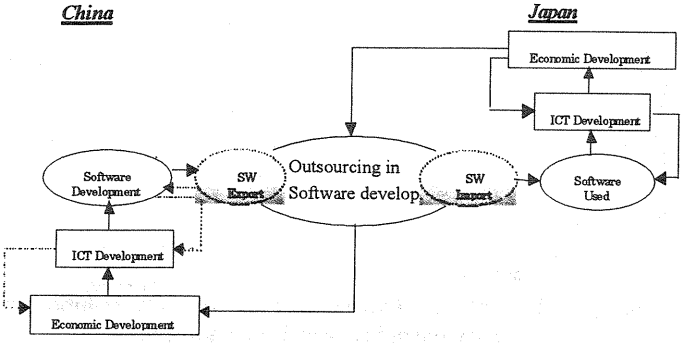


Figure 1-1. Co-evolutionary Dynamism between Japan and China through Outsourcing.

2. Analytical Framework

2.1 Substitution of Software Development

Outsourcing from country Y to X can be analyzed based on a concept of substitution dynamism from country Y to X. Elasticity of substitution of software in country X for that of in Japan is depicted as follows:

$$\sigma_{xj} = \frac{d\left(SW_x/SW_j\right)/\left(SW_x/SW_j\right)}{d\left[\left(\partial V_j/\partial SW_j\right)/\left(\partial V_x/\partial SW_x\right)\right]/\left[\left(\partial V_j/\partial SW_j\right)/\left(\partial V_x/\partial SW_x\right)\right]} \quad (2\text{-}1)$$

where SW_x and SW_j: *potential of software development* in country X and Japan; and

V_j and V_x: GDP in Japan and country X; therefore,

$\frac{\partial V_x}{\partial SW_x}$: marginal productivity of software in country X.

When software developers endeavor to maximize their profits under the competitive circumstance, marginal productivity of software in country X corresponds to the relative prices of software as follows:

$$\frac{\partial V_x}{\partial SW_x} = \frac{P_{sx}}{P_{vx}} \quad (2\text{-}2)$$

where P_{sx} and P_{vx}: prices of software and GDP in country X.

Therefore, σ_{xj} can be developed as follows:

$$\sigma_{xj} = \frac{d\left(SW_x/SW_j\right)/\left(SW_x/SW_j\right)}{d\left(P_{sj}/P_{sx}\right)/\left(P_{sj}/P_{sx}\right)} = \frac{d\ln\frac{SW_x}{SW_j}}{d\ln\frac{P_{sj}}{P_{sx}}} \quad (2\text{-}3)$$

Integrating the equation (2-11), the following equation can be obtained:

$$\ln\frac{SW_x}{SW_j} = a + \sigma_{xj}\ln\frac{P_{sj}}{P_{sx}} \quad (2\text{-}4)$$

where a: coefficient.

When $\sigma_{xj} > 0$, relatively lower software prices in country X induces substitution of its software development for Japan's software development which implies that cheaper software production cost in country X is the source of such substitution. When $\sigma_{xj} < 0$, relatively higher software prices in country X induces substitution of its software development for Japan's software development which implies that higher functionality in country X is the source of such substitution.

2.2 Measurement of Software Prices

Since diffusion of software in the nation is governed by nation's economic capacity, this trajectory can be traced by the logistic growth function with GDP as follows (see **Figure 2-1**):

$$\frac{dSW}{dV} = aSW\left(1-\frac{SW}{\overline{SW}}\right) \quad (2\text{-}5)$$

where V: GDP; a: velocity of software diffusion; and $\overline{SW}$: carrying capacity of software.

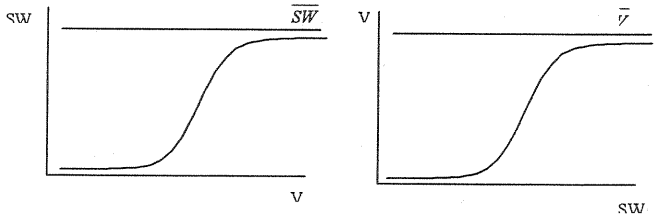


Figure 2-1. Mutual Inspiration between Diffusion Trajectories of Software and Economic Capacity.

Given that software (SW) leads the trajectory of economic development in the nation, GDP (V) can be depicted by the following function:

$$V = F(SW) \quad (2\text{-}6)$$

Differentiating V by SW leads to the following equation:

$$\frac{dV}{dSW} = \frac{\partial V}{\partial SW}\cdot\frac{dSW}{dSW} = \frac{\partial V}{\partial SW} \quad (2\text{-}7)$$

Provided that software developers endeavor to maximize their profits under the competitive circumstance, marginal

productivity of software development in equation (2-7) can be depicted as follows:

$$\frac{\partial V}{\partial SW} = \frac{P_s}{P_v} \tag{2-8}$$

where P_s and P_v: prices of software and GDP.

Given the existence of the reverse function with respect to software development and GDP of the nation, equation (2-8) can be developed as follows:

$$\frac{\partial SW}{\partial V} = \frac{P_v}{P_s} = \frac{dSW}{dV} = aSW\left(1 - \frac{SW}{\overline{SW}}\right) \tag{2-9}$$

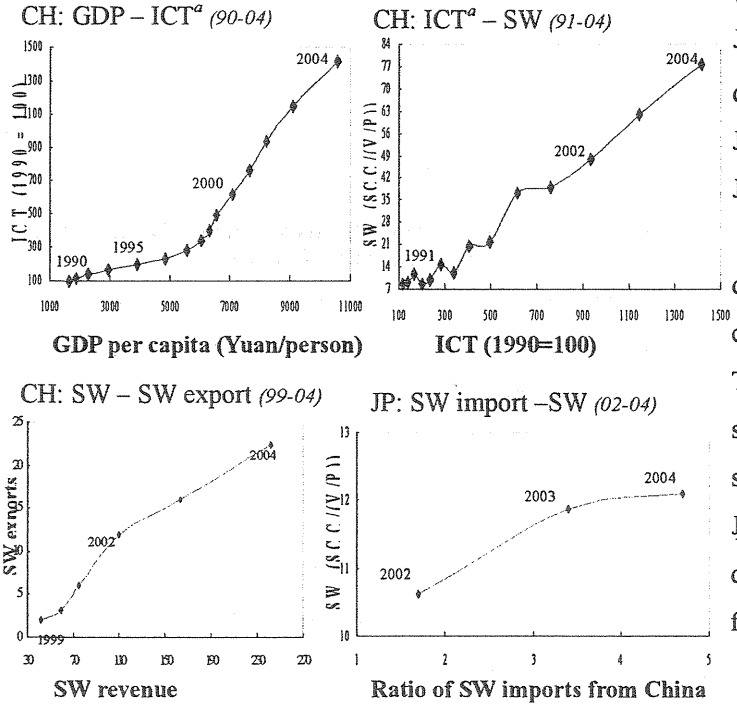
Therefore, relative price of software can be computed by the following equation:

$$\frac{P_s}{P_v} = \frac{1}{aSW\left(1 - \frac{SW}{\overline{SW}}\right)} \tag{2-10}$$

3. Empirical Analysis

3.1 Co-evolutionary Dynamism Triggered by Software Outsourcing

Japan's outsourcing in its software development to China has increased in recent years. Consequently, co-evolutionary dynamism between Japan and China in their GDP-ICT-SW (software) development has activated as demonstrated in **Figure 3-1**.



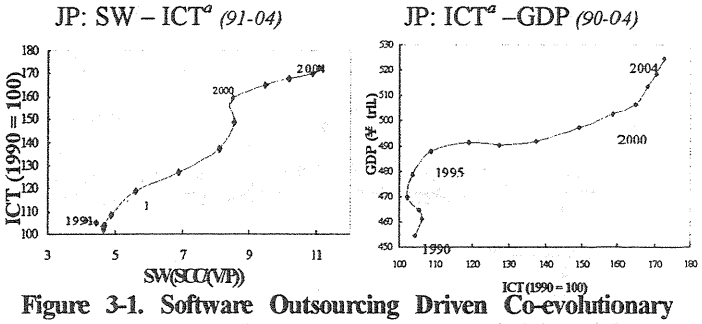


Figure 3-1. Software Outsourcing Driven Co-evolutionary Dynamism between Japan and China.

[a] ICT is based on IT index (1990 = 100).

3.2 Substitution of Software Development – Outsourcing Dynamism

In light of the significance of this outsourcing triggering such a co-evolutionary dynamism, the dynamism spurring this outsourcing was analyzed. Given the global nature of *the potential of software development* (nation's resources potential in software innovation) and provided that this potential can be internationally substitutable depending on its prices and functionality, substitution of software development in country X (SW_x) for that of in Japan (SW_j) can be depicted by the following equation:

$$\ln\frac{SW_x}{SW_j} = a + \sigma_{xj}\ln\frac{\frac{\partial V_j}{\partial SW_j}}{\frac{\partial V_x}{\partial SW_x}} = a + \sigma_{xj}\ln\frac{P_{sj}}{P_{sx}} \tag{3-1}$$

where SW_x and SW_j: software development in country X and Japan; a: coefficient; σ_{xj} : elasticity of substitution of software development in country X for that of in Japan; V_j and V_x: GDP in Japan and country X; and P_{sj} and P_{sx}: fixed prices of software in Japan and country X.

Figure 3-2 illustrates trends in the ratio of software development between Japan and three software-leading countries (China, USA and India) over the period 1992-2004. The figure demonstrates that China's development of software increased dramatically than that of Japan. India's software development also increased slightly higher than Japan, while the reverse trend continued in USA's software development before it changed to slightly higher than Japan from 2002.

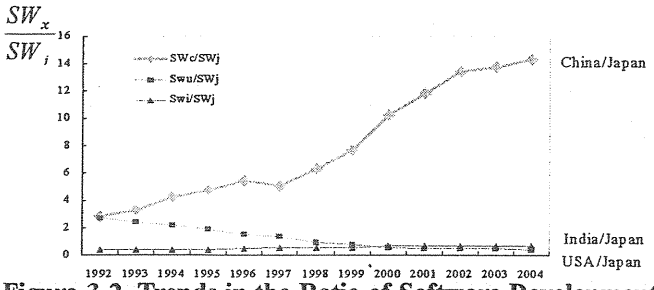


Figure 3-2. Trends in the Ratio of Software Development between Japan and Three Software-Leading Countries.

Based on these estimated logistic growth function results , **Figure 3-3** illustrates trends in the ratio of relative prices of software between Japan and three software-leading countries over the period 1992-2004.

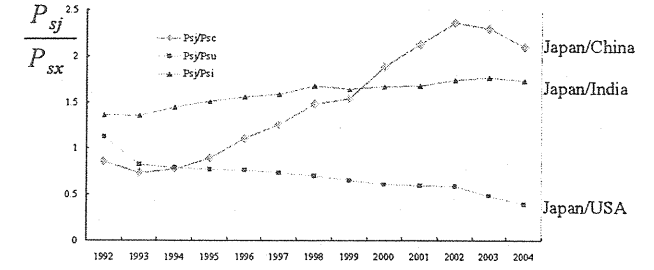


Figure 3-3. Trends in the Ratio of Relative Prices of Software between Japan and Three Software-Leading Countries.

Looking at the figure we note that Japan and China ratio continued to increase in the 1990s to the beginning of the 2000s before it changed to decreasing trend from 2002. This trend suggests that while China's software demonstrated the advantages of cheaper prices, it changed to demonstrate the advantages of higher functionality from 2002 corresponding to "The Action Program for Vitalization of Software Industry: 2002-2005" initiated by the Chinese government in 2002. Based on the analyses on Figures 3-2 and 3-3, **Figure 3-4** demonstrates the trends in the substitution of software development in China, USA and India for Japan over the period 1992-2004.

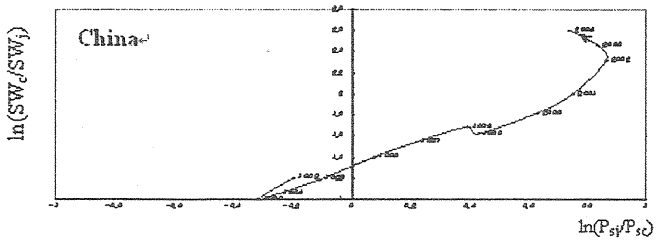


Figure 3-4. Trends in Substitution of Software Development in China for Japan *(1992-2004)*.

Since structural change was observed in 4 countries examined between the period before and after 2002, regression analysis between the ratios of software development and relative prices was conducted taking dummy variables reflecting such a structural change as (3-2), result of the analysis is summarized in **Table 3-1.**

$$\ln \frac{SW_x}{SW_j} = a + bD + \sigma_{xj1}(1-D)\ln \frac{P_{sj}}{P_{sx}} + \sigma_{xj2} D \ln \frac{P_{sj}}{P_{sx}} \qquad (3\text{-}2)$$

where D: dummy variable (2002-2004 = 1, other years = 0).

Table 3-1 Elasticity of Substitution of Software Development in China, USA and India for Japan (1992-2004)

	a	b	σ_1	σ_2	adj. R^2	DW
China	1.316	2.847	2.847	-2.100	0.991	1.96
	(77.20)	(6.50)	(6.50)	(-3.90)		
USA	2.295	-0.583	0.852	-0.194	0.697	1.10
	(36.78)	(-2.36)	(4.58)	(-0.62)		
India	1.011	0.956	0.684	-0.776	0.790	2.10
	(9.94)	(1.93)	(2.97)	(-0.88)		

4. Conclusion

With an empirical analysis of Japan's outsourcing of its software development to China by utilizing the concept of substitution dynamism between Japan's own software development and the development by software-leading countries, China, USA and India, co-evolutionary dynamism between Japan and China in software outsourcing was elucidated Such a co-evolution can also be enabled by a co-evolutionary dynamism between advancement of economy, ICT and software in both countries.

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