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## Conference Paper

# Analysis about the development of mobile electronic commerce: An application of production possibility frontier model

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# **The 19th ITS Biennial Conference 2012**

## **“Moving Forward with Future Technologies: Opening a Platform for All”**

18 - 21 November 2012, Thailand

**Analysis about the Development of Mobile Electronic Commerce  
– An Application of Production Possibility Frontier Model –**

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# Analysis about the Development of Mobile Electronic Commerce – An Application of Production Possibility Frontier Model –

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## Abstract:

This study aims to further develop our previous research on Production Possibility Frontier Model (PPFM). An application of model to provide analysis on the mobile commerce survey for which data was collected in Japan and Thailand is presented. PPFM looks into the consumer behaviors as the results from the perception on the relationship between “Convenience” and “Privacy Concerns” of certain electronic commerce services. From the data of consumer surveys, PPFM is expected to provide practical solution for service providers by offering useful information about what levels of trade-offs between “Convenience” and “Privacy Concerns” the service should be attained. This study provides a finding that the survey data seem to draw the oath of technology innovation PPFM.

Key topic: ICT and economic development

Key words: Production Possibility Frontier, mobile commerce, electronic commerce

## 1. Introduction

This study aims to further our previous research (Okada et al.: 2009) on Production Possibility Frontier Model (PPFM)<sup>1</sup>. In the previous study, we presented theoretical framework of the model. Since its early development (Samuelson: 1954, Hicks: 1965), PPFM has been used as a tool for microeconomic analysis. Such issues as technology development was also object for the analysis by PPFM (Jorgenson: 2001). Our aim in this paper is to investigate appropriate type of PPFM and apply to the analysis of the development to the mobile electronic commerce.

Since the penetration of the smartphones advances so rapidly; and the numbers of the users among developing countries increase remarkably, there are vast frontiers for mobile electronic commerce. However, the trade-offs between costs and benefits are arising and prevailed, too. One of these problems is the protection of privacy. As the technology becomes more sophisticated, the gap created by the trade-offs between “Privacy Concerns” and “Convenience” becomes more serious.

Our previous study provided some observation about the consumer behavior in using e-Money (Okada et al.: 2009) together with a prototype of PPFM. In this research, we are going to present the development about the PPFM modeling as well as more case analysis using survey data. In the previous study, we focused on the case in

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<sup>1</sup> The term PPF hereinafter includes the term Production Possibility Curve (PPC), otherwise, explicitly stated to avoid duplication and confusions.

Japan. In this paper, we also use the case from Thailand in addition to Japan's case.

This study asks questions about how we can utilize the mobile communication technology and develop electronic commerce in the development economies. PPFM is applied to solve the questions.

## 2. Related works

### 2.1 About PPFM

Since the use of PPFM in the analysis of trade-off between "Convenience" and "Privacy Concerns" in mobile commerce is an original concept of ours, related works can only be found from our previous researches as above mentioned.

However, literatures that treat PPF can be found in a large volume. The use of PPF changed the role since its development. PPF was first developed as to describe the choice of technologies of productions. In other words, it provided tools for production function analysis at microeconomic level. Then, it moved to macroeconomic level. PPF was deployed to the analysis of trades between nations.

When Samuelson (1954) discussed about PPF, it was rather dealing with the former issues. He extended function of PPF to include "government expenditure on collective consumption goods" (ibid. p.388). It seems like his inclusion of government role into PPF opened the possibilities of use of PPF in macroeconomics. (Farrell: 1957)

Worswick (1957) followed up Samuelson (1954) and provided analysis on the convexity of PPF. In 1970's, the sophistications of PPF advanced resulting from such works as Christensen et al. (1973) and Aigner et al. (1977).

PPF has been deployed in the analysis of various sectors such as farming (Danso-Abbeam et al.: 2012) and environmental problems (Taylor et al.: 1994).

### 2.2 About Privacy concerns

There is no doubt about the convenience what IT delivers. However, it is not as apparent as convincing when it comes to what cost the convenience is requiring. The cost does not count only the "price" the convenience is provided. For example, business models that require no payments from the users are well known. It requires no cost in a shape of "price."

Most of the cases, users are, without noticing, required to give up some levels of their privacy related information. In some case, it is the information about location, preference, amount of spending, timing, and other more personal things that are acquired by the providers of convenient services.

## 3. Data structure

We used the survey data collected for comparative analysis about mobile commerce in Japan and Thailand. Originally, data was collected in 2010 through 2011 from collage students of respective nations. The questions were structured to test the mechanism of trust in mobile commerce which was published in Atchariyachanvanich et al.: 2011b.

Among these questionnaires, we used items, which ask about the perceptions on mobile commerce with relation to "Convenience" and "Privacy Concern." They are presented in sentences and respondents are required to answer following the Likert Scales of 5 categories.

Demographic data of respondents are summarized in Table 3.1 and the texts of questions are summarized in Table 3.2. As shown in Table 3.2, question sentences about “Convenience” are taken from McKnight’s (2002) “Perceived Usefulness.” Question sentences about “Privacy Concerns” are taken from Chen’s (2004) “Perceived Trust.”

TABLE 3.1 DEMOGRAPHIC CHARACTERISTICS

COUNTRY	JAPAN	554
	THAILAND	440
SEX	MALE	456
	FEMALE	534
	NA	4
AGE	17	1
	18	312
	19	352
	20	173
	21	100
	22	32
	22<	24

N=994

Table 3.2 TEXTS OF QUESTIONS

[Convenience]

- (1) I feel good about how things go when I do purchasing or other activities on the Internet.
- (2) I am comfortable making purchases on the Internet.

Adopted from McKnight (2002)

[Privacy Concern]

- (1) It bothers me when the virtual store asks me for personal information.
- (2) I am concerned that the virtual store is collecting too much personal information from me.
- (3) I am concerned that the virtual store will use my personal information for other purposes without my authorization.
- (4) I am concerned that the virtual store will share my personal information with other companies without my authorization.
- (5) I am concerned my personal information in the virtual store’s database is not accurate.
- (6) I am concerned that unauthorized people (i.e. hackers) have access to my personal information.
- (7) I am concerned about the security of my personal information during transmission.

Adopted from Chen (2004)

#### 4. Description of Results

##### 4.1 Results from Survey Data

Figure 4.1 shows the relationship of “Convenience” and “Privacy Concern” in scattered bubble chart. Table 4.1 shows the raw data for constructing Figure 4.1

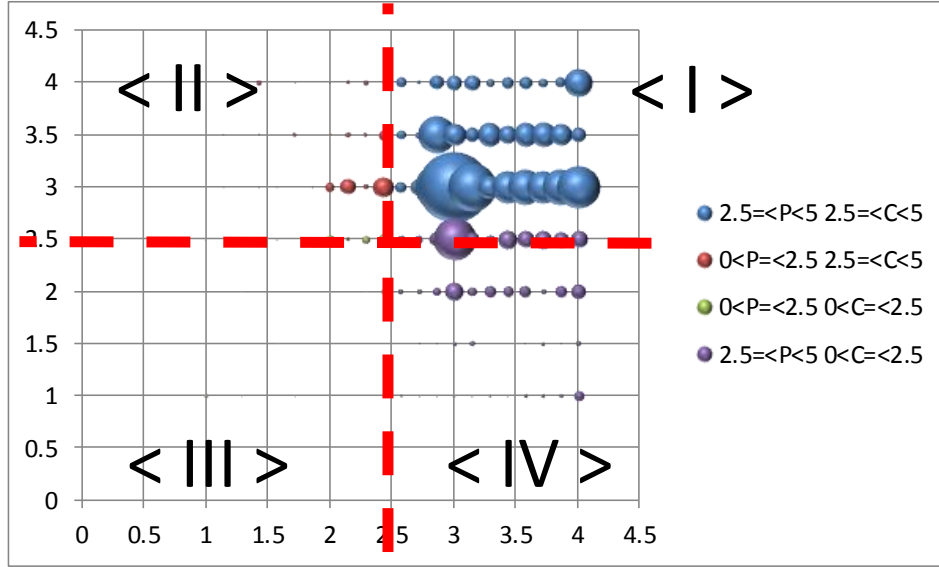


FIGURE 4.1 RELATIONS BETWEEN CONVENIENCE AND PRIVACY CONCERN

##### 4.2 PPF and Simulation

In this section, firstly, the method to construct PPF in this paper is presented. Secondly, the simulated results and calculated results from the usage of actually observed data are presented.

Firstly, following the process of Kamakura (2011), let us construct PPF. Suppose a Cobb-Douglas Production Function:

$$Y = A K^a L^{(1-a)} \quad (1)$$

where  $Y$  represents the level of Utility which results from combination of  $A$ ,  $K$  and  $L$ , and  $A$  represents level of Technology,  $K$  represents the level of “Privacy Concerns” and  $L$  represents the level of “Convenience.”

Suppose the case where two kinds of combinations of “Privacy Concerns” and “Convenience” exist, from (1),

$$\left. \begin{aligned} Y_1 &= A K_1^{a_1} L_1^{(1-a_1)} \\ Y_2 &= A K_2^{a_2} L_2^{(1-a_2)} \end{aligned} \right\} \quad (2)$$

This can be solved as (3) where if  $L$  is given,  $K$ ,  $K_1$ ,  $L_1$ ,  $K_2$  and  $L_2$  are calculated.

$$K_1 = \frac{a_1(1-a_1)L_1K}{(1-a_1)a_2L+(a_1-a_2)L_1} \quad (3)$$

Secondly, we use data of <Category I > and <Category IV > in Table 4.1. The reason why these data are used is presented in discussion section. Let us construct PPF using (2) and (3). The results are indicated as Y<I> and Y<IV> in Figure 4.2.

Let  $A=1, K=3, L=3$  and  $a_1 = a_2 = 0.5$ ,

and let  $L_1$  substituted a series of continuous numbers to simulate a series of  $K_1$ , and gain a set of  $\{K_2, L_2\}$  and calculate Y<I>S and Y<IV>S in Figure 4.2.

TABLE 4.1 DISTRIBUTIONS OF SURVEY RESULTS

CATEGORY < I >			CATEGORY < II >			CATEGORY < III >			CATEGORY < IV >		
2.5=<P<5	2.5=<C<5	# of Items	0<P=<2.5	2.5=<C<5	# of Items	0<P=<2.5	0<C=<2.5	# of Items	2.5=<P<5	0<C=<2.5	# of Items
2.57143	2.5	6	1	2.5	1	1	1	3	2.57143	1	2
2.57143	3	9	1.142	3	1	1.28571	1	1	2.57143	2	4
2.57143	3.5	7	1.142	3.5	1	1.71429	1	1	2.57143	2.5	6
2.57143	4	8	1.285	2.5	1	2	1	1	2.71429	1	1
2.71429	2.5	6	1.285	4	2	2.42857	1	1	2.71429	1.5	1
2.71429	3	13	1.428	3	1	1.57143	1.5	1	2.71429	2	4
2.71429	3.5	5	1.428	3.5	2	1.28571	2	1	2.71429	2.5	6
2.71429	4	3	1.428	4	4	2	2	1	2.85714	1	1
2.85714	2.5	11	1.571	2.5	1	2.28571	2	1	2.85714	1.5	1
2.85714	3	36	1.571	3	1	2.42857	2	3	2.85714	2	6
2.85714	3.5	30	1.714	3.5	3	1	2.5	1	2.85714	2.5	11
2.85714	4	11	1.714	4	1	1.28571	2.5	1	3	1	2
3	2.5	34	1.857	2.5	2	1.57143	2.5	1	3	1.5	3
3	3	59	1.857	3	1	2	2.5	7	3	2	15
3	3.5	18	2	2.5	5	2.28571	2.5	6	3	2.5	34
3	4	12	2	3	7	2.42857	2.5	8	3.14286	1	1
3.14286	2.5	11	2	3.5	2				3.14286	1.5	4
3.14286	3	40	2	4	1				3.14286	2	7
3.14286	3.5	11	2.142	2.5	3				3.14286	2.5	11
3.14286	4	12	2.142	3	12				3.28571	1	2
3.28571	2.5	7	2.142	3.5	4				3.28571	2	9
3.28571	3	18	2.142	4	3				3.28571	2.5	7
3.28571	3.5	19	2.285	2.5	3				3.42857	1	1
3.28571	4	6	2.285	3	4				3.42857	2	8
3.42857	2.5	15	2.285	3.5	3				3.42857	2.5	15
3.42857	3	26	2.285	4	4				3.57143	1	3
3.42857	3.5	14	2.428	2.5	8				3.57143	1.5	1
3.42857	4	9	2.428	3	16				3.57143	2	9
3.57143	2.5	13	2.428	3.5	8				3.57143	2.5	13
3.57143	3	28	2.428	4	2				3.71429	1	3
3.57143	3.5	19							3.71429	1.5	3
3.57143	4	10							3.71429	2	4
3.71429	2.5	14							3.71429	2.5	14
3.71429	3	26							3.85714	1	3
3.71429	3.5	20							3.85714	1.5	1
3.71429	4	7							3.85714	2	9
3.85714	2.5	12							3.85714	2.5	12
3.85714	3	29							4	1	8
3.85714	3.5	18							4	1.5	4
3.85714	4	8							4	2	11
4	2.5	13							4	2.5	13
4	3	35									
4	3.5	11									
4	4	23									
P: Privacy Concern, C: Convenience											

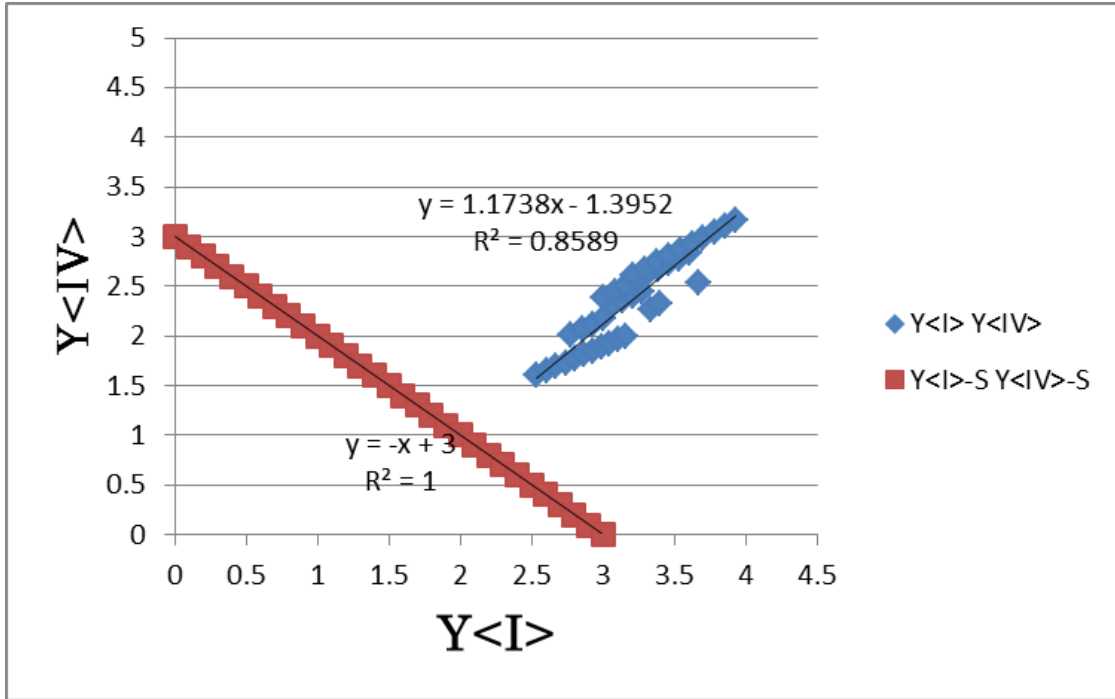


FIGURE 4.2 SIMULATED COMBINATION AND ACTUAL NUMBERS COMBINATION BETWEEN CONVENIENCE AND PRIVACY CONCERNS

The results of regression analysis which were calculated by MS-Excel 2010 are the followings.

$$Y\langle IV \rangle = 1.1738 Y\langle I \rangle - 1.3592 \quad (4)$$

$$Y\langle IV \rangle S = -Y\langle I \rangle S + 3 \quad (5)$$

## 5. Discussions

As presented in Figure 4.1, all responses are divided into four categories. The division is made in accordance with the level of average and mode of responses, namely, 2.5.

<Category I> and <Category IV> are used because of the availability of the data. <Category I> represents the presence of respondents which show high levels of valuation on both "Privacy Concerns" and "Convenience." This is the category which holds largest numbers of respondents. There are several reasons. Because respondents of the survey are mostly students, they care their own privacy. At the same time, they are willing to pursuit the convenience of mobile commerce. Therefore, <Category I> accumulate the largest number of responses. In other words, they are well-balanced users of mobile commerce.

<Category IV> is the next largest and represents the respondents of combination of "high level" of "Privacy Concerns" and "low level" of "Convenience." This would be because the next largest category is the one which collects those who give more concerned about protecting their privacy. They may be the beginners and/or well-educated veteran users of mobile commerce who know the danger of the privacy



divulgence in electronic commerce.

These data are deployed to construct PPF, supposing the responses in <Category I> and <Category IV> are receiving the same levels of Utility.

The result of the relationship between (4) and (5) is not really the one which we expected.

The relationship between (4) and (5) indicate almost vertical crossing. We expected that two would have matched, or at least, paralleled to each other. So, the results were out of our expectation.

Generally, in PPF, when a certain kind of change occurs in technology, the combination of resources changes. In Figure 4.3, the move from “Security Oriented” to “Privacy Oriented” is the example of such case.

Likewise, the bold line in the middle of Figure 4.3 with 45 degree toward two o'clock direction is considered the path of “Technological Innovations.”

As Figure 4.2 indicates, the PPF calculated from the survey data appears as though a path which appears when technological innovation happens. We do not yet know the theoretical explanation about this.

Interpretation of the result may include some problems such as:

- a) The methodology does not justifiable.
- b) The data are not appropriate.
- c) The structures of the data are not suitable.
- d) Construction of formula and simulation are not appropriate.

It is the future task to examine the above; however, it is present task to provide explanations.

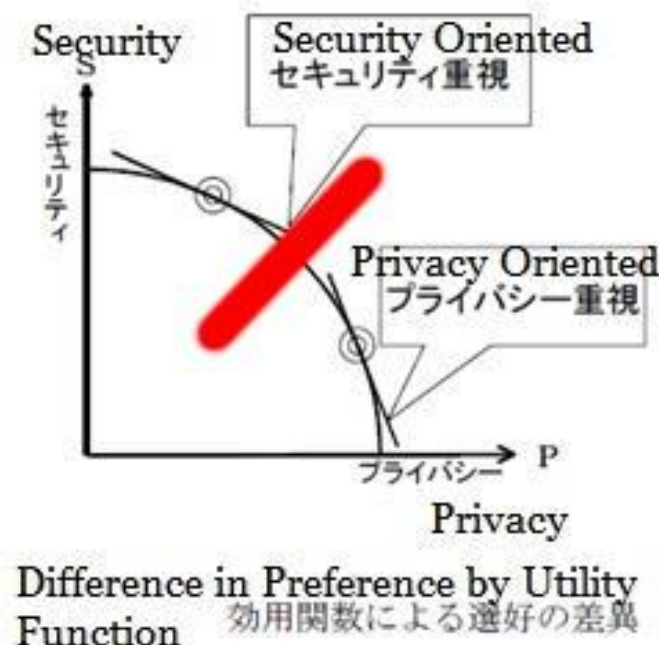


FIGURE 4.3 TECHNOLOGY INNOVATION AND SHIFTING THE COMBINATION (SOURCE: OKADA(2001))

## 6. Conclusions and future studies

This paper provides an analysis of application of PPF depending on the international data about mobile commerce survey. It aimed to present the proof that the trade-off relationship between "Privacy Concerns" and "Convenience" would construct PPF on the basis of Cobb-Dougllass Production Function.

As a result, there is an indication that construction of PPF is possible. The shape of the PPF, however, is not what we expected. Instead, comparing from simulated shape of PPF, the actual data seems to draw a path of technological innovation.

There are several problems relating methodologies and data constructions. It is the remaining tasks for us to investigate such problems.

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