

# DEMAND FOR INTERACTIVE TELEVISION

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Submitted to the Department of Electrical Engineering and Computer Science  
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## **Abstract**

This thesis uses the results of our survey to analyze the demand for interactive TV, a multimedia network service. Today, technical and regulatory conditions for interactive TV are being satisfied and the evaluation of the demand for interactive TV has become crucial; however, not enough studies on this topic have been made yet.

We performed a survey of individuals' preferences for hypothetical interactive TV services. Stated preference data were used for the estimation of a nested logit model of individuals' choice to subscribe to these services. The key finding was that individuals' personal characteristics as well as the attributes of the service offerings, such as price and packaging have a remarkable effect on individuals' choice. Price elasticities were computed for both flat monthly and pay-per-view fees. Based on the results, we suggest guidelines for designing interactive TV services which meet potential customers' needs.

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# Table of Contents

<b>Chapter 1</b>	<b>Introduction</b>	<b>8</b>
1.1	What are "Multimedia ?"	8
1.2	Current Trend in the Telecommunications Industry	9
1.2.1	Deregulation	9
1.2.2	National Information Infrastructure (NII)	11
1.2.3	Advancing Technology	11
1.3	Forecast of Multimedia Market	12
1.4	Objectives of the Research	12
1.5	Outline of Thesis	14
<b>Chapter 2</b>	<b>Multimedia Services: Critical Factors for Determining Demand for Interactive TV</b>	<b>15</b>
2.1	Applications of Multimedia	15
2.2	The Prospects of Multimedia Network Services	17
2.2.1	Services Based on CATV Networks (Interactive TV)	17
2.2.2	Services Based on the Public Switched Telephone Network (Video Dialtone)	17
2.2.3	Services Based on Computer Networks	18
2.3	Outline of Interactive TV	19
2.4	Field Tests of Interactive TV	20
2.4.1	Service Menus	20
2.4.2	Pricing Scenario	21
2.5	Critical Factors for Determining Demand for Interactive TV	21
<b>Chapter 3</b>	<b>Survey of Demand for Interactive TV</b>	<b>25</b>
3.1	Questionnaire Design	25
3.1.1	Stated Preference Survey	25
3.1.2	Menu Approach	26
3.1.3	Building Menus	28
3.1.3.1	Selection of Individual Services	28
3.1.3.2	Pricing Scenario	30
3.1.3.3	Discount Packages	31
3.1.3.4	Combination of Attributes in Menus	32
3.1.4	Respondents' Usage of Audio-Visual Equipment	36
3.2	Sample Design	36
3.3	Descriptive Statistics	38
3.3.1	Profile of Respondents	38
3.3.2	Choice Behavior	39
<b>Chapter 4</b>	<b>Model Formulation and Estimation</b>	<b>43</b>
4.1	Formulation of Model	43
4.1.1	Logit Model	43
4.1.2	Nested Logit Model	44
4.2	Estimation Methods	44
4.2.1	Sampling of Alternatives	46
4.2.2	Model Variables in Lower Level Model	46
4.2.3	Model Variables in Upper Level Model	47
4.3	Estimation Results	48
4.3.1	Lower Level Model	48

4.3.2	Upper Level Model . . . . .	50
<b>Chapter 5</b>	<b>Analysis of Estimation Results</b>	<b>56</b>
5.1	Elasticity . . . . .	56
5.1.1	Introduction . . . . .	56
5.1.2	Simulation Procedure . . . . .	56
5.1.3	Simulation Results . . . . .	60
5.2	Discussion on Implementation of Estimation Results . . . . .	60
5.2.1	Service Menus . . . . .	62
5.2.2	Pricing Scenario . . . . .	63
5.2.3	Effect of Computer Network-Based Multimedia Services on the Demand for Interactive TV . . . . .	64
<b>Chapter 6</b>	<b>Conclusion</b>	<b>66</b>
6.1	Contributions . . . . .	66
6.2	Major Findings . . . . .	67
6.3	Future Work . . . . .	68
<b>Appendices</b>		
<b>A</b>	<b>The Questionnaire of the Survey</b>	<b>70</b>
<b>B</b>	<b>Descriptive Statistics of the Survey</b>	<b>78</b>
<b>C</b>	<b>Discrete Choice Theory and Models</b>	<b>83</b>
<b>D</b>	<b>Nested Logit Model</b>	<b>87</b>
<b>E</b>	<b>The Jackknife Method</b>	<b>90</b>
<b>Bibliography</b>		<b>92</b>

## List of Figures

1.1	Moves of Telephone and CATV Companies in the US . . . . .	10
2.1	New “Inter-industrial” Multimedia Services . . . . .	16
2.2	Network Configuration of ADSL . . . . .	18
2.3	Network Configuration of the Full Service Network . . . . .	23
3.1	Configuration of Services in Packages . . . . .	33
3.2	Data Collection Procedure . . . . .	37
3.3	Comparison between Author’s Survey and Times Mirror Survey . . . . .	41
3.4	The Number of Services Chosen in the Reference Menu . . . . .	41
3.5	How Services Were Chosen in the Reference Menu . . . . .	42
3.6	How Services Were Chosen in the Reference Menu . . . . .	42
4.1	Model Structure . . . . .	45
4.2	Packaging Effect . . . . .	49
5.1	Number of Worldwide Host Computers Accessible to the Internet . . . . .	65

## List of Tables

1.1	Forecasts of Multimedia Market . . . . .	13
2.1	Fundamental Techniques Used in Interactive TV . . . . .	19
2.2	Field Tests of Interactive TV . . . . .	22
2.3	Pricing Scenario of Interactive TV Services . . . . .	24
3.1	Menu Example . . . . .	27
3.2	Example of Pair Comparison . . . . .	27
3.3	Individual Services for Interactive TV . . . . .	29
3.4	Results of the Survey by the New York Times . . . . .	30
3.5	Reference Pricing Scenario of Individual Services . . . . .	31
3.6	Attributes of Menus . . . . .	34
3.7	Menu Example . . . . .	35
4.1	Estimation Results of the Lower Level Model . . . . .	52
4.2	Estimation Results of the Upper Level Model . . . . .	53
4.3	Estimation Results of the Upper Level Model (Without Subjective Variables) . . . . .	54
4.4	Comparison of A Priori Hypothesis and Estimation Results . . . . .	55
5.1	Base Case Price Structure . . . . .	57
5.2	Simulation Results . . . . .	61
5.3	Results of Louis Harris & Associates Survey on Interactive Services . . . . .	62

# Chapter 1

## Introduction

Nowadays, we see the buzzword “multimedia” much more often in newspaper and magazine articles, books and TV programs than we did several years ago. They are expected to change society and our daily lives. In this thesis, we assess the demand for a particular multimedia service, interactive television. Before we move any further, it is necessary to explain what “multimedia” means.

### 1.1 What are “Multimedia?”

In general, “multimedia” are recognized as integrated digital media which are composed of several forms of data such as text, graphics, picture, voice and even video, and which can be transmitted through one line. Indeed this literal definition is not wrong but multimedia are more than that. They are characterized by the following three prerequisites [UFL94]:

#### 1. To be interactive

In traditional media such as radio, TV and even Cable Television (CATV), providers have mainly transmitted information to listeners or viewers in one direction. Listeners or viewers have only been able to choose their favorite channels. Multimedia services, on the other hand, allow the receivers of information to choose the contents of a program to a greater extent. In other words, the portion of programs that the receivers can take part in has become much larger in multimedia than it was in conventional media.

#### 2. Digital Data (Consistency of Data)

In order to integrate various types of data such as text, graphics, full-motion pictures and voice, all of these data should be in digital form. This feature is also important in the other two prerequisites for multimedia, that is, that they be interactive and nonlinear as will be explained below. The rapid growth of the capacity of computer memories and the availability of faster and cheaper central processing units (CPU’s) enable us to process and store massive digital data (e.g., full-color full-motion pictures). This trend will contribute greatly to the progress of multimedia technology.

#### 3. Nonlinearity

We cannot immediately access data recorded far apart on an audio cassette tape or



a video cassette tape, which are typical linear recording media. In nonlinear media such as a compact disc (CD) and a hard disc, however, we can at once access data as we want them. Furthermore, nonlinear media enable us to edit the contents as we like and permits us to be interactive as described above.

## **1.2 Current Trend in the Telecommunications Industry**

In recent years, there have been important changes in the United States that have forced the telecommunications industry to move into the multimedia information age. The three major factors of these changes, deregulation, the National Information Infrastructure (NII) Project promoted by the Federal Government and advancements in technology are discussed in this section.

### **1.2.1 Deregulation**

In July 1992, the Federal Communications Commission (FCC) relaxed the cable-telephone crossownership prohibition and allowed telephone companies to transmit video on a common carrier basis. This so-called video dialtone ruling means that regional telephone companies can become a provider of multimedia services including the transmission of moving pictures. CATV companies, on the other hand, have been controlled by FCC regulations since then. Furthermore, in August 1993, the Federal District Court allowed a telephone company to participate in CATV business outside of its service area. These decisions triggered the advent of new services such as the Video Dialtone (VDT<sup>1</sup>) and Asymmetrical Digital Subscriber Line (ADSL<sup>2</sup>).

Since the video dialtone ruling, telephone, CATV and TV broadcasting companies have been able to compete for interactive multimedia services. As a consequence, many merges and alliances between cable and telephone companies began to occur for the purpose of encouraging collaboration in testing interactive CATV. The most important and also the most surprising was Bell Atlantic's merger with TCI, America's largest CATV company, in October 1993, which was called off after four months. Some of the merges and alliances between telephone and cable companies as well as the principal movements of these companies over the past few years are shown in Figure 1.1. More detailed information of such field tests is expressed in section 2.4.

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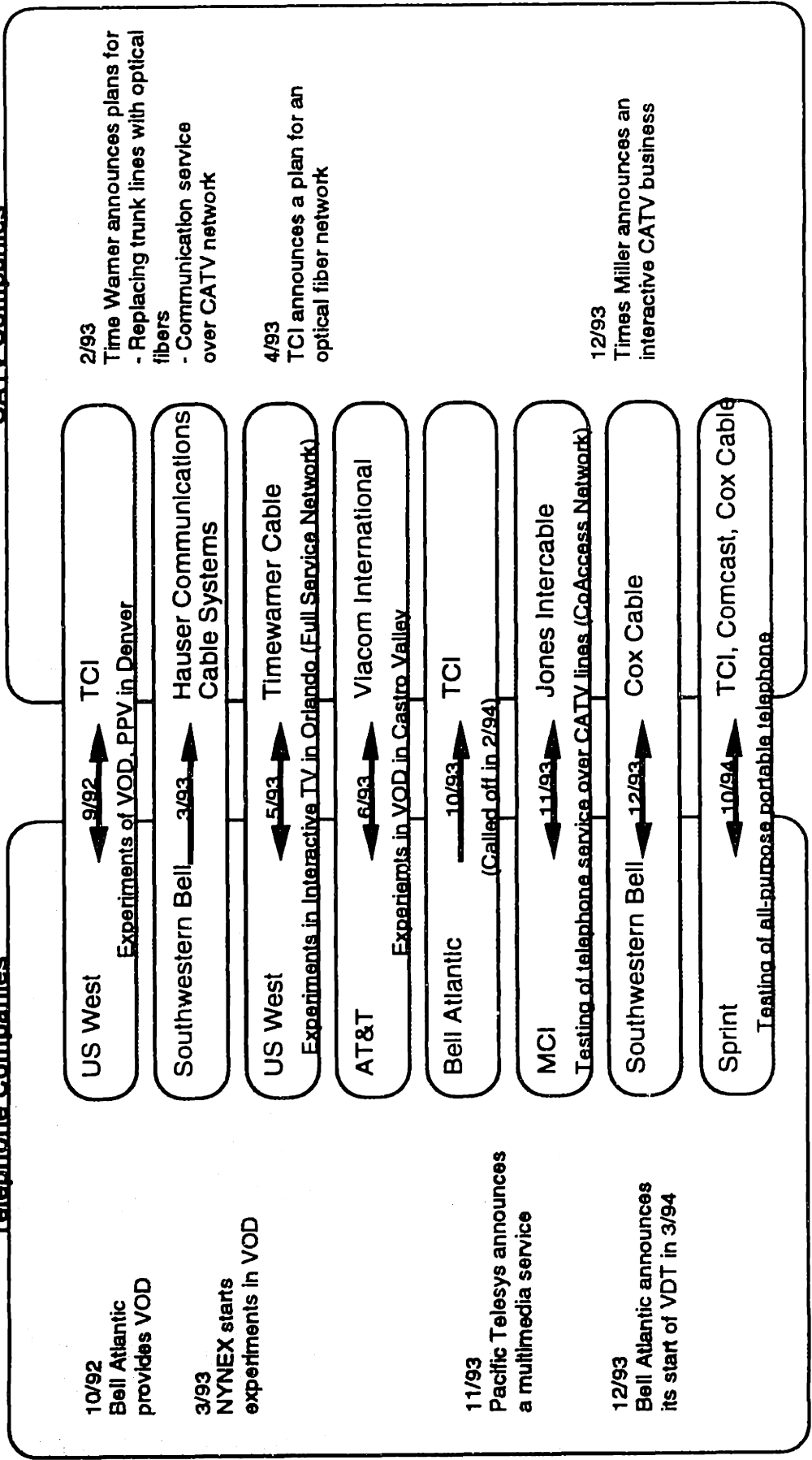
<sup>1</sup>VDT is a video data transmission service which US regional telephone companies including seven regional holding companies (RHCs: e.g., Nynex, US West) provide for households.

<sup>2</sup>ADSL is one type of VDT service, in which an interactive multimedia service is provided through existing metallic phone lines (see Section 2.2.2).

month/year → merger  
 month/year ← alliance

**CATV Companies**

**Telephone Companies**



Source: [NTT94]

Figure 1.1 Moves of Telephone and CATV Companies in the US

### **1.2.2 National Information Infrastructure (NII)**

“Imagine you had a device that combined a telephone, a TV, a camcorder, and a personal computer. No matter where you went or what time it was, your child could see you and talk to you, you could watch a replay of your team’s last game, you could browse the latest additions to the library, or you could find the best prices in town on groceries, furniture, clothes – whatever you needed.” This is the first paragraph of the Clinton Administration’s release on Sept. 15, 1993, in *NII: the Agenda for Action* [NII93].

Since the Clinton-Gore Administration took office, they have gone ahead with the NII plan, in which every citizen in the United States can get what s/he wants or needs as a form of multimedia information through a high-speed network whenever it becomes available and wherever s/he is. The NII is composed of the four components shown below;

- (1) Dozens of telecommunications networks interconnected and interoperable
- (2) Information equipment such as a computer system, a TV, a fax machine and a telephone
- (3) Software, an information service and a database (e.g., a “digitized library”)
- (4) People trained to construct, maintain and operate these systems

The high-Performance Computing and Communications Program (HPCC) is the main impetus promoting the development of fundamental technology for NII. In addition to the Internet, which is the world’s largest and most widespread network, the National Research and Education Network (NREN) is constructed for research institutes, universities and libraries. NREN is the super-high-speed network of gigabit order (faster than that of the Internet) and is expected to form the heart of the HPCC.

In May, 1994, Vice President Gore proposed an expanded version of NII, the Global Information Infrastructure (GII) project, in which schools, hospitals and libraries are interconnected to a worldwide network and every person in the world can access the network. In response to the approval of the GII project, the US, Europe and Japan agreed to collaborate in promoting it.

### **1.2.3 Advancing Technology**

High performance CPU’s, mass-storage devices and data compression techniques enable a computer system to process multimedia data, including full-color full-motion pictures of a tremendous amount of data. A quick progression of these techniques in

recent years as well as the changes in the telecommunications industries described in former section has accelerated the movement toward the multimedia information age.

Here, the standardization of image compression illustrates advancing technology. The Joint Photographic Coding Expert Group (JPEG) has already been standardized for compressing still pictures and compressed data can be transmitted at a rate of 64 kb/s. The Motion Picture Image Coding Expert Group (MPEG), on the other hand, sets the international standard for compressing motion pictures. The MPEG1 enables a system to transmit 30 frames of images of 360 x 240 pixels per second at a rate of 1.5 Mb/s. By the MPEG2, 30 frames of National Television System Committee (NTSC) video images of 720 x 480 pixels per second can be transmitted at a higher rate than by the MPEG1. The MPEG2 is now the key standard adopted by many interactive multimedia systems such as interactive CATV and Video Dialtone (VDT).

### **1.3 Forecast of Multimedia Market**

Now that the regulatory and technical conditions for the multimedia information age are being satisfied, it is crucial to assess the demand for multimedia services and to forecast the scale of the multimedia market. Even though a multimedia service is state-of-the-art, it could fail if it does not attract customers or if it does not meet the potential customers' needs.

As shown in Table 1.1, some research firms and manufacturers have forecasted the scale of the multimedia market. Dataquest, for example, forecasted that the scale of the worldwide multimedia computer market including multimedia capable PCs, editing software and network equipment, will grow from \$ 1.9 billion in 1992 to \$ 9 billion in 1996. These forecasts present the scale of multimedia market from 1996 to 2015; however, they focus on hardware such as PCs and semiconductor devices rather than software (e.g., multimedia services). Many of the forecasts do not quantitate individually the future scale of each multimedia service such as video on demand (VOD) and interactive TV. Furthermore, it is not clear whether these forecasts were based on an analysis of consumers' preferences for multimedia services.

### **1.4 Objectives of the Research**

The purpose of this thesis is to show a method of assessing the demand for a particular multimedia service, interactive TV, through the analysis of the customers' preferences.

Field tests of interactive TV have began only a few years ago and there are not enough data for telephone and cable companies to evaluate customers' preferences for

enough data for telephone and cable companies to evaluate customers' preferences for

**Table 1.1 Forecasts of Multimedia Market**

Organizations	Area	Ser- vices	Hard- ware	Year	Market Scale
IBM ('92)	World		X	1995	US\$ 19 billion
Apple Computer ('92)	World		X	2000	US\$ 3.3 trillion
Dataquest ('92)	World		X	1996	US\$ 6 billion
McKinsey & Company ('92)	Japan		X	2000	¥ 14.4 trillion (US\$ 144 billion)
New Media Development Association ('92)	Japan	X	X	2000	¥ 15.3 trillion (US\$ 153 billion)
Electronic Industries Association of Japan ('92)	Japan	X	X	2000	¥ 57.9 trillion (US\$ 577 billion)
Ministry of International Trade and Industry (MITI) ('94)	Japan	X	X	2000	¥ 61-- 70 trillion (US\$ 608--698 billion)
Electronic Industries Association of Japan ('94)	Japan	X	X	2000	¥ 17.7 trillion † (US\$ 176 billion)
Conference of New Visual Communication Industries (in MITI) ('94)	Japan	X	X	2000	¥ 25.4 trillion (US\$ 253 billion)
		X	X	2015	¥ 71 trillion (US\$ 708 billion)
Ministry of Posts and Telecommunications ('94)	Japan	X	X	2010	¥ 123 trillion (US\$ 1.22 trillion)

Source: [COM94] [DIA94]

Remarks: † Multimedia market for home use  
For all prices the exchange rate on Dec. 16, 1994  
US\$ 1= ¥100.31

interactive TV services. The pioneer of a field test of full-feature interactive TV, the Full Service Network (see Section 2.4), was launched in December, 1994 in Orlando. At a convention in February, 1994, Time Warner's Jim Chiddix said about the Full Service Network Project, "The technology can do anything we can dream up. The questions are: What do we do and what do the customers want us to do? [JES94]" Furthermore, some people including providers of interactive TV are skeptical whether interactive TV is a business which can pay for the tremendous investment in network required to launch it.

It is quite meaningful to examine customers' demands for the specific interactive TV multimedia service now for two reasons: One is that multimedia services such as interactive TV and video on demand (VOD) have many options and they should be tailored to each customer's needs. In other words, it depends highly on customers' preferences and demands whether multimedia services turn out to be a successful business or end in failure. The other reason is that specific features of interactive TV have become clear enough for researchers to evaluate customers' demands.

## **1.5 Outline of Thesis**

The next chapter of this thesis narrows its focus from broad multimedia services to more specific multimedia network services; it then concentrates on interactive TV, a multimedia network service. It also reviews interactive TV services tested or planned in preparation for Chapter 3.

Chapter 3 focuses on our survey of the demand for hypothetical interactive TV services. It covers the design of a questionnaire, the method for conducting the survey and the descriptive statistics of the responses. In Chapter 4, the formulation of a model for estimating the demand for interactive TV is discussed. A nested logit model is adopted. Chapter 4 also describes the estimation results using the model. In Chapter 5, we analyze the estimation results discussed in Chapter 4 and give some suggestions as to how they can be applied to the business world. Future work and major findings are discussed as well in the conclusion to the last chapter.

## Chapter 2

### Multimedia Services:

## Critical Factors for Determining Demand for Interactive TV

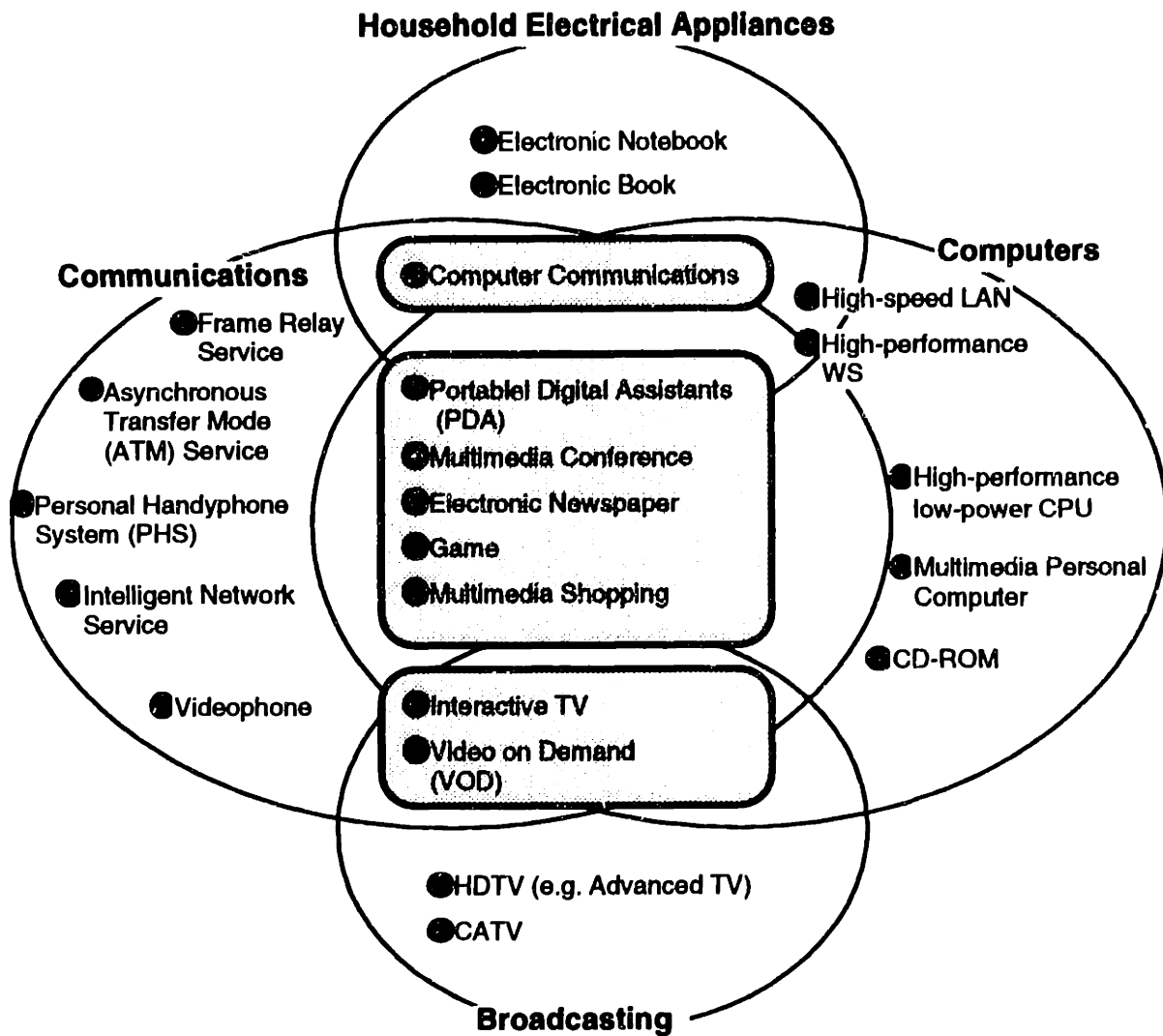
The purpose of this chapter is to describe the critical factors affecting the demand for interactive TV services. At first, some specific multimedia services are reviewed briefly. Then, we focus on multimedia network services, which are taking shape now and seem to have a promising future. We further focus on an interactive TV, one of multimedia network services. Finally, we discuss two critical factors for determining demand for interactive TV: the specification of services and the pricing scenario.

### 2.1 Applications of Multimedia

What kind of services will be provided for the general public in the coming multimedia information age? They are summarized as follows [NII93]:

- Health care services provided when and where required (telemedicine)
- Retrieval of the best price of groceries, furniture and clothing in a community (community access networks)
- Free flow of information between the government and the public
- Support for scientific collaboration —access to database, sharing of vast resources of documents and communication with colleagues
- Latest movies, video games, shopping and banking services available at home
- The best education equally available to all students regardless of geographic distance
- Realistic communications over videophones

The pamphlet *Fundamental Concepts for Multimedia Age* [NTT94], issued for media use and published by Nippon Telegraph and Telephone Corporation (NTT) of Japan in January, 1994, shows schematically new “inter-industrial” services in the coming multimedia age (Figure 2.1). This figure shows the four interrelated industries, computers, household electrical appliances, broadcasting and communications, and the specific multimedia services corresponding to each industry. Services in the categories of communications and computers, which are shaded in Figure 2.1, are especially important and will play key roles. Therefore, we will concentrate on these multimedia services, in other words, multimedia network services, from now on.



Source: [NTT94]

Figure 2.1 New "Inter-industrial" Multimedia Services



## **2.2 The Prospects of Multimedia Network Services**

Multimedia network services are defined as services that provide users in fairly wide areas with multimedia information including moving pictures through networks.

Three scenarios are considered as to how multimedia network services will develop; these scenarios are based on CATV networks, on the public switched telephone network and on computer networks.

### **2.2.1 Services Based on CATV Networks (Interactive TV)**

As described in Section 1.2.1, many US cable TV and telephone companies have been collaborating in the field tests of interactive CATV services in the last few years. In this study, we define interactive TV as a multimedia network service based on a CATV network. About 95 percent of US households live in areas where they can subscribe to CATV and more than 60 percent of them are subscribers. Therefore, interactive TV is currently thought to provide the most promising scenario, especially in the US.

The disadvantage of interactive TV is its cost. It takes a great deal of money to build an infrastructure such as the replacement of an analog CATV network with a digital optical fiber network. Although US West and Time Warner Cable have said that the interactive TV business is profitable if they can bring the introductory cost of interactive TV to within \$1,000 per household, a US research firm estimated it would be \$1,700 [NIK94]. There is hope that the cost will decrease because of economics of scale in manufacturing and because of advancing technology.

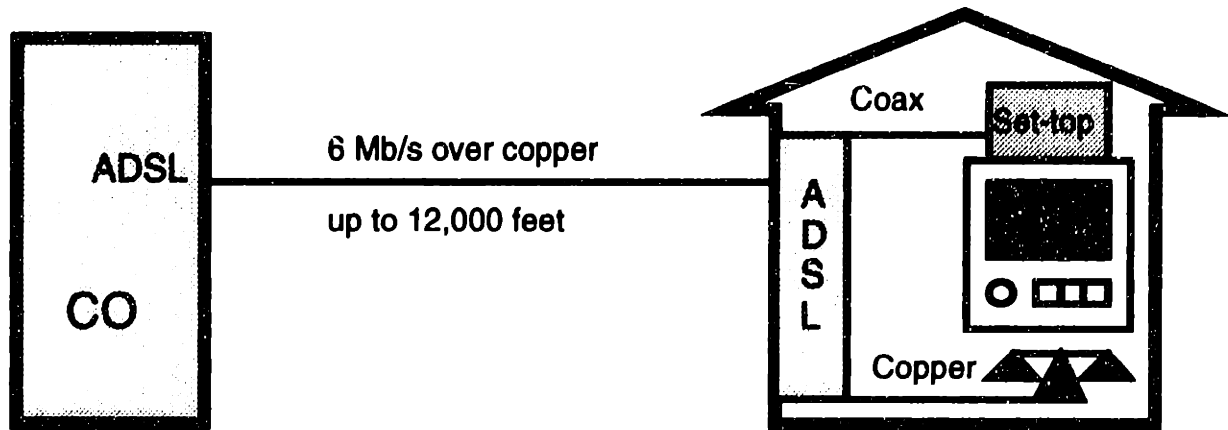
### **2.2.2 Services Based on the Public Switched Telephone Network (Video Dialtone)**

After the video dialtone ruling in 1992, telephone companies were allowed to provide video signal transmission services using their own telephone lines (video dialtone). Many telephone companies started testing video dialtone services through a copper wire network and optical fiber lines.

One of the video dialtone services is the asymmetrical digital subscriber line (ADSL), the network configuration of which is shown in Figure 2.2. It is composed of phone lines and the motion picture compression standard, MPEG1. The telephone companies make the most of the existing infrastructures such as phone lines and switches and this service has captured the spotlight because of its low cost.

Although the picture quality of the ADSL is good enough for a practical service, it can provide video signals only within a few miles of a central office. Because of this constraint of distance, the video dialtone will be limited to complement other types of

multimedia network services. Individual features provided by the video dialtone are almost the same as those provided by interactive TV.



ADSL Asymmetrical digital subscriber line  
CO Central office

Source: [TEL94]

Figure 2.2 Network Configuration of ADSL

### 2.2.3 Services Based on Computer Networks

Besides the existing personal computer communications such as CompuServe and America Online, some computer or software companies have brought out advanced personal computer communication services that are more user-friendly and more suitable for transmitting picture data. Another attempt to transmit video data to multiple locations on the Internet, called Multicast, has been tried. The greatest advantage of this scenario is that even the user of a network can become a producer or a provider of information, and that it realizes the interactive multimedia network service in its ultimate form. One of the disadvantages of this scenario is that the Internet at present does not have enough capacity to transmit a large amount of moving picture data smoothly. As far as services providing full-motion pictures are concerned, the interactive TV and the video dialtone are now ahead of the computer network-based

multimedia service. Once these disadvantages are overcome, this scenario is thought to be the most promising for the multimedia age in the long run.

When our survey was made of customers' demands and preferences for multimedia network services using hypothetical service models, these models had to be concrete and specific enough for the respondent to make realistic choices. Although the computer network-based multimedia service is thought to be the most promising in the long run, this service cannot be used in our survey as its individual features are not yet specific enough so that adequate field tests have not yet been conducted. As for the first two scenarios, the number and variation of field tests of interactive TV is much larger than of the video dialtone. Because more than 90 percent of US households are able to subscribe to CATV, we will concentrate on the first scenario, interactive TV, in our analysis of the demand for multimedia network services.

### 2.3 Outline of Interactive TV

As defined in the previous section, interactive TV is a service that provides multimedia information, especially full-motion picture (e.g., video), through a CATV network according to a viewer's request. Table 2.1 shows the fundamental techniques supporting interactive TV. As is shown here, an interactive TV system is composed of

**Table 2.1 Fundamental Techniques Used in Interactive TV**

	Data Server	Transmission	Terminal Equipment
Hardware	<ul style="list-style-type: none"> <li>• Video Server</li> </ul>	<ul style="list-style-type: none"> <li>• Optical Fiber / Coaxial Cable</li> <li>• Communication Satellite</li> <li>• Wireless Transmission</li> <li>• ATM Exchange</li> </ul>	<ul style="list-style-type: none"> <li>• Set Top Box</li> <li>• TV</li> <li>• Video Game Terminal</li> <li>• Telephone / Fax Machine</li> <li>• Remote Control</li> </ul>
Software	<ul style="list-style-type: none"> <li>• Still Picture Compression (JPEG)</li> <li>• Motion Picture Compression (MPEG)</li> <li>• Multimedia Database Management System</li> </ul>	<ul style="list-style-type: none"> <li>• ATM Exchange</li> </ul>	<ul style="list-style-type: none"> <li>• Decompression</li> <li>• Transformation</li> </ul>

Source : [COM94]

three main parts: a data server, a transmission network and terminal equipment. The two most essential elements are a video server and a set top box. The video server stores compressed, digital video on storage devices such as magnetic hard drives, and sends out the video data according to a request from a viewer. Even in the case of a deluge of requests, the video server is required to process each one correctly and rapidly. This is the key technique for interactive TV.

A set top box, on the other hand, is connected between a coaxial cable and a television set at a viewer's home. The set top box retrieves video data packets from the video server, then reassembles and decompresses them in order to display them on the screen.

## **2.4 Field Tests of Interactive TV**

Recently, telephone companies collaborated with CATV companies in planning and conducting field tests of interactive TV in the United States. In Japan, on the other hand, an association of telephone, cable, broadcasting companies and manufacturers began the New-generation Communications Network Pilot Project in July, 1994. Table 2.2 outlines these field tests, and Figure 2.3 illustrates the network configuration of the Full Service Network, one of those field tests.

### **2.4.1 Service Menus**

Almost all field tests include a video-on-demand (VOD), considered the hottest-selling feature in their menus of interactive TV services. Here, let us compare VOD with Near VOD (NVOD), a commercialized CATV service known also as a pay-per-view channel. In NVOD, a viewer can select from several programs broadcast in staggered time (e.g., 30 minutes apart). So, in NVOD a viewer usually has to wait until the chosen program starts. VOD, on the other hand, allows viewers to choose and to watch their favorite programs such as movies and music programs whenever they like. Viewers can select their favorite movie using key words, or the names of actors/actresses or directors. Once viewers choose a program, they can handle (play, review, pause, fast-forward) it as they like for a fixed period. In the field test by USA Video and Rochester Telephone, for example, the period is 24 hours. In VOD, the number of movie titles available to viewers ranges from 500 to 2000.

Other interactive TV services being tested or planned in field tests are videophone, teleshopping, entertainment programs such as a multi-player game, information services such as digital libraries, electronic news and on-screen TV guide. These individual features cover many service categories as have been shown in [NII93] (See Section 2.1).

Interactive System Corp. (ISI) in Oregon, USA is now testing some entertainment interactive TV programs including interactive TV game shows (e.g., The Wheel of Fortune) and interactive football [NHK94]. In interactive football, participants input their prediction of the next play by pressing the buttons of the remote control. If they make a right guess, they score. The highest score wins the prize.

#### **2.4.2 Pricing Scenario**

The price of interactive TV is usually the combination of the flat monthly fee and the pay-per-view fee and is similar to the existing telephone service. Table 2.3 compares the pricing scenarios of five interactive TV field tests in the US and Japan, and existing pay-per-view channels by CATV companies in the US.

### **2.5 Critical Factors for Determining Demand for Interactive TV**

As discussed in this chapter, there are two critical factors for determining demand for interactive TV: one is the specification of interactive TV services, and the other is the pricing scenario.

As for the specification of interactive TV services, it is essential for each service to be well defined and clearly presented to customers. In our survey, the specifications and characteristics of interactive TV services were explained only through text, not by visual media such as a demonstration video or samples of displayed services which appeal directly to vision. Since we relied upon a written text, it was important to define and explain services distinctly.

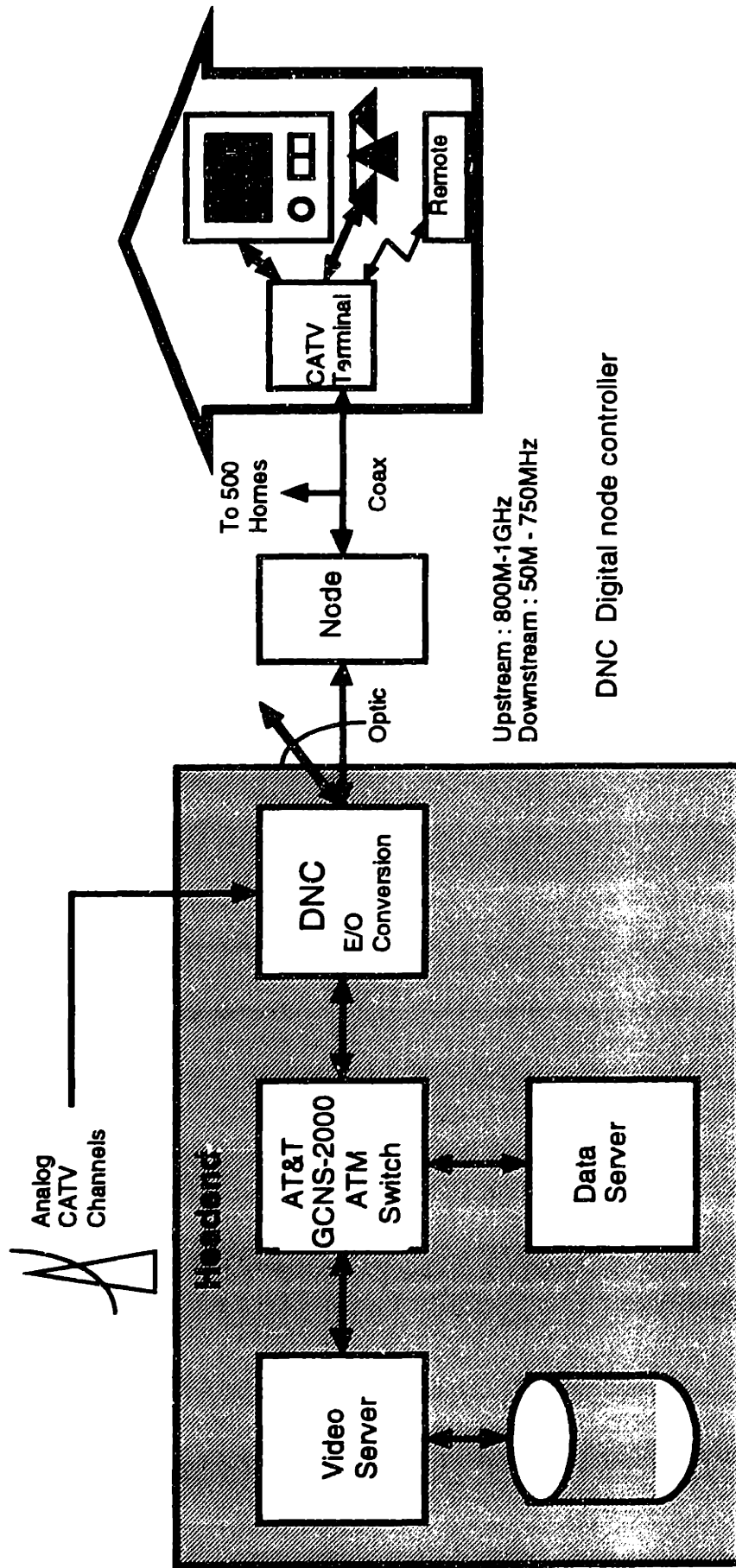
The second factor, pricing scenario, must be clear-cut and realistic. Price is as important as service specifications for customers in judging whether they subscribe to the service or not. Therefore, it is preferable to adopt the combination of pay-per-view fees and flat monthly fees, since many customers are already familiar with an existing cable TV service and public services such as telephone, electricity and gas which have this pricing system. In this pricing system, customers are provided with the fundamental services once they pay the flat monthly fee. If they want to obtain more services, they pay as they use the services (a pay-per-view fee). In our survey of interactive TV, it is also essential that all prices of services be presented distinctly so that respondents can understand the pricing system easily and evaluate the subjective value of the service.

Table 2.2 Field Tests of Interactive TV

	Full Service Network (Time Warner Cable, US West, Toshiba Corporation, Itochu Corporation)	VCTV (Phase 1) (TCI, AT&T, US West)	Castro Valley Cable System (AT&T, Viacom)	New Generation Communications Network Pilot Project Promoted by MPT 1) Conducted by PNES 2), CRL 3), private companies
Services	<p><u>First Stage</u></p> <ul style="list-style-type: none"> <li>• VOD (library of 500 to 1000 titles of digitized movies)</li> <li>• Interactive Video Shopping</li> <li>• Interactive Video Games</li> </ul> <p><u>Further Stages</u></p> <ul style="list-style-type: none"> <li>• Personal Communication Services (PCS)</li> <li>• More choices in VOD</li> <li>• Extensive Retail Shopping</li> <li>• News on Demand</li> <li>• Educational Services</li> <li>• Picture Phone</li> </ul>	<ul style="list-style-type: none"> <li>• Near VOD (library of 1500 to 2000 titles of movies)</li> <li>• Pay-per-view (24 channels in the phase 1)</li> </ul>	<ul style="list-style-type: none"> <li>• VOD</li> <li>• Virtual Mall (Home Shopping)</li> <li>• Multi-player Video Game</li> <li>• Personal Communication Services (PCS)</li> <li>• StarSight (electronic on-screen programming guide)</li> <li>• Interactive Versions of Music TV and Nickelodeon</li> <li>• Interactive Quiz Show</li> <li>• Interactive Advertising</li> </ul>	<ul style="list-style-type: none"> <li>• High Quality VOD</li> <li>• Teleshopping</li> <li>• Delivery of Video Game Software</li> <li>• Personal Handy-phone System (PHS)</li> <li>• "Karaoke" on Demand</li> <li>• Home Ticketing Service</li> <li>• Video Telephone</li> </ul>
Timing	Begin Dec 1994	Aug 1992 - June 1994	Phase 1 : Mid 1992 Phase 2 : Nov 1993 Phase 3 : July 1994	Begin July 1994 + 3 years
Location	4000 customers in suburban Orlando, FL	300 households in suburban Denver, CO	Suburban San Francisco, CA	300 households in and around Kansai Science City, Japan

Source: [TWC94], [TOB93], [BUS94], [VIA94], [PNE94], [NTT94-2]

Remarks :  
 1) MPT: Ministry of Posts and Telecommunications  
 2) PNES: Association for Promotion of New Generation Network Services  
 3) CRL: Communications Research Laboratory of MPT



Source : [TWC94]

Figure 2.3 Network Configuration of the Full Service Network

Table 2.3 Pricing Scenarios of Interactive TV Services

companies (location)	TCl, AT&T, US West (Denver)	USA Video, Rochester Telephone	ISI (Oregon)	MPT 5), PNES 6), private companies (Japan)	MediaBank Kikaku (Tokyo, Japan)	CATV Companies (USA)
services	expanded PPV VOD	VOD	Interactive Football TV Game Show	High Quality VOD	VOD, Karaoke on demand, Game Delivery, Ticketing Service	Pay-per-view channels (existing)
equipment rental fee	N/A	free	US\$ 299 3)	N/A	free	free
flat monthly fee 1)	N/A	US\$ 10 2)	US\$ 15 4)	N/A	¥ 2,000 (US\$ 19.94)	US\$ 15- 50
pay-per-view fee (per one movie)	US\$ 0.99 - 3.49 PPV 30% more for VOD	N/A	N/A	¥ 1,000 (US\$ 9.97) 7) free, ¥50 (US\$ 0.50), ¥100 (US\$ 1.00) or ¥300 (US\$ 2.99) 8)	¥ 300 9) (US\$ 2.99)	US\$ 3.95 10) US\$ 5.95 11) US\$ 10-25 12)

Source: [TOB93], [KER94], [NHK94], [PNE94], [NKS94]

Remarks:

- 1) For the first five interactive TV services, fees for existing CATV services are not included.
  - 2) Includes one favorite movie
  - 3) Includes set top box rental fee and the service fee for first six months
  - 4) Charged after the sixth month
  - 5) MPT: Ministry of Posts and Telecommunications
  - 6) PNES: Association for Promotion of New Generation Network Services
  - 7) Price of latest movies and TV dramas not available for lease
  - 8) Price of other movies and TV programs available for lease
  - 9) Price of movies in the VOD service
  - 10) Price of movies
  - 11) Price of special movies (e.g., adult movies)
  - 12) Price of special programs (e.g., concerts, pro-boxing title matches)
- \* For all prices the exchange rate on Dec. 16, 1994 US\$ 1 = ¥ 100.31



## **Chapter 3**

### **Survey of Demand for Interactive TV**

In this chapter, our survey of the demand for interactive TV is discussed. In Section 3.1, we explain how we designed the questionnaire for the survey. We focus on the most important part of the questionnaire, the design of hypothetical interactive TV services, such as selection of services, pricing scenario and packaging. Section 3.2 outlines how the respondents were selected and how the responses were collected. Section 3.3 outlines the descriptive statistics of the survey such as the profile of the respondents and how the services were chosen.

#### **3.1 Questionnaire Design**

The questionnaire of our survey is based on the New York Times survey (see [TIE93]) and field tests of interactive TV (for the questionnaire, see Appendix A). The questionnaire is composed of three parts: (1) the respondent's usage of audio-visual equipment relevant to the interactive TV, (2) the respondent's choice among hypothetical interactive TV services, and (3) the respondent's socio-economic characteristics. Section 3.1.1 describes the advantages of a stated preference (SP) survey, which is included in part (2) of the questionnaire. In Section 3.1.2, the characteristics of the menu approach, which is also used for part (2) of the questionnaire, are compared with the pair comparison method. Section 3.1.3 describes the selection of individual services, the pricing scenario, the introduction of discount packages and the overall structure of the menu. Section 3.1.4 describes part (1) of the questionnaire that covers the respondent's usage of audio-visual equipment.

##### **3.1.1 Stated Preference Survey**

Stated Preference (SP) data are based on choices respondents would make under hypothetical situations. It is necessary to conduct a survey for a choice model in analyzing customer preference for potential interactive TV services, because we do not currently have real market data on actual choices.

SP data have many advantages for an analysis of demand for potential services. First, the designer of a survey can arbitrarily set values of attributes comprising choice sets. It is also beneficial that a measurement error of attribute values be negligible.

Second, the choice set is defined clearly in SP data. Third, the designer of a survey can ask a preference from the respondent in various ways: rating, ranking, matching and choice. [BEN93]

### **3.1.2 Menu Approach**

The design of a realistic choice task in such cases as enhanced telephone calling features and interactive TV services requires a menu approach. With menu approach, survey respondents are presented with a menu listing available features and their corresponding prices similar to the way customers are presented with a menu in a restaurant. Table 3.1 is an example of a menu for interactive TV services. Individual services and their fees are listed. Customers read the explanations of services which accompany a menu, then they select services they wish to subscribe to. They can also calculate how much they would pay per month for their choices.

Let us clarify the advantages and disadvantages of the menu approach by comparing it to the pair comparison, shown in Table 3.2. A respondent reads the list of the attributes of the two VOD services, such as the number of movie titles and its pay-per-view fee, compares the two and then answers which one s/he prefers on the scale given.

The greatest advantage of the menu approach is that customers' choice behavior in the questionnaire is analogous to a great extent to their actual decision-making behavior. Another advantage is the greater degree of freedom in the menu approach. The hypothetical interactive TV service in the pair comparison is virtually confined to VOD because of its limited number of attributes. With the menu approach, we can design the full-function interactive TV including amusement programs and information services as well as VOD. Discount packages in which the total fee of individual services is discounted can also be introduced in the menu approach.

However, a disadvantage of the menu approach is the complexity of its experimental design and data analysis. A disadvantage for survey respondents is that it takes longer to make a choice in the menu approach than that in the pair comparison. Therefore, the number of menus provided to one respondent should be smaller in the menu approach.

We chose the menu approach because of its similarity to actual choice behavior and adopted it for building hypothetical interactive TV services in our survey. (For menu approach, see [BEN93])

**Table 3.1 Menu Example**

Services	Flat Monthly Fee (US Dollars)	Pay-per-view Fee (US Dollars)
Basic Monthly Fee	4.20	—
VOD	—	2.80
On-screen TV Guide	1.35	—
TV Reruns	—	1.95
Interactive TV Game Show	—	1.95
Interactive Football Game	—	2.80
Interactive Sports TV	—	1.60
TV Home Banking	2.80	—
Music Store on Your TV	1.60	—

**Table 3.2 Example of Pair Comparison**

<b>VOD 1</b>			<b>VOD 2</b>		
Number of movie titles is 500			Number of movie titles is 1500		
Number of movie titles updated a month is 50			Number of movie titles updated a month is 25		
You can watch for 48 hours after choosing			You can watch for 24 hours after choosing		
Monthly fee is \$5.50 \$2.95 per movie			Monthly fee is \$6.50 \$3.55 per movie		
Which VOD service would you choose?					
Definitely	Possibly	Cannot	Possibly	Definitely	Neither
VOD 1	VOD 1	decide	VOD 2	VOD 2	of these
( )	( )	( )	( )	( )	( )

### **3.1.3 Building Menus**

#### **3.1.3.1 Selection of Individual Services**

The eight individual services of the Interactive TV for the survey and their brief definitions are listed in Table 3.3.

The first thing which must be considered in the selection of individual interactive TV services is that each of them should be specific and defined clearly enough for a respondent to make a realistic choice. Therefore, the selection is based on interactive TV services actually tested by CATV and telephone companies. As described in Section 2.4.1, VOD is the most fundamental and seems to be the most promising interactive TV service. On-screen TV Guide, which allows viewers to choose their favorite TV programs directly from the guide on the TV screen, is also tested together with VOD and is already commercialized by some CATV companies. As another example, teleshopping is tested by many companies, however, the "teleshopping" or "shopping on your TV" itself is not specific for a service in our survey. So, we integrate teleshopping and the Music TV (MTV), one of the most famous CATV channels featuring up-to-date information on music, and create the service of "Music Store on Your TV."

Another consideration is that the overall set of individual services cover a wide field of home-oriented entertainment features such as movie, sports, music and games in order to attract the general public, not the people in a specific area. For music and shopping lovers, the Music Store on Your TV is offered. For sports fans, there are two services provided, Interactive Football Game and Interactive Sports TV, both of which are actually tested by CATV companies.

The New York Times performed a survey on viewers' preference for some future TV features in June, 1993 [TIE93]. Table 3.4 shows the results of the survey together with the corresponding categories of interactive TV services in our survey. The most popular feature in the NYT survey was TV Reruns, which enables viewers to watch reruns of TV program they have missed. More than 70 percent of the respondents showed some interest in it. TV Reruns was offered as an individual service in our survey. The interactive TV Game Show, which more than half of the Times' respondents expressed an interest in, is also included in the individual services for TV game show lovers. Nearly half of the Times' respondents showed an interest in TV Home Banking, which also offered in the individual services in our survey. A video telephone service, which was the second most popular feature mentioned in the Times' survey, was not included in our survey because the complicated pricing system of the video telephone would make

the pricing scenario of our menu too complex.

**Table 3.3 Individual Services for Interactive TV**

Service Title	Service Definitions
<b>VOD (Video on demand)</b>	This feature allows viewers to choose their favorite movies whenever they want. Once they choose, they can handle (play, review, pause, fast-forward) it as you like for some period, as if they used their own VCR.
<b>On-screen TV Guide</b>	Viewers can choose their favorite TV program on any given day directly from the guide on their TV screen.
<b>TV Reruns</b>	Viewers can watch reruns whenever they want of TV programs they've missed whenever they want. They can choose among programs previously broadcasted up to a month ago.
<b>Interactive TV Game Show</b>	Viewers can participate in a TV game show from their home at the touch of a remote control button. At the end of the program, they can compare their score to those of the participants on the actual TV show and to the scores generated via interactive TV service (like theirs). They can win a prize for the highest score.
<b>Interactive Football Game</b>	This feature corresponds with a televised football game, both NFL and collegiate. Participants predict whether the next play is "run" or "pass," or whether next pass/run is toward right, middle or left/ short, middle or long. If they guess correctly, they score. If they earn the highest score at the end of the game, they win prize money.
<b>Interactive Sports TV</b>	This feature allows viewers to choose the camera angle from which to watch a televised sports event, such as baseball, tennis and football, by just pressing buttons on their controller.
<b>TV Home Banking</b>	In this feature, viewers can review bank statements and pay bills (public utility charges such as electricity, gas and telephone) on their TV screen.
<b>Music Store on Your TV</b>	First, viewers choose a genre (e.g., rock, rap, top 10.) Then, an MTV-like video clip is broadcast. They can "browse" video clips and they can order the corresponding CD, cassette tape, or video if they like.

**Table 3.4 Results of the Survey by the New York Times**

Question asked in the New York Times Survey	Corresponding service in our survey	Very interested (%)	Some-what interested (%)	Not at all interested (%)
How interested would you be in watching reruns of programs you've missed whenever you wanted by pressing a few buttons?	TV Reruns	38	39	23
Making video telephone calls that allow you to see the other person on your television?		35	35	29
Playing along with a television game show?	Interactive TV Game Show	22	35	43
Choosing a camera angle to watch a televised sports event?	Interactive Sports TV	22	31	46
Reviewing bank statements and paying bills?	TV Home Banking	21	27	51
Ordering products or brochures directly from a catalogue on your television screen?	Music Store on Your TV	14	35	51

Source: [TIE93]

### 3.1.3.2 Pricing Scenario

We have to settle the reference (or "base") pricing scenario of interactive TV services in our survey. The pricing scenario of the interactive TV services in our survey assumes that a viewer has already subscribed to an existing CATV service. So, each fee in this section does not include that of existing CATV.

The pricing scenario consists of two parts: a flat monthly fee and a pay-per-view fee. The former includes the monthly basic fee and fees for unlimited services. Once a customer pays the basic monthly fee, s/he can use any interactive TV services at the given cost. The latter is charged every time a viewer watches a program such as VOD and TV Reruns. For instance, in the field test of USA Video and Rochester Telephone, the flat monthly fee for VOD and On-screen TV Guide is \$10.00, which includes viewing one favorite movie of VOD [KER94]. Each VOD movie in the testing phase costs from \$1 to \$4 and each movie of commercialized pay-per-view channels provided by CATV

companies normally costs \$3.95 as shown in Table 2.3. Considering the manufacturing economies of scale, the fee for VOD is a bit cheaper in our survey than those in field tests or commercialized pay-per-view channels. Unlimited individual services are available for TV Reruns, Interactive Football Game and Interactive Sports TV, and flat monthly fees are charged for them. The flat monthly fees for unlimited services is three times that of the pay-per-view fees. The reference pricing scenario of individual services in our survey is shown in Table 3.5. To make the system simple, the rental fee of a set-top box is free. If a consumer chooses two movies on VOD and On-screen TV Guide in a specific month, the total monthly cost is \$11.15.

**Table 3.5 Reference Pricing Scenario of Individual Services**

Services	Flat Monthly Fee (US Dollars)	Pay-per-view Fee (US Dollars)
Basic Monthly Fee	4.20	—
<b>INDIVIDUAL SERVICES</b>		
VOD	—	2.80
On-screen TV Guide	1.35	—
TV Reruns	—	1.95
Unlimited TV Reruns (including TV Reruns)	5.85 (= 1.95 * 3)	—
Interactive TV Game Show	—	1.95
Interactive Football Game	—	2.80
Unlimited Interactive Football Game (including Interactive Football Game)	8.40 (= 2.80 * 3)	—
Interactive Sports TV	—	1.60
Unlimited Interactive Sports TV (including Interactive Sports TV)	4.80 (= 1.60 * 3)	—
TV Home Banking	2.80	—
Music Store on Your TV	1.60	—

### 3.1.3.3 Discount Packages

There are eleven types of individual services. Thus, it may be complicated for customers to choose the combination of services to which they want to subscribe. As is often the case with products and services with multiple features, it would be better to

introduce discount packages.

The advantages of a discount package for customers are as follows:

- Economical -- charges are discounted from total fees of individual services.
- Convenient – it saves customers trouble in selecting from a lot of individual services and choosing between pay-per-view and unlimited services.

The advantage of packaging for the operating company, on the other hand, is that it may encourage customers to subscribe to more services including ones they will not use otherwise.

To avoid complexity, all services included in the discount packages are charged as a flat monthly rate except for VOD. Three kinds of discount packages are introduced in the menu. The first one (Package A) could be referred as the reasonable or fundamental package, which includes VOD, On-screen TV Guide and TV Reruns. Package B includes VOD and all individual services with flat monthly fees except Unlimited Interactive Sports TV, and is for those who would subscribe to whatever they can afford. Package C is specialized for sports fans. Figure 3.1 shows the configuration of services in the discount packages. Both the pay-per-view fee for VOD and flat monthly fees are discounted in those packages. A respondent may choose at most one package. Therefore, there are four general categories for respondents' choices: no service at all, individual feature(s) only, a discount package only, and one discount package together with individual feature(s).

#### **3.1.3.4 Combination of Attributes in Menus**

Table 3.6 indicates the thirteen attributes of menus. Nine of the attributes are basic monthly fee, and fees for pay-per-view services and unlimited services. The remainder of the attributes is the number of movie titles provided in VOD, length of time when viewers can watch a movie in VOD, the discount ratio in packages, and the ratio of a monthly fee to a pay-per-view fee. Each attribute has three levels as shown in Table 3.6. All fees set by the reference pricing scenario shown in Table 3.5 are on the medium level. The prices of lower and higher priced services are set to 0.7 times and 1.4 times of medium priced ones, respectively. Using a  $3^{13-10}$  fractional factorial design, 27 menus were generated. In addition to the 27 menus, the 28th menu, in other words, the reference menu was created. It is thought to be the most realistic or to be similar to the service which would be provided for the public in the future. The values of attributes of the reference menu are underlined in Table 3.6. All 28 menus have the same three discount packages, A, B and C. Table 3.7 shows an example of a menu.

These 27 menus were randomly divided into nine groups, and each group contains



three menus. Each respondent was presented with four menus, three from one of the nine groups, plus the reference menu. Therefore, the reference menu was presented to every respondent, and it enables us to analyze the choice behaviors of all respondents toward the same menu.

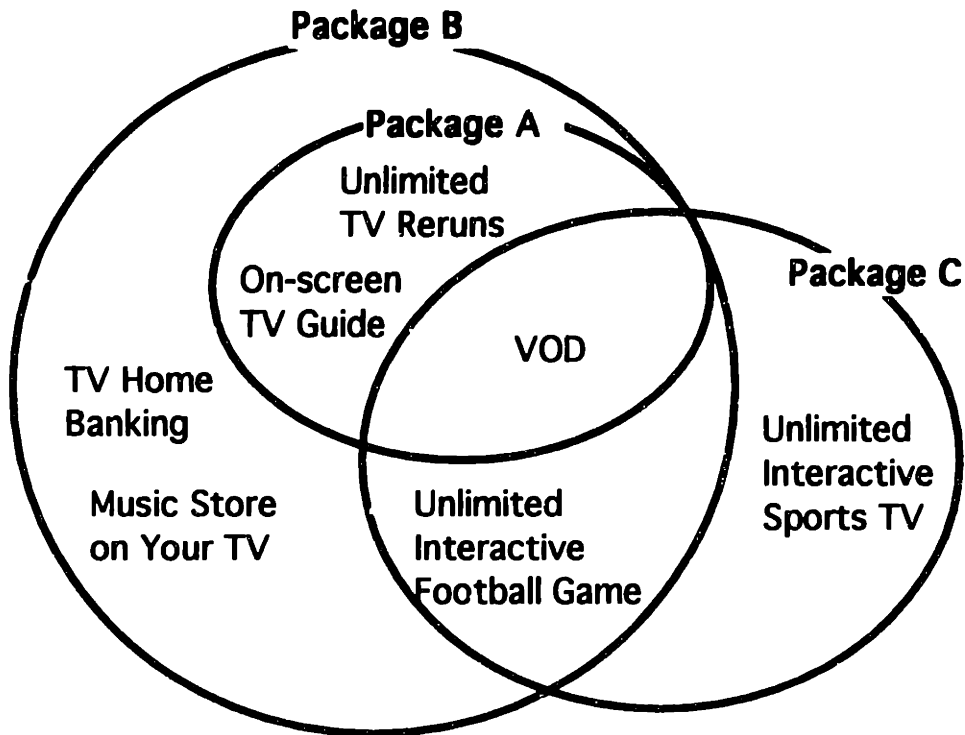


Figure 3.1 Configuration of Services in Packages

**Table 3.6 Attributes of Menus**

Attributes	# of Levels	Value of each level
# of movie titles provided in VOD	3	(200, 500, <u>1500</u> )
Length of time when viewers watch the movie	3	(8 hours, <u>24 hours</u> , 48 hours)
Discount ratio in packages [ Fee for individual services ]	3	(20%, 30%, <u>40%</u> ) (High=Middle*1.4, Low=Middle*0.7)
Basic monthly fee (overall Interactive TV)	3	(2.95, <u>4.20</u> , 5.90)
VOD fee (PPV fee)	3	(1.95, <u>2.80</u> , 3.90)
On-Screen TV Guide fee	3	(0.95, <u>1.35</u> , 1.90)
TV Reruns fee (PPV)	3	(1.35, <u>1.95</u> , 2.75)
Interactive TV Game Show fee (PPV)	3	(1.35, <u>1.95</u> , 2.75)
Interactive Football Game fee (PPV)	3	(1.95, <u>2.80</u> , 3.90)
Interactive Sports TV fee (PPV)	3	(1.10, <u>1.60</u> , 2.25)
TV Home Banking fee	3	(1.95, <u>2.80</u> , 3.90)
Music Store on Your TV fee	3	(1.10, <u>1.60</u> , 2.25)
Ratio of monthly fee (unlimited services) to pay-per-view fee	3	(2, <u>3</u> , 4)

Note : Underlined figures are for the reference menu distributed to all respondents and thought to be the most realistic interactive TV service.

**Table 3.7 Menu Example**

**MENU**

- Basic monthly fee for any Interactive TV services is US\$ 5.90, which is not included in prices listed below.
- Number of movie titles you can choose in VOD is 500.
- Length of period you can handle your chosen movie in VOD is 8 hours.

Check this column	<b>DISCOUNT PACKAGES (30% discount)</b>	Monthly fee (US Dollars)	Pay per view fee (US Dollars)
	Package A : VOD, On-Screen TV Guide Unlimited TV Reruns	6.90	1.35 (VOD)
<input type="checkbox"/>	Package B : VOD, On-Screen TV Guide Unlimited TV Reruns Unlimited Interactive Football TV Home Banking Music Store on Your TV	17.20	1.35 (VOD)
<input type="checkbox"/>	Package C : VOD Unlimited Interactive Football Unlimited Interactive Sports TV	12.35	1.35 (VOD)
Check this column	<b>INDIVIDUAL SERVICES</b>	Monthly fee (US Dollars)	Pay per view fee (US Dollars)
<input type="checkbox"/>	VOD	—	1.95
<input type="checkbox"/>	On-screen TV Guide	1.35	—
<input type="checkbox"/>	TV Reruns	—	2.75
<input type="checkbox"/>	Unlimited TV Reruns (including TV Reruns)	10.95	—
<input type="checkbox"/>	Interactive TV Game Show	—	1.35
<input type="checkbox"/>	Interactive Football Game	—	2.80
<input type="checkbox"/>	Unlimited Interactive Football Game (including Interactive Football Game)	11.20	—
<input type="checkbox"/>	Interactive Sports TV	—	2.25
<input type="checkbox"/>	Unlimited Interactive Sports TV (including Interactive Sports TV)	8.95	—
<input type="checkbox"/>	TV Home Banking	1.95	—
<input type="checkbox"/>	Music Store on Your TV	1.60	—

### **3.1.4 Respondents' Usage of Audio-Visual Equipment**

There are many existing services and types of equipment which seem to have connections with interactive TV services, questions about the usage of which are included in our survey. The respondents' usage of TV and how much they are satisfied with it will be associated with their choice behavior toward the hypothetical interactive TV services. Existing pay-per-view programs on CATV network are thought to be the initial stage of the VOD service of the interactive TV. So, the respondents' usage of CATV and pay-per-view programs will be important factors in estimating their preferences to interactive TV. Respondents' attitudes to video-rental services are also connected to their attitudes to the interactive TV.

As mentioned in Section 2.2, multimedia network services will develop based on three types of infrastructures, CATV networks, the public switched telephone network and computer networks, and these three types of multimedia network services are related to each other to a great extent. Therefore, questions which refer to whether respondents have personal computers, fax machines, two or more phone lines and an access to a computer network at home are included in the questionnaire.

### **3.2 Sample Design**

It was necessary for the responses to the questionnaire to be collected within a limited period of time in our survey. Therefore, we limited ourselves to a convenience sample. We made use of the Internet and the e-mail system as is shown in Figure 3.2, which is thought to be the fastest way to collect answers from respondents from geographically various areas.

First, we posted a notice of our survey on some newsgroups on the Internet. The subjects of newsgroups on which the notice was posted varied from areas closely related to that of the survey (e.g., CATV, telecommunications, movies) to more general areas that have little to do with the survey topic (e.g., general bulletin boards) so that respondents of various backgrounds could take part in the survey. Then, the questionnaire was sent as an e-mail only to those who showed an interest in the survey. In this way, the "response ratio" (the ratio of the number of those who returned their answers to that of those who received the questionnaire) was quite high (more than 60%).

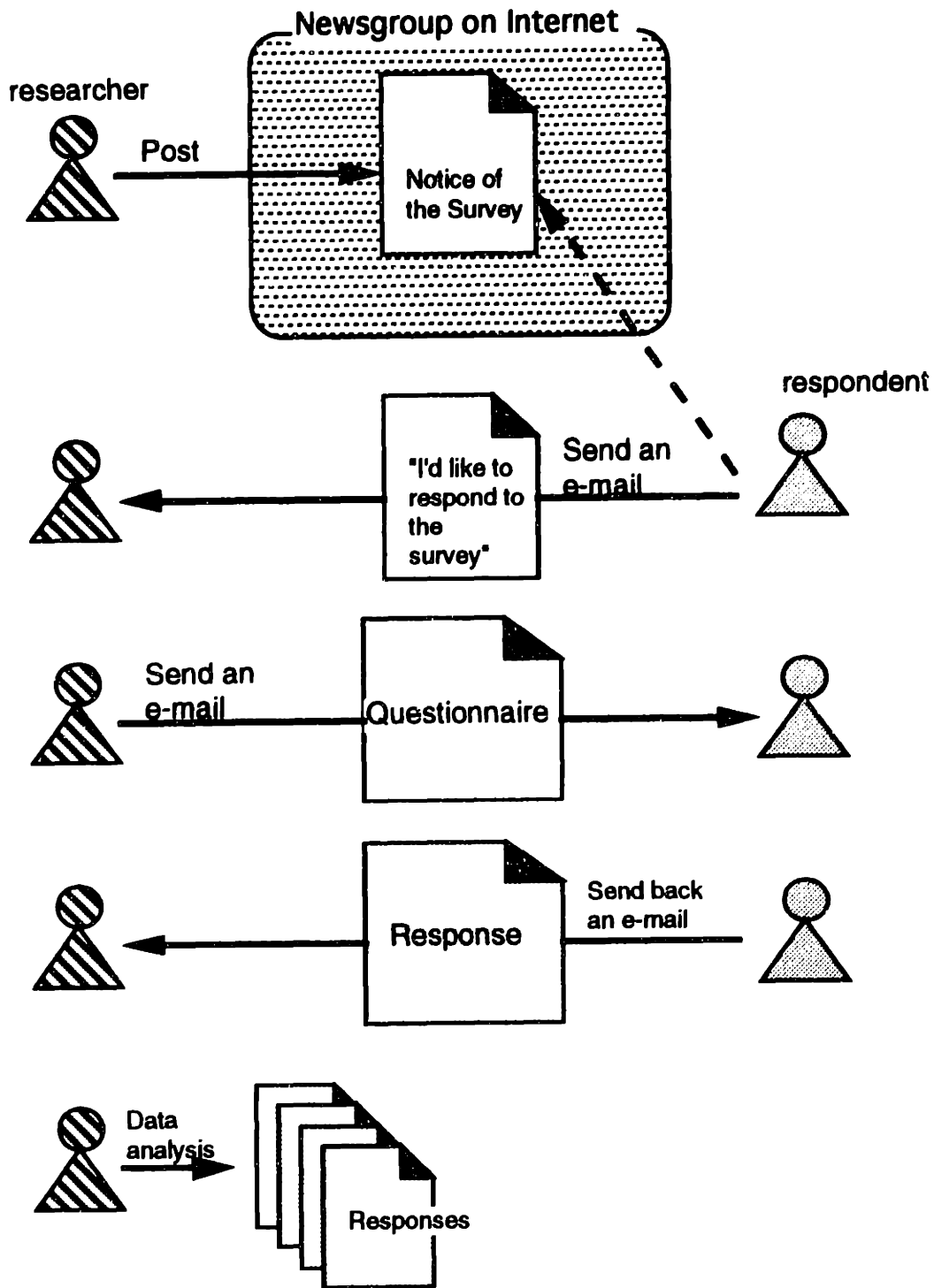


Figure 3.2 Data Collection Procedure

### **3.3 Descriptive Statistics**

#### **3.3.1 Profile of Respondents**

As a result of our survey, we were able to receive 119 valid responses. The complete coverage of the results of our survey is shown in Appendix B.

First, we describe the socio-economic characteristics of the respondents. Just over one-fifth (22%) of the respondents were female. The respondents' age is distributed almost uniformly except for the fact that there was only one respondent of the age of 55 or over. As to their educational background, almost half (47%) of them have completed graduate programs or higher programs. While almost one-quarter (24%) of them are living alone, 11% are living in a household of 5 or more people. As mentioned in Section 3.2, this survey was performed through the e-mail system on the Internet. So, the locations of respondents' homes are not only in the US (78%) but also in Canada (3%), Europe (17%), Australia (1%) and Singapore (1%). The US residents responded from 26 states. The highest concentrations came from: Massachusetts (15 respondents), California (14) and Virginia (8).

Second, we describe the respondents' attitudes toward audio-visual equipment and services such as TV, CATV and a personal computer. More than one-quarter (27%) of the respondents feel very satisfied or fairly satisfied with the choice of programs available on TV, however, just over a half (52%) feel dissatisfied with the choice of movies available on TV. The percentage of the respondents who are dissatisfied with the choice of entertainment programs other than movies on TV is smaller than that of those who are dissatisfied with the choice of movies on TV. More than one-third (35%) prefer to watch a movie at home rather than go out to a movie theater. Nearly 95% of them live in an area where CATV is available and more than two-thirds subscribe to CATV. Regarding pay-per-view channels available in CATV, 28% of the respondents have paid for them at least once. The vast majority of the respondents (84%) are currently members of video-rental shops.

Let us compare the results of our survey which address the 93 respondents who live in the US with these of the Times Mirror Survey to more than 4,000 US households [TIM94]. The comparison is shown in Figure 3.3. Generally, a higher percentage of respondents in our survey have or use audio-visual equipment or services than in the Times Mirror Survey. The percentages of respondents who own a videocassette recorder (VCR) at home, who have a video game system at home, and who subscribe to CATV are close in the two surveys. However, the percentages of those who have a personal computer, who own an access to a computer network (or a modem), and who have a fax

machine at home are much higher in our survey than those in the Times Mirror Survey. The percentages of those who have or use equipment or services in the Times Mirror Survey is thought to be close to those of the US nationwide. So, it can be said that the US respondents to our survey own personal computers, the ability to access a computer network and fax machines at home at much higher rate than the average US household. This conclusion is reasonable considering the fact that the respondents to our survey are collected through a computer network, the Internet. In regard to the subscription to CATV, and ownership of VCRs and video games, the US respondents in our survey are not so different from the average US household.

As shown in this section, the group of the respondents to our survey is not representative of the US household. Therefore, the absolute values of the result from our survey cannot be applied to the US nationwide.

### **3.3.2 Choice behavior**

Figures 3.4 to 3.6 show how the respondents chose the interactive TV services in the reference menu, which was given to all the respondents and is thought to be the most realistic. The vast majority of the respondents (85%) chose one or more service(s). Over forty percent of them (44%) chose a discount package only and over one-quarter (27%) chose one discount package and one or more individual service(s), while only 14% chose individual service(s) only. More than half (57%) chose Package A, which includes VOD, On-screen TV Guide and Unlimited TV Reruns. More than one out of ten respondents (11%) chose Package B. As a result, more than two-thirds of them chose VOD, On-screen TV Guide and Unlimited TV Reruns.

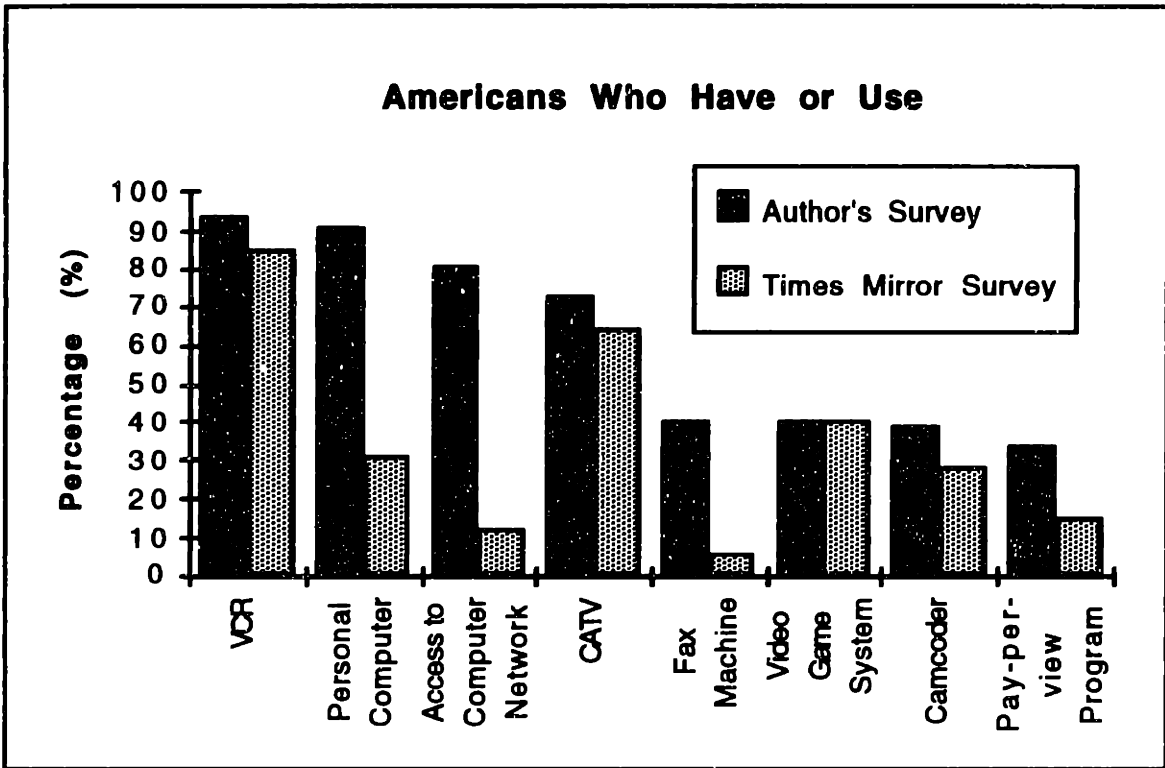
Let us concentrate on three services, TV Reruns, Interactive Football Game and Interactive Sports TV, provided in both the unlimited style and in the pay-per-view style. While most of the TV Reruns and Interactive Football Game choices were chosen as an unlimited program, 40% of Interactive Sports TV were chosen as a pay-per-view program. On the whole, as some respondents commented, people prefer to pay a flat monthly fee for unlimited services rather than pay every time they use it.

Services such as VOD, On-screen TV Guide and Interactive Football Game included in the packages were chosen as a package in many cases. In other words, people tend to choose services as a package rather than a combination of individual services. However, surprisingly enough, TV Home Banking and Music Store on Your TV were chosen more often as individual services than as packages.

Many respondents (41%) chose three services and 12% chose six services, because the number of individual services of the Packages A, B and C are 3, 6 and 3,

**respectively. Nobody chose eight services, which is the upper limit of possible choice combination.**





Source: [TIM94]

Figure 3.3 Comparison between Author's Survey and Times Mirror Survey

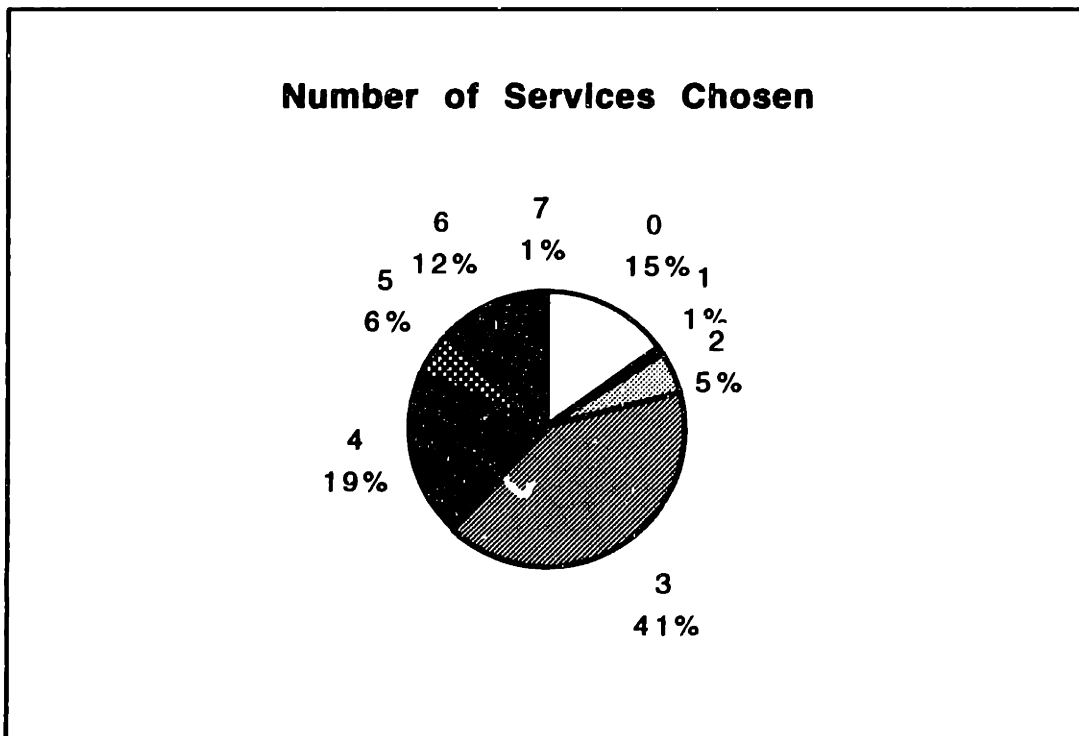


Figure 3.4 The Number of Services Chosen in the Reference Menu

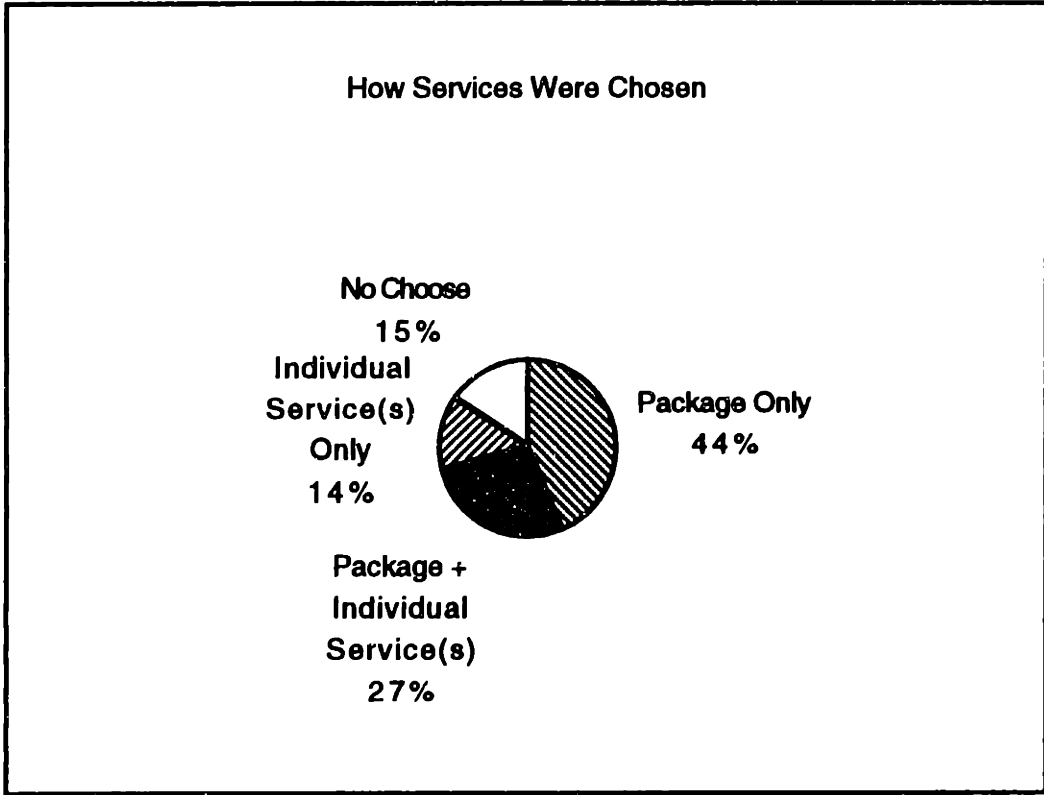


Figure 3.5 How Services Were Chosen in the Reference Menu

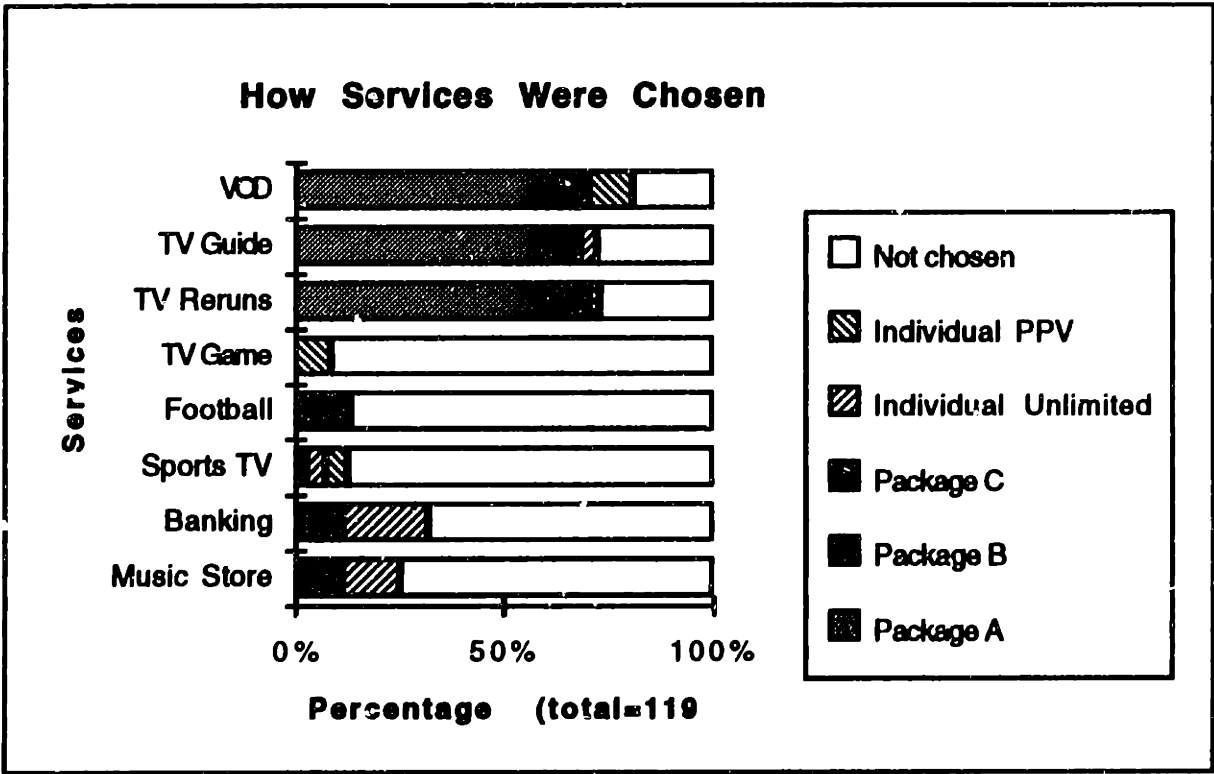


Figure 3.6 How Services Were Chosen in the Reference Menu

# Chapter 4

## Model Formulation and Estimation

This chapter describes the formulation and estimation of the interactive TV choice model. Section 4.1 describes the nested logit (NL) model we adopted for model formulation. In the estimation of the lower level of the NL model, we employed the technique called sampling of alternatives in order to estimate the model using a subset of alternatives rather than all alternatives. Section 4.2 describes the estimation method using sampling of alternatives and the variables for the model estimation. In Section 4.3, the estimation results of lower and upper level models are described.

### 4.1 Formulation of Model

#### 4.1.1 Logit Model

The discrete choice model assumes that each decision maker will choose the most desirable alternative, or more technically, s/he will choose the alternative with the highest utility.

Various kinds of discrete choice models have been developed. A logit model was chosen here because of its simplicity in estimating parameters. Appendix C is a brief description of some of the concepts of choice theory together with a general overview of discrete choice analysis and of the logit model (see [BEN85] ).

The multinomial Logit (MNL) model is expressed as:

$$P(i) = \frac{\exp V_i}{\sum_{j \in C} \exp V_j}$$

where  $P(i)$  is the choice probability of alternative  $i$ ,  $V_i$  is the systematic component of the utility for alternative  $i$  and  $C$  is the choice set. The MNL model is generally superior to other models in terms of computational time required for model estimation.

The logit model has a property known as Independence from Irrelevant Alternatives (IIA). Concisely stated, the IIA property holds that the ratio of choice probabilities of any two alternatives is unaffected by the presence of any other alternatives. In the case of MNL, this can be expressed as:

$$\frac{P(i)}{P(k)} = \frac{\exp V_i / \sum_j \exp V_j}{\exp V_k / \sum_j \exp V_j} = \exp(V_i - V_k)$$

The IIA property of the logit model permits us to estimate the model using a sampled subset of alternatives. For estimation purposes, the procedure is called "sampling of alternatives," and it is described in Section 4.2.1.

#### 4.1.2 Nested Logit Model

The structure of a nested logit (NL) model applied to the estimation in our research is diagrammed in Figure 4.1 and the structure is the same as that of the NL model used in [BEN93] (see Appendix D for more details of the NL model). Figure 4.1 shows a decision maker's decision between buying nothing (no buy) and subscribing to at least one service (buy) as the upper level of the NL model and choice among possible alternatives (combinations of services) as the lower level.

In the upper level model, we can calculate the probability that the choice maker decides to buy (or subscribe to) nothing or buy one or more services. The lower model, on the other hand, represents the conditional probability of choosing a particular combination of services given a decision to buy at least one service. We adopt the NL model because a priori we thought that the unobserved attributes of alternative service combinations are more similar to one another than to the no buy alternative.

#### 4.2 Estimation Methods

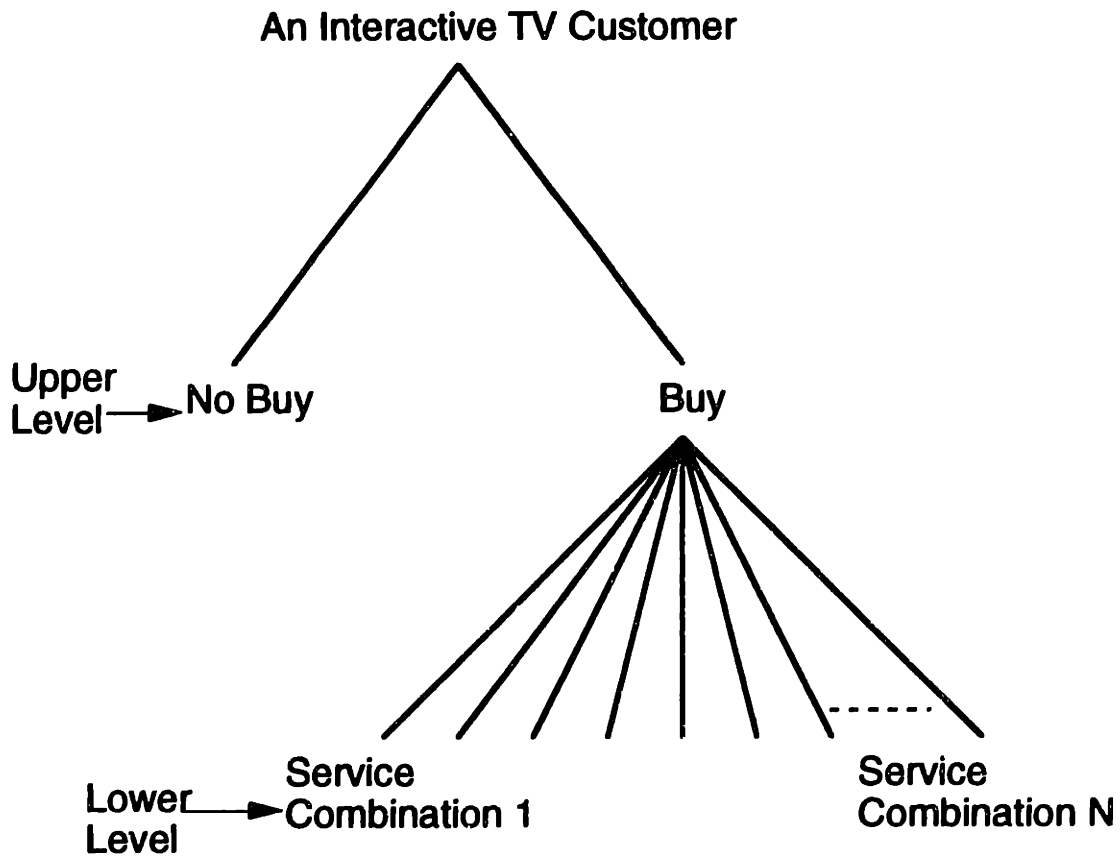
The estimation of the lower level and upper level MNL models were performed using SST, a statistical package. In the estimation, we used many observations for each individual, violating the assumption of independence among observations. Therefore, the estimated parameter obtained through calculations of standard statistical packages are consistent<sup>1</sup> but not efficient<sup>2</sup>. Moreover, obtained t-statistics are overestimated (see [AME85] for formal proof).

The Jackknife Method (see Appendix E) was used to calculate the correct standard errors of the estimated coefficients. Both originally calculated t-statistics by SST and

---

<sup>1</sup>A consistent estimator has a distribution that converges on the true parameter value as the sample gets larger.

<sup>2</sup>An efficient estimator has the smallest variance of all other estimators.



- Service Combinations**
- A. One or more individual service(s)
  - B. Discount package
  - C. Discount package plus one or more add-on service(s)

**Figure 4.1 Model Structure**

corrected ones using the Jackknife Method are shown in Tables 4.1, 4.2, 4.3.

#### **4.2.1 Sampling of Alternatives**

There are eleven individual services. For TV Reruns, Interactive Football Game, and Interactive Sports TV, people may choose either a pay-per-view service or an unlimited service. Therefore, there are 863 ( $=3^3 \cdot 2^5 - 1$ ) possible combinations of alternatives in the lower level model, minus one stands for nothing being chosen.

In terms of computation, it would be time-consuming to include all 863 combinations as alternatives. So, we employed a technique called "sampling of alternatives" (see [BEN85]) where, as the name suggests, we estimate a choice model based upon a subset of the available alternatives instead of upon all 863 combinations.

There are two issues in employing the sampling of alternatives: one is the sampling method, the other is the number of alternatives included in the subset.

Considering the simplicity in generating alternatives and in computation, we used simple random sampling of alternatives. Taking computational limitations such as the limited capacity of a memory and the performance of statistical package into consideration, the number of alternatives assigned to each observation was fixed to six. Therefore, five alternatives were randomly drawn from 862 (863 minus the one actually chosen). The assigned choice set consisted of these five alternatives plus the chosen service combination.

Although the simple random sampling of alternatives is clear-cut in terms of computation, there are some problems. One problem is that the probability of each individual service being included in the alternative subset is equal. This is different from the real respondents' choice behaviors, in which they selected specific services (e.g., VOD, Unlimited TV Reruns) more often than other services (e.g., pay-per-view Interactive Football Game). Thus, an estimation using more complex stratified sampling methods should improve our results.

#### **4.2.2 Model Variables in Lower Level Model**

The explanatory variables included in the lower level model (choice of service combination) are divided into four categories:

- (1) Price of service combination
- (2) Benefits provided by a particular service contained in the combination of alternatives  $i$
- (3) Type of combination (package only, individual services only, package plus individual services)

#### (4) Number of services included in the combination

For category (1) -- price of service combination -- there are two kinds of fees: a flat monthly fee and a pay-per-view fee. A viewer will use a different number of pay-per-view programs a month (e.g., two VOD movies, one TV Rerun and four Interactive Football Games). Therefore, for model variables, it would be more realistic to include pay-per-view fees for each service separately. Considering the fact that quite a small number of respondents selected two or more pay-per-view services in our survey and that there is a computational limitation, we summed up all pay-per-view fees and included the total as a variable.

For category (2) -- benefits provided by individual services contained in combination of alternatives  $i$  -- we created dummy variables, which are one if the service is present in combination of alternatives and zero otherwise.

For categories (3) and (4), we use dummy variables which are equal to one if a combination of alternatives is in a particular category (e.g., the number of services included in the combination is 5 or more) and zero otherwise. In category (3), we define the case of only individual services being present in the combination as the base, and two of package only and package plus individual services, are included as variables. The dependent variable is an indicator of the chosen alternative.

#### 4.2.3 Model Variables in Upper Level Model

The explanatory variables included in the upper level model (buy/no buy) are divided into five categories:

- (1) Attributes inherent in each menu
- (2) Subjective variables
- (3) Respondents' usage of audio-visual equipment or services
- (4) Socio-economic variables
- (5) Other variables (e.g., the alternative specific constant, the inclusive value)

The first category includes attributes which correspond to each menu and do not vary with different combination of alternatives. They are the number of movie titles in VOD, length of time a viewer can watch a VOD movie, the ratio of pay-per-view fee to unlimited monthly fee, and the discount ratio given in percentage.

All the variables in categories (2), (3) and (4) are dummy variables and are based on the replies of respondents in our survey. These variables equal one if a respondent is in the category corresponding to each variable (e.g., s/he subscribes to CATV) and zero otherwise.

The inclusive value in category (5) is the logsum of the utilities of the lower level

model (see Appendix D for detail).

### **4.3 Estimation Results**

Tables 4.1 to 4.3 show the estimation results of the lower and upper level models of the NL. Two kinds of t-statistics, one was originally calculated by SST and the other was corrected by the Jackknife Method, are shown in these tables.

First of all, the estimated coefficients of inclusive value in the upper level model (Table 4.2, 4.3) are between zero and one and are also significantly different from zero and one. Therefore, the NL model, the structure of which is shown in Figure 4.1, can be applied to our parameter estimation.

#### **4.3.1 Lower Level Model**

Table 4.1 presents the estimation result of the lower level model.

The price coefficients of flat monthly fee and the sum of pay-per-view fee are both negative; however, only the coefficient for flat monthly fee is significant.

The estimation results in Table 4.1 indicate that the service benefits vary dramatically among the different services. The most notable finding is the very large negative coefficient of the pay-per-view Interactive Football Game. It is due to the fact that the service was not chosen by any respondent in our sample. Almost two-thirds of the respondents chose VOD, On-screen TV Guide and Unlimited TV Reruns. So, the coefficients of these services should be significantly positive; however, all of them are not significant according to corrected t-statistics. These three services were chosen mostly as Package A or B and people who chose these services overlap to a great extent. Therefore, the variables corresponding to these services are highly correlated and is the reason for these insignificant t-statistics.

It is notable that the coefficient of TV Home Banking is significantly positive. This is because a fairly large number of respondents chose TV Home Banking as an individual service. One respondent in our survey who chose nothing commented that he was interested in only TV Home Banking but did not choose it because of the lack of information on its confidentiality and data integrity. This means that more people will subscribe to this service once the requirements on confidentiality and data integrity are completely satisfied.

The coefficient for the dummy variable equal to one if both VOD and pay-per-view TV Reruns are included in the alternative, is negative. This indicates that people tend not to choose these two services at the same time. The negative value of the coefficient of the variable equal to one if at least one pay-per-view service is present in the



alternative shows that people are less likely to choose pay-per-view services.

As for packaging, the coefficient of package only is especially large compared to its base, the coefficient of individual service only (Fig 4.2). As expected, the results indicate that, all else being equal, people are more likely to select a package than the same set of individual services if they are not offered as a package. This may reflect the fact that discounted packages are highlighted on top of the menu and that they attract people's attention more than individual services do. It may also reflect the ease of selection associated with packages. People will take less time and effort to choose packages than to choose a combination of individual services.

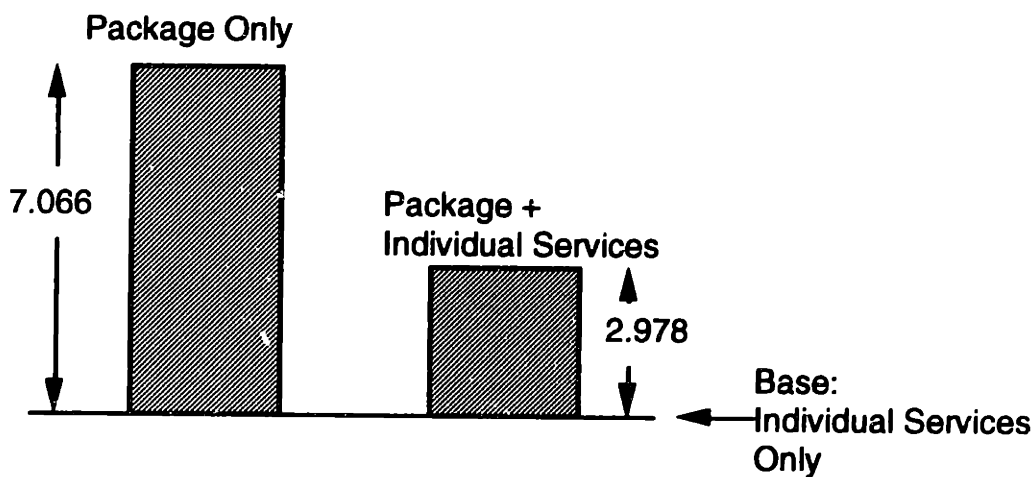


Figure 4.2 Packaging Effect

The estimated models also indicate that people prefer to subscribe to fewer services rather than to many and that, all else being equal, the utility decreases significantly as the number of services increases.

The findings that people are more likely to choose a package than the same set of individual services not offered as a package, and that people prefer to subscribe to fewer services are the same as those in [BEN93].

### 4.3.2 Upper Level Model

Table 4.2 indicates the estimation results of the upper level model (buy / no buy) and Table 4.3 shows the estimation results excluding subjective variables. All the variables in the upper level except attributes inherent to the menu, the alternative specific constant, and the inclusive value, are dummy variables equal to one if the respondent is in the category corresponding to the variable, and zero otherwise. If a t-statistic is significantly positive in Table 4.2 and 4.3, people who are in the category corresponding the dummy variable are more likely to choose interactive TV services. Subjective variables are associated with the subjective perceptions and preferences such as whether the respondents are satisfied with TV programs or whether they prefer to watch a movie at home. Table 4.4 compares our a priori hypotheses on the sign of each variable included in the upper model with the estimated results shown in Table 4.2.

It is reasonable to say that people tend to choose the interactive TV service, which has the large number of the VOD movies. A respondent commented that he worried that a VOD with a small (e.g., 200) movie library will offer only limited categories of movies such as pornography and horror movies which do not interest him.

As expected, those who are dissatisfied with the choice of movies available on TV are more inclined to subscribe to interactive TV than those who are satisfied. However, contrary to expectation, there is a tendency that people who are dissatisfied with the choice of programs available on TV do not choose interactive TV. It is because these people are not interested in audio-visual services on the whole and they are skeptical about the new version of an audio-visual service, interactive TV. The conspicuous finding is that the corrected t-statistic of the dummy variable equal to one if the respondent prefers to watch a movie at home, exceeds six, which shows that people who prefer to watch movies at home rather than go out to a theater are inclined to subscribe to interactive TV.

Although we expected people who watched TV for more than two hours on the previous day generally would like to spend their time in receiving audio-visual information and tend to subscribe to interactive TV, the reverse was the result. The reason can be that those who watch TV for longer times have less time to spend with interactive TV services. So, they do not want to pay extra money for interactive TV. The same thing can be said to people who are members of video-rental shops.

Despite a respondent's comment (she does not subscribe to cable TV) saying that she will not subscribe to any service forcing her to take cable TV, there is no significant relationship between people's subscription to CATV and their choice of interactive TV.

The estimated coefficients of three dummy variables, which equal to one if people

have paid for existing pay-per-view programs on CATV, or if they own a personal computer or a VCR at home are strictly positive and their corrected t-statistics are quite large. The pay-per-view program is the existing audio-visual service which is closest to VOD in interactive TV. Therefore, the result that pay-per-view customers are more likely to subscribe to interactive TV, is quite reasonable. Although ownership of a personal computer has a positive effect on choosing interactive TV, ownership of an access to a computer network (e.g., a modem) has a negative effect. A respondent commented that he is far more interested in browsing data on the Internet than in watching normal (not interactive) TV programs. Nowadays, many people are accessing computer networks including the Internet without the recognition of paying a charge, and this inexpensiveness of accessing a computer network attracts many people. Another factor is that people who own a means to access a computer network at home usually spend a long time accessing a computer network and they do not have enough time to use other services including interactive TV.

As far as socio-economic variables are concerned, the large positive values of the corrected t-statistic and estimated coefficient corresponding to young people (age of 29 or younger) are noticeable. As expected, the difference of gender in choosing interactive TV is not very significant. It is quite reasonable that people living alone are likely to choose interactive TV, because such people usually want a means of entertaining themselves. It is interesting that people with higher educational backgrounds (graduate school or higher) are inclined to subscribe to interactive TV. The reason is that people with high educational backgrounds are more exposed to these types of technology such as computers and visual communications equipment. The effect of being a US resident on choosing interactive TV is not significant, although we expected a significantly positive t-statistic because of the high CATV penetration rate of the US.

Table 4.3 shows the estimation results of the upper level model without subjective variables. In general, the upper level model including significant subjective variables (Table 4.2) is better than that without subjective variables (Table 4.3) because the rho bar square ( $\bar{\rho}^2$ ) of the former model is larger than that of the latter model. However, the sign and significance of the coefficients are similar to each other in these two kinds of upper level models. In the estimation of the revenue price elasticity in Chapter 5, we use the model including subjective variables (Table 4.2) as the upper level model.

Table 4.1 Estimation Results of the Lower Level Model  
(Choice of Service Combination)

Variable Name	Estimated Coefficient	t-Statistic	Jackknife t-Statistic
<b>Fees</b>			
Flat monthly fee (\$)	-0.188	-2.05	-1.64
Pay per view fee (\$)	-0.251	-0.72	-0.70
<b>Services/Benefits</b> (1 if service included and 0 otherwise)			
VOD	5.127	3.05	0.77
On-Screen TV Guide	-0.257	-0.62	-0.92
PPV TV Reruns	2.494	1.50	0.35
Unlimited TV Reruns	0.355	0.56	0.44
TV Game Show	0.248	0.31	0.33
PPV Football Game	-12.370	-0.26	-8.03
Unlimited Football Game	-1.149	-1.35	-1.15
PPV Sports TV	-1.078	-1.38	-0.92
Unlimited Sports TV	-0.919	-1.76	-1.53
TV Home Banking	0.814	1.97	1.60
Music Store on Your TV	-0.408	-1.07	-0.93
VOD and PPV TV Reruns	-2.744	-1.66	-0.39
At Least One PPV Service	-4.505	-2.91	-0.66
<b>Packaging</b>			
Package only	7.066	5.73	3.65
Package plus individual services	2.978	4.39	3.64
<b>Number of Services in Combination</b> >=5	-1.989	-3.16	-2.85

**Summary Statistics**

Number of observations = 382

$L(0) = -684.45$

$L(\hat{\beta}) = -81.05$

$\rho^2 = 0.882$

$\hat{\rho}^2 = 0.855$

Table 4.2 Estimation Results of the Upper Level Model  
(Buy vs. No Buy Choice)

Variable Name	Estimated Coefficient	t-Statistic	Jackknife t-Statistic
<b>Attributes of Menu</b>			
Number of movie titles in VOD/1000	0.540	1.99	2.19
<b>Subjective Variables</b>			
Dissatisfied with choice of TV programs	-1.088	-2.58	-3.51
Dissatisfied with choice of TV movies	1.776	3.94	2.65
Prefer to watch movies at home	1.554	3.59	6.30
<b>AV Equipment Usage</b>			
Watch TV more than 2 hours	-1.356	-3.31	-3.42
Live in an area where CATV is available	-0.619	-0.99	-0.70
Have paid for PPV programs	2.030	3.75	10.65
Member of a video-rental shop	-1.914	-3.42	-2.65
Own PC at home	3.913	5.15	5.21
Own fax machine at home	-0.871	-2.08	-1.98
Own access to computer network at home	-1.798	-2.79	-3.59
Own VCR at home	4.160	6.14	5.36
Own camcorder at home	0.776	1.73	1.88
<b>Socio-economic</b>			
Gender female	0.702	1.63	1.45
Age younger than 30 years old	3.572	6.74	11.61
Graduate school or higher education	1.075	2.93	2.61
Living alone	0.723	1.53	2.90
One or more children 18 or younger	0.644	1.44	1.71
USA resident	0.728	1.39	1.05
Constant for Buy	-7.992	-6.23	-4.52
Inclusive Value	0.209	5.40	5.62

**Summary Statistics**

Number of observations = 476

$L(0) = -329.94$        $L(\beta) = -128.94$

$\rho^2 = 0.609$        $\hat{\rho}^2 = 0.546$

Table 4.3 Estimation Results of the Upper Level Model  
(Buy vs. No Buy Choice, without subjective variables)

Variable Name	Estimated Coefficient	t-Statistic	Jackknife t-Statistic
<b>Attributes of Menu</b>	0.451	1.80	1.65
Number of movie titles in VOD/1000			
<b>AV Equipment Usage</b>			
Watch TV more than 2 hours	-0.493	-1.45	-2.35
Live in an area where CATV is available	-1.092	-1.81	-1.76
Have paid for PPV programs	1.748	3.70	7.20
Member of a video-rental shop	-1.175	-2.54	-3.10
Own PC at home	2.278	3.66	4.52
Own fax machine at home	-0.522	-1.48	-2.21
Own access to computer network at home	-1.509	-2.76	-3.67
Own VCR at home	3.062	5.51	4.88
Own camcorder at home	0.451	1.18	0.78
<b>Socio-economic</b>			
Gender female	0.538	1.34	1.30
Age younger than 30 years old	2.526	6.18	10.72
Graduate school or higher education	1.136	3.50	2.85
Living alone	0.197	0.47	0.98
One or more children 18 or younger	0.416	1.05	1.16
USA resident	0.776	1.88	1.44
Constant for Buy	-4.638	-4.72	-4.56
Inclusive Value	0.198	5.61	7.70

**Summary Statistics**

Number of observations = 476

$$L(0) = -329.94 \quad L(\beta) = -149.74$$

$$\rho^2 = 0.546 \quad \hat{\rho}^2 = 0.492$$

Table 4.4 Comparison of A Priori Hypotheses and Estimation Results for Upper Level

Variable Name	A priori Hypotheses	Estimation Results
<b>Attributes of Menu</b>		
Number of movie titles in VOD/1000	+	+
Hours when viewers can watch VOD movies	+	X
Discount ratio in packages (%)	+	X
<b>Subjective Variables</b>		
Dissatisfied with choice of TV programs	+	-
Dissatisfied with choice of TV movies	+	+
Dissatisfied with choice of TV entertainment programs	+	X
Prefer to watch movies at home	+	++
<b>AV Equipment Usage</b>		
Watch TV more than 2 hours	+	-
Subscribe to CATV	+	X
Paid \$30 or more for CATV on the previous month	+	X
Have paid for PPV programs	+	++
Member of a video-rental shop	+	-
Rented 5 or more video tapes on the previous month	+	X
Own PC at home	+	++
Own fax machine at home	X	-
Own access to computer network at home	X	-
Own VCR at home	+	++
Own video game at home	X	X
Own two or more phone lines at home	X	X
Own camcorder at home	X	+
<b>Socio-economic</b>		
Gender female	X	X
Age younger than 30 years old	+	++
Graduate school or higher education	X	+
Living alone	+	+
One or more children 18 or younger in household	+	+
Household annual income before taxes is \$70,000 or more	+	X
USA resident	+	X

Estimation Results: +/-:positive/negative significant (|t-statistics|>1.6), X:insignificant, ++:corrected t-statistic exceeds 5

# Chapter 5

## Analysis of Estimation Results

In this chapter, analysis of estimation results is discussed. Section 5.1 describes the demand price elasticity, which is an important indicator explaining the relation between the change of price and the change of demand. Section 5.2 discusses how we can apply the estimation results to the implementation of interactive TV. The discussions are based on three topics: service menus, pricing scenarios and the effect of computer network-based multimedia network services on the demand for interactive TV.

### 5.1 Elasticity

#### 5.1.1 Introduction

The discrete choice models which were estimated in Chapter 4 were developed at the disaggregate level (i.e., individual or household). So, the data availability was at the individual consumer level, and this information was used to develop disaggregate models to represent each consumer's behavior as accurately as possible. In order to implement these results, we are interested in aggregate results (e.g., interactive TV revenue from overall residents in a city). The aggregation is done using a variety of criteria such as geographical locations or socio-economic characteristics, after estimation results have been obtained at the disaggregate level.

In our survey, the number of samples (119) was relatively small and the group of respondents is not representative because the respondents were collected through e-mails on the Internet. Considering these characteristics of the sample in our survey, we selected three representative individuals from 119 respondents and calculated monthly revenues of interactive TV from each individual enumerating the individuals' choice probabilities of each combination of services. This method is explained in the next section.

#### 5.1.2 Simulation Procedure

First, we picked up three representative individuals from 119 respondents of the survey. In the enumeration, we used the reference menu, which is the most realistic and was presented to all respondents, as the base case price structure. This structure is shown in Table 5.1.



**Table 5.1 Base Case Price Structure**

• Basic monthly fee for any Interactive TV services is US\$ 4.20, which is not included in prices listed below.

<b>DISCOUNT PACKAGES (40% discount)</b>	<b>Monthly fee (US Dollars)</b>	<b>Pay per view fee (US Dollars)</b>
Package A : VOD, On-Screen TV Guide Unlimited TV Reruns	2.65	1.70 (VOD)
Package B : VOD, On-Screen TV Guide Unlimited TV Reruns Unlimited Interactive Football TV Home Banking Music Store on Your TV	10.30	1.70 (VOD)
Package C : VOD Unlimited Interactive Football Unlimited Interactive Sports TV	6.25	1.70 (VOD)
<b>INDIVIDUAL SERVICES</b>	<b>Monthly fee (US Dollars)</b>	<b>Pay per view fee (US Dollars)</b>
VOD	—	2.80
On-screen TV Guide	1.35	—
TV Reruns	—	1.95
Unlimited TV Reruns (including TV Reruns)	5.85	—
Interactive TV Game Show	—	1.95
Interactive Football Game	—	2.80
Unlimited Interactive Football Game (including Interactive Football Game)	8.40	—
Interactive Sports TV	—	1.60
Unlimited Interactive Sports TV (including Interactive Sports TV)	4.80	—
TV Home Banking	2.80	—
Music Store on Your TV	1.60	—

Second,  $P(i | \text{Buy})$ , the conditional probability of alternative  $i$  being chosen given the buy alternative is selected in the upper level, is calculated for all alternative  $i$ 's as follows:

$$P(i | \text{Buy}) = \frac{\exp V_i}{\sum_{j=1}^{863} \exp V_j} = \frac{\exp \beta' x_i}{\sum_{j=1}^{863} \exp \beta' x_j} \quad (i = 1, \dots, 863)$$

$P_n(\text{Buy})$ , the probability that an individual  $n$  chooses the buy alternative in the upper level is calculated as follows:

$$P_n(\text{Buy}) = \frac{\exp V_{\text{Buy},n}}{\exp V_{\text{Buy},n} + \exp V_{\text{NoBuy},n}} \quad (n = 1, 2, 3)$$

$P_n(i)$ , the probability that an individual  $n$  chooses the alternative  $i$  is expressed:

$$P_n(i) = P(i | \text{Buy})P_n(\text{Buy})$$

Therefore,  $R_{\text{base},n}$ , the monthly revenue from individual  $n$  for the base case can be estimated as follows:

$$\begin{aligned} R_{\text{base},n} &= P_n(i)(R_i^1 + R_i^2) \\ &= P_n(\text{Buy}) \sum_{i=1}^{863} P(i | \text{Buy})(R_i^1 + R_i^2) \quad (n = 1, 2, 3) \end{aligned}$$

where  $R_i^1, R_i^2$  are monthly revenue from the flat fee and the pay-per-view fee corresponding to alternative  $i$ , respectively. In calculating the revenue from the pay-per-view fee, we fixed the monthly number of pay-per-view service usage per user to three for VOD and one for other pay-per-view services (e.g., PPV Interactive Football, Interactive TV Game Show). This number is based on the result that the average monthly usage of near VOD movies was 2.5 per household in the VCTV field test by TCI, US West and AT&T (Table 2.2).

Third, monthly revenues per user under two scenarios are computed. These scenarios are shown below:

- Scenario A Increasing only the flat monthly fee by 10%
- Scenario B Increasing only the pay-per-view fee by 10%

Here, let  $R_{A,n}, R_{B,n}$  be the monthly revenues from individual  $n$  under scenarios A and B,

respectively.

Fourth, we compute the demand price elasticity (the price elasticity of demand), which measures how the change in price P will affect the quantity Q. The demand price elasticity is defined as:

$$\text{Demand Price Elasticity} = \frac{\text{percent change in } Q}{\text{percent change in } P} = \frac{\partial Q}{\partial P} \cdot \frac{P}{Q}$$

where P is the price and Q is the quantity.

From the simulation procedure, we obtained information about expected revenues. We define the expected revenue as the product of the price P and the quantity Q. The revenue price elasticity (the price elasticity for a revenue) is defined as:

$$\text{Revenue Price Elasticity} = \frac{\text{percent change in } PQ}{\text{percent change in } P} = \frac{\partial PQ}{\partial P} \cdot \frac{1}{Q}$$

Differentiating PQ with respect to P yields

$$\frac{\partial PQ}{\partial P} = Q + \frac{P \partial Q}{\partial P}$$

Dividing both sides by Q, we have

$$\frac{\partial PQ}{\partial P} \cdot \frac{1}{Q} = 1 + \frac{\partial Q}{\partial P} \cdot \frac{P}{Q}$$

Therefore we have

$$\text{Revenue Price Elasticity} = 1 + \text{Demand Price Elasticity}$$

or

$$\text{Demand Price Elasticity} = \text{Revenue Price Elasticity} - 1$$

For example, the revenue price elasticity for scenario A can be computed as follows:

$$\begin{aligned} \text{Revenue Price Elasticity} &= \frac{\text{percent change in revenue}}{\text{percent change in price}} \\ &= \frac{-(R_{\text{base}} - R_A)}{R_{\text{base}}} \times 100 = \frac{10(R_A - R_{\text{base}})}{R_{\text{base}}} \end{aligned}$$

### **5.1.3 Simulation Results**

Table 5.2 shows the simulation results for the scenario A, in which only the flat monthly fee increases by 10% from the base case, and the scenario B, in which only the pay-per-view fee increases by 10% from the base case. We can find from the result in Table 5.2 that the change in price and the change in expected revenue move in the same direction in both scenario A and B. For example, Table 5.2 shows a 10% increase in flat fee which corresponds to a 2.5% increase in revenue from the respondent 1. This happens because the change in price rises proportionately more than the decreasing change in quantity.

All demand price elasticities of each respondent for scenarios A and B in Table 5.2 are between 0 and -1. Under the usual terminology, if the value of the demand price elasticity is greater than -1, the demand price response is defined as inelastic. Therefore, all the values found for the demand price elasticities both for scenarios A and B, are in the inelastic range.

The demand price elasticity for scenario B (increase pay-per-view fees by 10%) is closer to -1 than that for scenario A (increase flat fees by 10%) except for respondent 1. Therefore, the revenue from the pay-per-view fee is more elastic than that from the flat monthly fee. In other words, there is greater sensitivity to the pay-per-view fee than to the flat monthly fee. This result can explain the estimation result of the lower level model in Table 4.1 that the absolute value of the coefficient for the pay-per-view fee was larger than that for the flat monthly fee. Customers who subscribe both pay-per-view and unlimited monthly interactive TV services encounter the pay-per-view fee more often than the flat monthly fee. In that sense, it is reasonable that customers are more sensitive to the increase in the pay-per-view fee than to that of the flat monthly fee.

Table 5.2 also indicates that the less a customer would like to pay for interactive TV, the more elastic a revenue from the customer becomes. In other words, a customer who is less likely to subscribe to interactive TV, is more sensitive to the increase in price.

## **5.2 Discussion on Implementation of Estimation Results**

In this section, it is discussed how we should apply the estimation results to the business world. The discussions are based on the two critical factors for determining demand for interactive TV presented in Chapter 2: one is the specification of interactive TV services (or in a more general sense, service menus), and the other is the pricing scenario. The effect of other types of multimedia network service, especially computer network-based services, on the demand for interactive TV is discussed in Section 5.2.3.

Table 5.2 Simulation Results

(All prices in US\$)

	Monthly revenue in base case $R_{base}$	Monthly revenue in scenario A $R_A$	Monthly revenue in scenario B $R_B$	Revenue price elasticity in scenario A	Revenue price elasticity in scenario B	Demand price elasticity in scenario A $E_A$	Demand price elasticity in scenario B $E_B$
Respondent 1	1.97	2.02	2.02	0.25	0.25	-0.75	-0.75
Respondent 2	7.12	7.41	7.37	0.41	0.35	-0.59	-0.65
Respondent 3	12.60	13.28	13.11	0.54	0.40	-0.46	-0.60

Demand Price Elasticity = Revenue Price Elasticity - 1

$$= 10 (R_A - R_{base}) / R_{base} - 1$$

### 5.2.1 Service Menus

According to the poll by Louis Harris and Associates asking 1,000 adults in the continental US in July, 1994 [LEW94], the percentage of respondents who showed an interest in practical interactive services such as a medical information service and news on demand was higher than that of respondents who showed an interest in entertainment interactive services such as movie previews and ordering movies (Table 5.3).

**Table 5.3 Results of Louis Harris & Associates Survey on Interactive Services**

Question asked in the Times Survey (Services asked here are interactive services based on new technologies that combine CATV, telephone and computer network wiring)	Interested (%)	Not interested (%)
How interested would you be in obtaining information on staying healthy, on diseases or related topics	79	21
Choosing the kinds of news and features you want to see daily	74	25
Selecting and taking an educational course	65	35
Sending messages to Government agencies about their services	63	37
Viewing movie previews and ordering the movies you want to watch	61	39
Participating in opinion surveys on political or social issues	59	41
Shopping for and buying goods and services	32	68

Source: [LEW94]

Note: The survey of 1000 adults in the continental US was done in July, 1994 and has a margin of sampling error of plus or minus 3 percentage points.

In our survey, the high percentage of people who chose TV Home Banking reflects the tendency that a relatively large number of people are interested in practical interactive services. We did not include a medical service and an educational service into interactive TV services in our survey. If we had included these kinds of services, a greater number of the respondents might have selected them and the estimation results would have been different.

Data integrity and data security are big problems which should be solved in introducing interactive services (e.g., home banking service) using a database storing a tremendous amount of personal and confidential data. As a respondent of our survey pointed out, people do not intend to subscribe to these services until data security and data integrity are completely guaranteed.

As for more entertainment-oriented and seasonal services such as Interactive Football Game in our survey, there are two opposing perspectives. The negative side is the low subscription rate to the Interactive Football Game in our survey, despite the fact that the survey was performed in the midst of the football season. Furthermore, the Interactive Football Game can be provided for customers only for several months a year. So, it would be better to promote these services combined with other seasonal entertainment interactive services. The positive side, on the other hand, is that the subscription rate of these services will rapidly go up once consumers find something they like. There is a general tendency that at first consumers underestimate the value of entertainment-oriented services which they have never encountered. This tendency is reflected in the relatively low percentage of people showing an interest in the movie preview service in the Louis Harris and Associates survey.

### **5.2.2 Pricing Scenario**

From the estimation results described in Chapter 4 and the results in Section 5.1, we found that people are more sensitive to the increase in the pay-per-view fee than to that of the flat monthly fee. One reason is that, no pay-per-view service except VOD are included in discount packages in our survey model, so, if the prices increase, it is easier for customers to quit paying for a pay-per-view service than for an unlimited monthly service package. Therefore, when the prices increase, the decreasing change in quantity of pay-per-view services is larger than that of unlimited flat monthly priced services. Another reason for the sensitiveness toward pay-per-view services is that customers encounter pay-per-view fees every time they use the service and they face pay-per-view fees more often than they encounter flat monthly fees.

In general, the flat monthly pricing system is more advantageous than the pay-per-view fee. First of all, the flat monthly pricing system is more clear-cut than the pay-per-view pricing system. From the viewpoint of customers, it is easier in the flat monthly pricing system for them to evaluate the amount they would pay and to compare the amount with their budget than in the pay-per-view pricing system. Second, customers recognize paying a fee only once a month in the flat monthly pricing system, while they recognize it every time they use services in the pay-per-view pricing system. Therefore,

in the pay-per-view pricing system, customers tend to feel that they pay more money than they actually pay. Third, in the pay-per-view pricing system, there is a possibility that a customer is astonished at a bill showing a much higher amount than s/he expected.

Considering the discussions so far, the pay-per-view pricing system is suitable for those who have just subscribed to interactive TV and want to shop around to explore various kinds of services. But, even people like that do not prefer to subscribe to pay-per-view services after they have found their favorite services.

Judging from the remarkable effect of packaging in Table 4.1, it will be a good idea to combine packaging and the flat monthly pricing system. That is, a package of some (not too many) popular services is offered to customers at a monthly flat price which is as cheap as possible. Services in which relatively high usage rate is expected (e.g., VOD and video-phone) can be offered in the pay-per-view pricing system.

### **5.2.3 Effect of Computer Network-Based Multimedia Services on the Demand for Interactive TV**

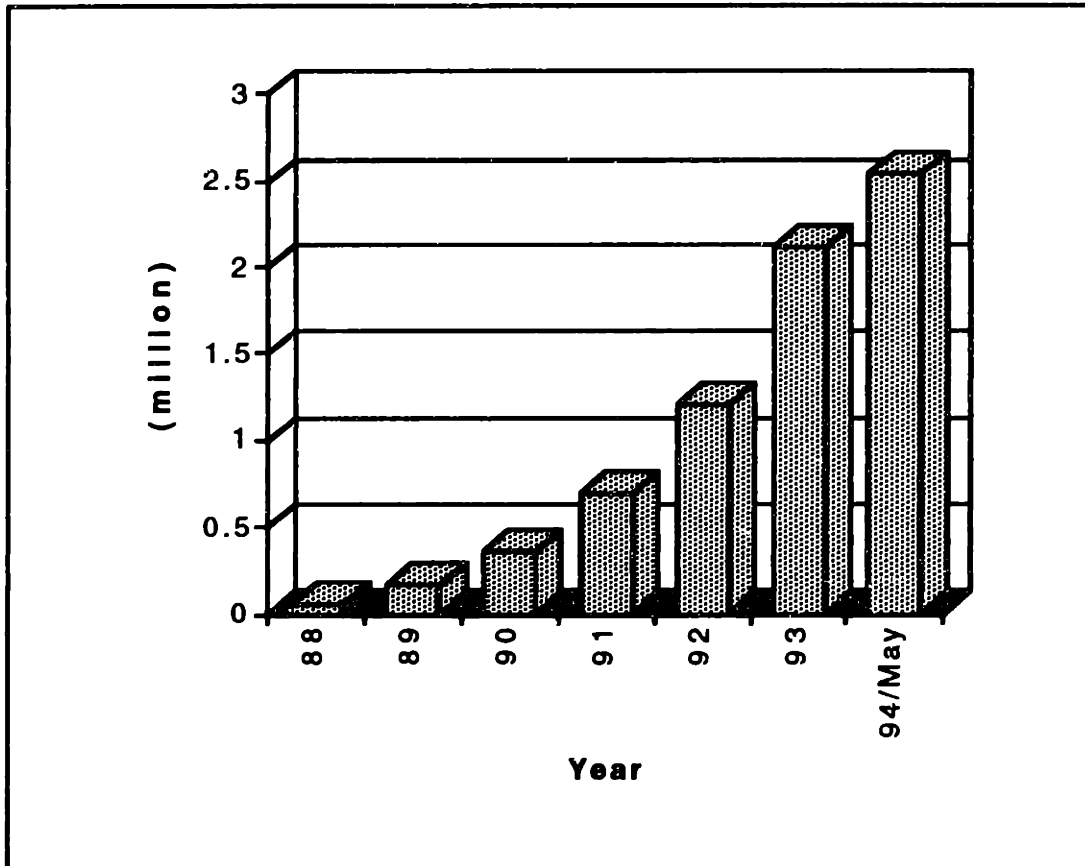
It is notable that the coefficient of respondent's ownership of a means to access a computer network at home was significantly negative in Table 4.2. This result will be the key to forecast the demand for multimedia network services such as interactive TV and computer network-based multimedia services.

Today, the Internet is the most widespread and the most notable computer network around the world. As Figure 5.1 shows, the number of worldwide host computers accessible to the Internet has been rapidly increasing in the past few years. It is reported that more than thirty million people use the Internet around the world now. It seems that the Internet is invincible; however, the largest disadvantage of the Internet is the limitation in line capacity of the existing public switched telephone network. So, moving pictures which contain a tremendous amount of data cannot be transmitted smoothly through the Internet. Because of this constraint, advanced digital video distributing services including VOD cannot be offered on the Internet with the existing infrastructure. In spite of this disadvantage, many people are using the Internet because of its accessibility to various kinds of information and its low price. An analyst said that interactive TV will become pervasive in the year 2000 at earliest, and that the penetration of personal computer communications will precede that of interactive TV before then [NIK94].

Judging from the negative coefficient of respondent's ownership of a means to access a computer network, the rapid growth of the number of people who use the Internet will



have a negative effect on the growth of the interactive TV market. If the conventional telephone network is refurbished and becomes faster, it will be possible to offer more advanced multimedia services (e.g., VOD) on the Internet. This means that multimedia network services on computer networks including the Internet will become strong competitors against multimedia network services on CATV networks, interactive TV.



Source: [NTT94-3]

Figure 5.1 Number of Worldwide Host Computers Accessible to the Internet

# Chapter 6

## Conclusion

### 6.1 Contributions

The major contributions of our work related to this thesis consist of the following:

- **Survey Design**

We designed the questionnaire including interactive TV menus, which are realistic enough to be applied to commercial interactive TV services, and we performed the survey using the questionnaire. Our interactive TV menus are realistic from the following perspectives: (1) They have the two-fold pricing system (i.e., flat monthly fees and pay-per-view fees), which is widely used in public utility charges (e.g., telephone services) and CATV services. (2) They include discount packaging which has been applied to various kinds of products and services. (3) They include wide range of interactive TV services from which are similar to existing audio-visual services to which are under planning.

- **Model Formulation**

We adopted the nested logit (NL) model in order to estimate parameters from the data we collected through the survey, and we confirmed statistically that the NL model is acceptable for our case of analyzing the customers' demands for interactive TV.

- **Model Evaluation**

Through the estimation of parameters using the NL model, it became clear that customers' socio-economic characteristics, their usage of existing audio-visual services, menu attributes and benefits of interactive TV services have great effects on customers' choice behaviors of interactive TV.

- **Analysis of Elasticities**

We computed demand price elasticities for the pay-per-view fee and the flat monthly fee using the NL model estimation results, and compared the two pricing systems in terms of elasticity.

- **Discussion on Implementation of Estimation Result**

Based on the estimation results, we suggested guidelines for designing interactive TV services in terms of the two critical factors for determining demand for interactive

TV, which are service specifications and pricing scenarios. We also clarified the effect of computer network-based multimedia services on the demand for interactive TV.

As described in Chapter 1, few data on customers' preferences and demands for interactive TV services are now collected, although the forecast of customers' demand for interactive TV has become more and more urgent and important recently. Comparing the forecasts made so far regarding the scale of the multimedia market, in which interactive TV services are included, our study is superior to the previous work from these two perspectives: (1) Our study is based on the survey which considers people's characteristics as well as their choice of interactive TV services. (2) The service menus of interactive TV used in our survey are close to the realistic situation which customers would encounter in choosing commercial interactive TV services.

A significant aspect of our study is that it can offer a guideline for designing an interactive TV system which reflects consumers' needs to a greater extent and is more acceptable for consumers.

## **6.2 Major Findings**

Major findings of our study are listed below:

- **Estimation Results of the NL model**
  - (1) As expected, discount packaging has a remarkably positive effect on customers' subscription to interactive TV services.
  - (2) People prefer to subscribe to fewer services rather than to many.
  - (3) Service benefits vary dramatically among the different services. Generally, unlimited services charged by the flat monthly fee have larger benefits than pay-per-view services charged every time they are used.
  - (4) The higher the fee becomes, the lower the utility for customers becomes.
  - (5) Customer's personal characteristics which have significantly positive effects on choosing interactive TV are:
    - a) dissatisfied with movies available on TV
    - b) has paid for pay-per-view programs on CATV
    - c) owns a VCR or a personal computer at home
    - d) living alone
    - e) younger than 30 years old
    - f) having an educational background of a graduate school or higher
  - (6) Customer's personal characteristics which have significantly negative effects on

choosing interactive TV are:

- a) spend a long time (more than 2 hours per day) watching TV
- b) owns a means to access a computer network (e.g., a modem) at home
- c) has a membership to a video-rental shop

- **Analysis of Elasticities**

- (7) People who pay less for interactive TV, that is, who are less likely to choose interactive TV services are more sensitive to the change in both pay-per-view fees and flat monthly fees.
- (8) Generally, people are more sensitive to the change in pay-per-view fees than that of flat monthly fees.

### **6.3 Future Work**

We used stated preference (SP) data in our model, so biases inherent to SP data are included in the estimation results. One of these biases is the difference between respondents' reactions to a survey presenting a hypothetical situation and their actual choice behavior. In our survey, specifications of interactive TV services were presented to the respondents in a text format. In a survey, it is difficult to give detailed specifications of complicated or advanced services in brief sentences. One way to solve the problem is the use of visual media such as a demonstration video or by giving examples of displayed services on a screen of interactive TV, which appeal directly to vision. If the service specifications are presented to the respondents as visual media, it will be easier for them to understand what they can do in interactive TV and to evaluate its services. To a great extent, such a presentation helps respondents choose their favorite services more precisely. So, it is expected that responses to a survey using visual media are closer to actual choice behaviors.

As for service menus of interactive TV, we emphasized entertainment-oriented services such as Football Game and VOD because of their lucidity in specifications. The more interactive TV services are tested and are commercialized, the more clear-cut the specifications of more advanced services will become. At that time, it will be possible to include more advanced interactive TV services, such as educational, medical and information services, which will attract a wide range of customers, in the model for a survey and to evaluate the demand for more realistic type of interactive TV. The use of visual media in a survey will also contribute greatly to the evaluation of customers' demand for full-functional interactive TV.

Our sample group was composed of people who showed an interest in our survey on the Internet. Therefore, the sample itself has a bias in that it is made up of people

sharing a higher rate of interest in advanced technologies (e.g., a computer network, multimedia) than does the general public. So, we cannot apply the result of our survey directly to an aggregated analysis such as US nationwide forecast of demand for interactive TV. The use of sampling techniques such as stratified random sampling makes it possible to estimate the aggregated demand for interactive TV or revenue from subscriptions to it. Another direction for further research in terms of sampling would be in the evaluation of a bias in the case that parameters are estimated using a small biased sample as in our case, where the sample was collected through the e-mail system on the Internet.

# Appendix A

## The Questionnaire of the Survey

We at the Operations Research Center at MIT are doing research on an interactive TV, the future multimedia service on a Cable TV network. This survey will help us know what kind of service people prefer. Your participation is very helpful and is greatly appreciated.

IMPORTANT: Please indicate your choice by checking the parenthesis like (x) or by filling out the parenthesis and return it to piki@mit.edu via e-mail.

NOTE: All \$'s in this survey are US Dollars.

If you have any questions, contact Yutaka Mori via piki@mit.edu.  
Please return it until Nov. 15 (Tue).

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### **PART 1. About Your Usage of Audio-Visual Equipment**

1. How many hours of TV did you watch yesterday?  
( ) 0-1 hour      ( ) 1-2 hours      ( ) 2-4 hours      ( ) more than 4 hours
  
2. Generally, how satisfied are you with the choice of programs available on TV these days?  
( ) very satisfied      ( ) fairly satisfied      ( ) intermediate  
( ) not too satisfied      ( ) not at all satisfied      ( ) don't care
  
3. Generally, how satisfied are you with the choice of movies available on TV these days?  
( ) very satisfied      ( ) fairly satisfied      ( ) intermediate  
( ) not too satisfied      ( ) not at all satisfied      ( ) don't care
  
4. Generally, how satisfied are you with the choice of entertainment programs other than movies available on TV these days?  
( ) very satisfied      ( ) fairly satisfied      ( ) intermediate  
( ) not too satisfied      ( ) not at all satisfied      ( ) don't care
  
5. Which is your favorite way to watch a movie?  
( ) go out to a theater      ( ) watch at home
  
6. Do you currently live in an area where you could subscribe to Cable TV?  
( ) yes      ( ) no (go to question 12)
  
7. Do you currently subscribe to Cable TV?  
( ) yes      ( ) no (go to question 12)

8. How much did you pay for a Cable TV service excluding pay-per-view programs last month?  
 less than \$20     \$20-\$29.99     \$30-\$39.99     \$40 or more
9. Have you ever paid for a pay-per-view program (e.g. movies, sports program)?  
 yes     no (go to question 12)
10. How many pay-per-view programs did you pay for last month?  
 0     1     2-3     4-5     6 or more
11. Which category of pay-per-view programs did you pay for last month? (Please check as many as apply)  
 movie     sports     music     other, please specify (        )
12. Are you currently a member of any video-rental shops?  
 yes     no (go to question 15)
13. How many video tapes did you rent last month?  
 0     1     2-4     5-8     9 or more
14. Which category of video tapes did you rent last month? (Please check as many as apply)  
 movies     sports     music     educational  
 TV programs (e.g. dramas, soap operas)  
 other, please specify (        )
15. Which of the following pieces of equipment or services do you have at home (Please check as many as apply)?  
 personal computer including laptops  
 game machine such as Nintendo or Sega  
 fax  
 access to a computer network  
 VCR (video cassette recorder)  
 video camera or camcorder  
 two or more phone lines

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**PART 2. Your Preference for Interactive TV Services**

Suppose we were providing an Interactive TV having individual services shown below. After the explanation of individual services, we'll present you with some different scenarios. In each one, you may choose one package and/or as many individual services you want, or nothing.

---

**Individual Services**

1. VOD (Video on demand) : This feature allows you to choose your favorite movie whenever you want. Once you choose, you can handle (play, review, pause, fast-forward) it as you like for some period, as if you used your own VCR.

2. On-screen TV Guide : You can choose your favorite TV program on any given day directly from the guide on your TV screen. You no longer need a published guide for TV programs.

3. TV Reruns : You can watch reruns whenever you want of TV programs you've missed whenever you want. You can choose among programs previously broadcasted up to a month ago.

4. Interactive TV Game Show : You can participate in a TV game show from your home just by pressing a "participate" button. At the end of the program, you can compare your score to those of the participants on the actual TV show and to the scores generated via interactive TV service (like yours). You can win a prize for the highest score.

5. Interactive Football Game : This feature corresponds with a televised football game, both NFL and collegiate. Participants predict whether the next play is "run" or "pass," or whether next pass/run is toward right, middle or left/ short, middle or long. If you guess correctly, you score. If you earn the highest score at the end of the game, you win prize money.

6. Interactive Sports TV : This feature allows you to choose the camera angle from which to watch a televised sports event, such as basketball, football and golf, by just pressing buttons on your controller.

7. TV Home Banking : In this feature, you can review bank statements and pay bills (public utility charges such as electricity, gas and telephone) on your TV screen.

8. Music Store on Your TV : First, you choose a genre (e.g. rock, rap, top 10.) Then, an MTV-like video clip is broadcast. You can "browse" video clips and you can order the corresponding CD, cassette tape, or video if you like.

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## **INTERACTIVE TV SERVICES**

You are provided four menus of interactive TV services.

In EACH menu, you may choose no more than one DISCOUNT PACKAGE and/or as many INDIVIDUAL SERVICES as you like. Indicate your choice(s) by checking the parentheses in the left column.

NOTE: To get this interactive TV service, you have to subscribe to Cable TV. Fee for Cable TV is not included in prices listed below.



## **MENU1**

- Basic monthly fee for any Interactive TV services is US\$ 5.90, which is not included in prices listed below.
- Number of movie titles you can choose in VOD is 200.
- Length of period you can handle your chosen movie in VOD is 48 hours.

Check this column	<b>DISCOUNT PACKAGES (40% discount)</b>	Monthly fee (US Dollars)	Pay per view fee (US Dollars)
<input type="checkbox"/>	Package A : VOD, On-Screen TV Guide Unlimited TV Reruns	3.15	1.70 (VOD)
<input type="checkbox"/>	Package B : VOD, On-Screen TV Guide Unlimited TV Reruns Unlimited Interactive Football TV Home Banking Music Store on Your TV	11.50	1.70 (VOD)
<input type="checkbox"/>	Package C : VOD Unlimited Interactive Football Unlimited Interactive Sports TV	4.95	1.70 (VOD)

Check this column	<b>INDIVIDUAL SERVICES</b>	Monthly fee (US Dollars)	Pay per view fee (US Dollars)
<input type="checkbox"/>	VOD	—	2.80
<input type="checkbox"/>	On-screen TV Guide	1.35	—
<input type="checkbox"/>	TV Reruns	—	1.95
<input type="checkbox"/>	Unlimited TV Reruns (including TV Reruns)	7.80	—
<input type="checkbox"/>	Interactive TV Game Show	—	1.35
<input type="checkbox"/>	Interactive Football Game	—	1.95
<input type="checkbox"/>	Unlimited Interactive Football Game (including Interactive Football Game)	7.80	—
<input type="checkbox"/>	Interactive Sports TV	—	1.10
<input type="checkbox"/>	Unlimited Interactive Sports TV (including Interactive Sports TV)	4.40	—
<input type="checkbox"/>	TV Home Banking	3.90	—
<input type="checkbox"/>	Music Store on Your TV	2.25	—

**MENU2**

- Basic monthly fee for any Interactive TV services is US\$ 5.90, which is not included in prices listed below.
- Number of movie titles you can choose in VOD is 500.
- Length of period you can handle your chosen movie in VOD is 8 hours.

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Check this column	<b>DISCOUNT PACKAGES</b> <b>(30% discount)</b>	Monthly fee (US Dollars)	Pay per view fee (US Dollars)
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<input type="checkbox"/>	Package A : VOD, On-Screen TV Guide Unlimited TV Reruns	6.90	1.35 (VOD)
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<input type="checkbox"/>	Package B : VOD, On-Screen TV Guide Unlimited TV Reruns Unlimited Interactive Football TV Home Banking Music Store on Your TV	17.20	1.35 (VOD)
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<input type="checkbox"/>	Package C : VOD Unlimited Interactive Football Unlimited Interactive Sports TV	12.35	1.35 (VOD)
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Check this column	<b>INDIVIDUAL SERVICES</b>	Monthly fee (US Dollars)	Pay per view fee (US Dollars)
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<input type="checkbox"/>	VOD	—	1.95
<input type="checkbox"/>	On-screen TV Guide	1.35	—
<input type="checkbox"/>	TV Reruns	—	2.75
<input type="checkbox"/>	Unlimited TV Reruns (including TV Reruns)	10.95	—
<input type="checkbox"/>	Interactive TV Game Show	—	1.35
<input type="checkbox"/>	Interactive Football Game	—	2.80
<input type="checkbox"/>	Unlimited Interactive Football Game (including Interactive Football Game)	11.20	—
<input type="checkbox"/>	Interactive Sports TV	—	2.25
<input type="checkbox"/>	Unlimited Interactive Sports TV (including Interactive Sports TV)	8.95	—
<input type="checkbox"/>	TV Home Banking	1.95	—
<input type="checkbox"/>	Music Store on Your TV	1.60	—

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### **MENU3**

- Basic monthly fee for any Interactive TV services is US\$ 4.20, which is not included in prices listed below.
- Number of movie titles you can choose in VOD is 1500.
- Length of period you can handle your chosen movie in VOD is 24 hours.

Check this column	<b>DISCOUNT PACKAGES (40% discount)</b>	Monthly fee (US Dollars)	Pay per view fee (US Dollars)
<input type="checkbox"/>	Package A : VOD, On-Screen TV Guide Unlimited TV Reruns	2.65	1.70 (VOD)
<input type="checkbox"/>	Package B : VOD, On-Screen TV Guide Unlimited TV Reruns Unlimited Interactive Football TV Home Banking Music Store on Your TV	10.30	1.70 (VOD)
<input type="checkbox"/>	Package C : VOD Unlimited Interactive Football Unlimited Interactive Sports TV	6.25	1.70 (VOD)

Check this column	<b>INDIVIDUAL SERVICES</b>	Monthly fee (US Dollars)	Pay per view fee (US Dollars)
<input type="checkbox"/>	VOD	—	2.80
<input type="checkbox"/>	On-screen TV Guide	1.35	—
<input type="checkbox"/>	TV Reruns	—	1.95
<input type="checkbox"/>	Unlimited TV Reruns (including TV Reruns)	5.85	—
<input type="checkbox"/>	Interactive TV Game Show	—	1.95
<input type="checkbox"/>	Interactive Football Game	—	2.80
<input type="checkbox"/>	Unlimited Interactive Football Game (including Interactive Football Game)	8.40	—
<input type="checkbox"/>	Interactive Sports TV	—	1.60
<input type="checkbox"/>	Unlimited Interactive Sports TV (including Interactive Sports TV)	4.80	—
<input type="checkbox"/>	TV Home Banking	2.80	—
<input type="checkbox"/>	Music Store on Your TV	1.60	—

**MENU4**

- Basic monthly fee for any Interactive TV services is US\$ 5.90, which is not included in prices listed below.
- Number of movie titles you can choose in VOD is 1500.
- Length of period you can handle your chosen movie in VOD is 24 hours.

Check this column	<b>DISCOUNT PACKAGES</b> (40% discount)	Monthly fee (US Dollars)	Pay per view fee (US Dollars)
<input type="checkbox"/>	Package A : VOD, On-Screen TV Guide Unlimited TV Reruns	3.90	3.10 (VOD)
<input type="checkbox"/>	Package B : VOD, On-Screen TV Guide Unlimited TV Reruns Unlimited Interactive Football TV Home Banking Music Store on Your TV	19.50	3.10 (VOD)
<input type="checkbox"/>	Package C : VOD Unlimited Interactive Football Unlimited Interactive Sports TV	16.40	3.10 (VOD)

Check this column	<b>INDIVIDUAL SERVICES</b>	Monthly fee (US Dollars)	Pay per view fee (US Dollars)
<input type="checkbox"/>	VOD	—	3.90
<input type="checkbox"/>	On-screen TV Guide	0.95	—
<input type="checkbox"/>	TV Reruns	—	1.35
<input type="checkbox"/>	Unlimited TV Reruns (including TV Reruns)	5.40	—
<input type="checkbox"/>	Interactive TV Game Show	—	1.35
<input type="checkbox"/>	Interactive Football Game	—	3.90
<input type="checkbox"/>	Unlimited Interactive Football Game (including Interactive Football Game)	15.60	—
<input type="checkbox"/>	Interactive Sports TV	—	1.60
<input type="checkbox"/>	Unlimited Interactive Sports TV (including Interactive Sports TV)	6.40	—
<input type="checkbox"/>	TV Home Banking	2.80	—
<input type="checkbox"/>	Music Store on Your TV	1.10	—



# Appendix B

## Descriptive Statistics of the Survey

The total number of the respondents was 119.

### **PART 1. About the Usage of Audio-Visual Equipment**

1. How many hours of TV did you watch yesterday?

38(32%) 0-1 hour  
 39(33%) 1-2 hours  
 32(27%) 2-4 hours  
 10( 8%) more than 4 hours

2-4. Generally, how satisfied are you with the following things available on TV these days?

Choice of programs	Choice of movies	Choice of entertainment programs other than movies	
1( 1)	1( 1)	2( 2)	very satisfied
31(26)	16(14)	23(19)	fairly satisfied
35(29)	35(29)	32(27)	intermediate
37(31)	39(33)	28(24)	not too satisfied
12(10)	23(19)	24(20)	not at all satisfied
3( 3)	5( 4)	10( 8)	don't care

5. Which is your favorite way to watch a movie?

77(65) go out to a theater  
 42(35) watch at home

6. Do you currently live in an area where you could subscribe to Cable TV?

112(94) yes  
 7( 6) no

7. Do you currently subscribe to Cable TV?

83(70) yes  
 36(30) no

8. How much did you pay for a Cable TV service excluding pay-per-view programs last month? (For those who answered "yes" in question 7)

25(30) less than \$20  
30(36) \$20-\$29.99  
14(17) \$30-\$39.99  
12(14) \$40 or more  
2(2) don't know

83

9. Have you ever paid for a pay-per-view program (e.g. movies, sports program)? (For those who answered "yes" in question 7)

33(40) yes  
50(60) no

83

10. How many pay-per-view programs did you pay for last month? (For those who answered "yes" in question 9)

The number of respondents who checked

22(67) 0  
7(21) 1  
4(12) 2-3

33

11. Which category of pay-per-view programs did you pay for last month? (Please check as many as apply) (For those who answered "yes" in question 9)

9 movie  
3 sports  
1 music

12. Are you currently a member of any video-rental shops?

100(84) yes  
19(16) no

13. How many video tapes did you rent last month? (For those who answered "yes" in question 12)

16(16) 0  
14(14) 1  
46(46) 2-4  
15(15) 5-8  
9(9) 9 or more

100

14. Which category of video tapes did you rent last month? (Please check as many as apply) (For those who answered "yes" in question 12)

The number of respondents who checked

83	movies
1	sports
3	music
2	educational
2	TV programs (e.g. dramas, soap operas)
4	other, please specify (video games)

15. Which of the following pieces of equipment or services do you have at home (Please check as many as apply)?

The number of respondents who checked

108(91)	personal computer including laptops
40(34)	game machine such as Nintendo or Sega
46(39)	fax
90(76)	access to a computer network
106(89)	VCR (video cassette recorder)
43(36)	video camera or camcorder
40(34)	two or more phone lines

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### **PART 3. Socio-economic Characteristics**

2-1. What is your gender?

93(78)	male
26(22)	female

2-2. What is your age?

5( 4)	under 20
28(24)	20 - 24
24(20)	25 - 29
37(31)	30 - 39
24(20)	40 - 54
1( 1)	55 or over

2-3. What is the highest level of education you have completed?

17(14)	secondary school
45(38)	college
40(34)	graduate program
16(14)	post-graduate
1( 1)	no answer



2-4-1. How many people are in your household, including yourself?

28(24) 1  
39(33) 2  
17(14) 3  
16(13) 4  
6( 5) 5  
5( 4) 6  
1( 1) 7  
1( 1) 9  
6( 5) no answer

2-4-2. How many children under 12 years of age in your household?

90(76) 0  
13(11) 1  
10( 8) 2  
3( 3) 3  
1( 1) 4  
2( 2) no answer

2-4-3. How many children under 18 years of age in your household?

82(69) 0  
15(13) 1  
14(12) 2  
3( 3) 3  
4( 3) 4  
1( 1) no answer

2-5,6. What is your/your household annual income before taxes?

respondent's	respondent's household	
29(25)	15(13)	\$19,999 and under
14(12)	7( 6)	\$20,000 - \$29,999
36(30)	24(20)	\$30,000 - \$49,999
21(18)	23(19)	\$50,000 - \$69,999
6( 5)	24(20)	\$70,000 - \$99,999
3( 3)	18(15)	\$100,000 and over
10( 8)	8( 7)	no answer

2-7-1. Country of respondent's home

93(78)	USA	1( 1)	Portugal
4( 3)	Canada	1( 1)	Ireland
1( 1)	Finland	1( 1)	Netherlands
6( 5)	Norway	1( 1)	France
1( 1)	Austria	1( 1)	Greece
3( 2)	United Kingdom	1( 1)	Australia
2( 2)	Germany	1( 1)	Singapore
2( 2)	Sweden		

2-7-2. State of respondent's home (for US residents only)

15	Massachusetts	2	Colorado
14	California	1	Washington
8	Virginia	1	Michigan
6	New Hampshire	1	Alabama
5	Texas	1	Wisconsin
5	Maryland	1	Oklahoma
5	New Jersey	1	Minnesota
4	Oregon	1	Kentucky
4	New Mexico	1	Missouri
4	Indiana	1	Alaska
3	Nebraska	1	New York
3	Florida	1	Georgia
2	Illinois	1	Pennsylvania

# Appendix C

## Discrete Choice Theory and Models

### Choice Theory

Choice theory is concerned with the sequence of processes an individual goes through in making a choice. This decision-making process includes:

- definition of the choice problem
- generation of alternatives
- evaluation of attributes of the alternatives
- choice
- implementation of choice

Elements defined in choice theories:

- **Decision Maker** is the unit that makes the decision. It can be an individual person, a group of persons, or an organization such as a firm or a government agency.
- **Alternatives** – any choice from which the decision maker has to choose is made from a nonempty set of alternatives. All the available alternatives constitute the universal set, while the alternatives that are available and feasible for a specific decision maker constitute his/her choice set, which is a subset of the universal set. There are two general types of choice sets. One is continuous. This is in line with microeconomic demand analysis, where the choice sets are defined by different levels of different products available to a household or individual. The other type is the discrete (discontinuous) choice set. It is composed of a discrete number of alternatives. We will focus on the discrete choice set.
- **Attributes of Alternatives** – the decision maker evaluates each alternative in the choice set through a vector of attribute values. These attributes can have an ordinal or a cardinal value which determines the attractiveness of each alternative.
- **Decision Rule** is the internal mechanism used by the decision maker to arrive at a choice. A rule of utility maximum is frequently used. Utility is a measure of the attractiveness of an alternative calculated from all its attributes. Under this rule, the decision maker selects the alternative with the highest utility from among all

alternatives in the choice set.

### **Probabilistic Choice Theory**

Choice theories assume that each decision maker behaves “rationally.” This concept of “rational behavior” refers to consistency and transitivity of preferences. Consistency of preferences implies that, under identical circumstances, the decision maker will repeat the same choice. Transitivity implies that if alternative A is preferred to alternative B, and alternative B preferred to alternative C, then alternative A is preferred to alternative C. Experimental observation, however, showed violations of consistency and transitivity of preferences. Probabilistic choice theory was developed to explain these violations.

From this perspective, the probabilistic element can be introduced in two ways into the decision-making process. First, it can be assumed that choice behavior in itself is probabilistic. In this case, a decision maker who chooses alternative A now, may choose alternative B later when confronted with the same choice problem. Second, human behavior may be assumed to be deterministic and the probabilistic element is introduced while observing choice behavior. This can happen because the analyst is unable to determine accurately the decision-making process, the set of alternatives and the alternative attributes. The latter approach gives rise to random utility models as a means of explaining consumer choice behavior and its probabilistic element.

### **Random Utility Models**

As described before, individuals are assumed to select the alternative with the highest utility. Any observed inconsistency in behavior is to be taken as a result of observational deficiencies on the analytical side. Utilities are not known with certainty to the analyst, so they are treated as random variables. Manski (1973) identified four distinct sources of randomness:

- unobserved attributes
- unobserved taste variations
- measurement error
- instrumental variables

The analyst is able to observe just a portion of the utility function, and any of the above sources will contribute to an error term of this utility. The utility of an alternative can then be expressed in terms of an observable (systematic) component and an unobservable (random) component. It follows

$$U_{in} = V_{in} + \varepsilon_{in}$$

where  $U_{in}$  is the utility of alternative  $i$  for individual  $n$ ,  $V_{in}$  is the systematic component of the utility, and  $\epsilon_{in}$  is the error term.

The utility function is now considered a random variable because one of its components,  $\epsilon_{in}$ , is a random variable. From this viewpoint, the probability of alternative  $i$  being chosen can be derived. According to the utility maximization, this probability is expressed as follows:

$$P_n(i) = \Pr[U_{in} \geq U_{jn}, \text{ all } j \in C_n]$$

where  $P_n(i)$ , the probability of alternative  $i$  being chosen, is equal to the probability that  $U_i$ , the utility of  $i$ , is greater than or equal to  $U_j$ , the utility for all the other alternatives in the individual's choice set  $C_n$ .

In terms of the systematic component of the utility, this probability is expressed:

$$P_n(i) = \Pr[V_{in} + \epsilon_{in} \geq V_{jn} + \epsilon_{jn}, \text{ all } j \in C_n]$$

or by rearranging terms

$$P_n(i) = \Pr[\epsilon_{in} - \epsilon_{jn} \geq V_{jn} - V_{in}, \text{ all } j \in C_n]$$

According to the different assumptions made about the error terms,  $\epsilon_{in} - \epsilon_{jn}$ , we would have different models. Some of them are:

- Linear Model:  $\epsilon_i - \epsilon_j$  is assumed to be uniformly distributed
- Probit Model:  $\epsilon_i$ 's and  $\epsilon_j$ 's are assumed to be normally distributed
- Logit Model:  $\epsilon_i - \epsilon_j$  is assumed to be logistically distributed

### The Multinomial Logit (MNL) Model

The MNL model is expressed as:

$$P(i) = \frac{\exp V_i}{\sum_{j \in C} \exp V_j}$$

where  $P(i)$  is the choice probability of alternative  $i$ ,  $V_i$  is the systematic component of the utility for alternative  $i$ , and  $C$  is the choice set.

The systematic utility  $V$  is a function of the attributes of the alternatives as well as the characteristics of the individuals. These components can be of any form, but for simplicity, they are assumed to have an additive linear form:

$$V_i = \sum_{j=1}^k X_{ij} \beta_j = X_{i1} \beta_1 + X_{i2} \beta_2 + \dots + X_{ik} \beta_k$$

where the  $X$ 's describe the attributes and characteristics of the individual and  $\beta$ 's describe the importance weight parameters to be estimated.

The underlying assumption for the logit model is that the error terms of the utilities are independent and identically distributed (IID) Gumbel. This is equivalent to assuming that  $\varepsilon_i - \varepsilon_j$  is logistically distributed. The logistic distribution approximates the normal distribution to a great extent and is analytically more convenient than the normal distribution.

# Appendix D

## Nested Logit Model

In the parameter estimation in the nonnested logit model described in Appendix C, it is assumed that the utilities of all the alternatives are independent and their variances are equal. However, there are cases when the prediction of individual behavior under this assumption does not reflect the actual situation. So people developed a nested logit (NL) model, in which a coefficient  $\gamma$  (inclusive value) expressing the difference in variances of utilities is introduced.

The NL model lends itself as easily to parameter estimation as does the nonnested logit model. Furthermore, a more realistic estimation can be performed in the NL model. The structure of the NL model is illustrated in Figure 1.

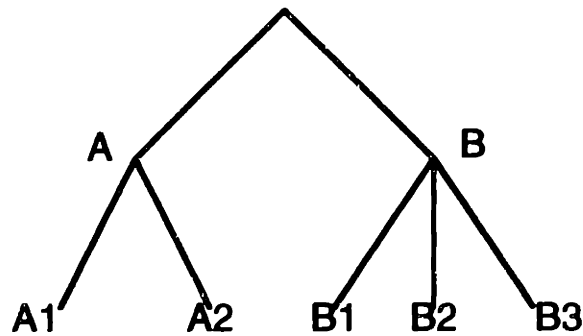


Figure 1 Nested Logit Structure

In the lower level model shown in Figure 1,  $P(i | A)$ , the conditional probability of alternative  $i$  (in "A" alternatives,  $i$  is either A1 or A2) being selected given that the alternative A is chosen, is expressed as follows:

$$P(i | A) = \frac{\exp V_i}{\exp V_{A1} + \exp V_{A2}}, \quad i = A1, A2$$

$$I_A = \ln(\exp V_{A1} + \exp V_{A2})$$

where  $I_A$  is the logsum for "A" alternatives.

For the "B" alternatives,  $P(i | B)$  can be expressed as follows:

$$P(i | B) = \frac{\exp V_i}{\exp V_{B1} + \exp V_{B2} + \exp V_{B3}}, i = B1, B2, B3$$

$$I_B = \ln(\exp V_{B1} + \exp V_{B2} + \exp V_{B3})$$

where  $I_B$  is the logsum for "B" alternatives.

In the upper level model,  $P(A)$ , the probability that the alternative A is chosen, is expressed as follows:

$$P(A) = \frac{\exp(a_A + \gamma I_A)}{\exp(a_A + \gamma I_A) + \exp \gamma I_B}$$

$$I_A = \ln(\exp V_{A1} + \exp V_{A2})$$

$$I_B = \ln(\exp V_{B1} + \exp V_{B2} + \exp V_{B3})$$

Therefore,  $P(A1)$ , the probability of alternative A1 being chosen, is described as follows:

$$P(A1) = P(A1 | A)P(A)$$

$$= \frac{\exp V_{A1}}{\exp V_{A1} + \exp V_{A2}} \cdot \frac{\exp(\alpha_M + \gamma I_A)}{\exp(\alpha_M + \gamma I_A) + \exp \gamma I_B}$$

Guidelines according to the value of  $\gamma$  (inclusive value) obtained through the NL evaluation are listed below:

- (1)  $0 < \gamma < 1$ ,  $\gamma$  is significantly different from 0 and 1; the NL model can be applied.
- (2)  $\gamma$  is not significantly different from 1 ( $\gamma$  can be assumed to be 1); the nonnested (ordinal) logit model can be applied because an NL model becomes a nonnested logit model in the case of  $\gamma$  being equal to 1
- (3)  $\gamma$  is not significantly different from 0 ( $\gamma$  can be assumed to be 0); plug  $\gamma = 0$  in the NL formula. In this case, choices in lower and upper levels are independent
- (4)  $\gamma > 1$ ,  $\gamma$  is significantly different from 1; another NL model, in which the lower and upper level are interchanged, should be considered.



(5)  $\gamma < 0$ ,  $\gamma$  is significantly different from 0; the NL model is inappropriate. The fundamental structure of the model should be re-organized.

## Appendix E

### The Jackknife Method

The jackknife method gives a nonparametric estimation of the statistical error. The attractive properties of this method is that it acquires very little in the way of modeling assumptions and can be applied in an automatic way to any situation no matter how complicated. The jackknife can be applied to any statistic that is a function of  $n$  independent and identically distributed variables.

The jackknife variance can be estimated in 5 steps:

1. Let our sample  $\psi$ , which consists of  $N$  observations. Partition  $\psi$  as  $\psi' = (\psi'_1, \psi'_2, \dots, \psi'_G)$  where  $G$  is the number of groups and  $m$  is the number of observations in each group such that  $G * m = N$ .
2. Let  $\hat{\beta}$ , the estimator acquired using all the data. Let  $\hat{\beta}_{-i}$ , the estimator obtained by omitting  $\psi_i$ , for  $i = 1, 2, \dots, G$ .

3. Calculate the pseudovalues:

$$\beta_i^* = G\hat{\beta} - (G-1)\hat{\beta}_{-i}$$

$$\text{for } i = 1, 2, \dots, G.$$

These  $\beta_i^*$  can be treated like  $G$  observations on  $\hat{\beta}$  (though not independent).

4. Calculate  $\hat{\beta}^*$  as:

$$\hat{\beta}^* = \frac{1}{G} \sum_{i=1}^G \beta_i^*$$

5. Estimate the variance of  $\hat{\beta}$  as:

$$\text{Var}(\hat{\beta}) = \frac{1}{(G-1)G} \sum_{i=1}^G (\beta_i^* - \hat{\beta}^*)(\beta_i^* - \hat{\beta}^*)'$$

For each coefficient, after the estimation of the variances the correct t-statistics were calculated as the ratio of the  $\hat{\beta}$  to the  $\sqrt{(\text{Var})}$ .

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