Possibilities and Constraints of Marketing Environmentally Friendly Produced Vegetables in Thailand

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ABSTRACT

During the last decade, there has been an increasing interest in environmental pollution and health concerns related to food contamination among Thai consumers, following the same trend seen within many industrialised countries. That development has produced a strong demand for vegetables from environmentally friendly production systems

This thesis aims to provide in-depth information on the possibilities and constraints associated with consumer-oriented marketing activities for environmentally friendly produced vegetables (EFPV) in Thailand, thus filling the current information gap. The study comprises an overview of vegetable production, consumption, and marketing of EFPV in Thailand; evaluation of product attributes desired by consumers; explanation of the purchase decision; assessment of consumers' willingness to pay (WTP); and, finally, conclusions for improving the marketing of EFPV in Thailand. The analyses are based on descriptive statistics and three advanced multivariate methods: conjoint analysis, logistic regression and the contingent valuation method.

A systematic description of the supplemented market for EFPV in Thailand has been compiled using official statistical data, complemented by information collected from the representatives of public and private organisations involved in the EFPV production-marketing system. In order to reveal consumer behaviour, the multivariate methods analysed the primary data that were collected by face-to-face interviews with 1,320 respondents at different points of sale in Bangkok, Chiang Mai and Khon Kaen.

According to the results from conjoint analysis, government certification and pesticide-safety levels are the attributes that consumers valued more than price. This indicates that the market development for EFPV is highly dependent on consumer confidence; so good quality control of the product is vital to any plan to develop and sustain the EFPV market. Like most European governments, the Thai Government should use a "unified certificate" policy to promote EFPV products in their domestic market in order to avoid the current consumer confusion caused by too many different labels and certificates.

Statistical analysis using logistic regression reveals that the positive important factors influencing purchase decisions are (in descending order of importance) income, age, awareness of pesticide contaminations (attitudes), affiliation to special diets (Macrobiotic and Cheewajit), reduction of pesticide contamination on vegetables by special dressing methods (by chemical liquid), concerns about pesticide residues, and higher education. The likelihood of purchasing EFPV is negatively correlated to the frequency of eating out. These results provide useful information that helps marketers to know their customers and develop market segmentation strategy.

Obtained from the contingent value method, the consumers' WTP for EFPV is 94% higher than the price of conventionally produced vegetables, and higher than the existing price premium (78%) for EFPV in the retail market. This indicates that the relatively high market prices for EFPV are not the limiting constraint for market development, although in any case the price premium for EFPV tends to decline. In fact, the high WTP indicates encouraging possibilities for EFPV market expansion in term of quantity, quality and varieties of product.

Regarding the factors that affect the magnitude of WTP, the latter is highly and positively influenced by the frequency of purchasing EFPV, affiliation to special diets, awareness of health and chemical residue problems, and household members suffering from chronic diseases. The likelihood of purchasing EFPV, and the magnitude of WTP, both increase as consumers become more aware of potential health hazards and environmental problems associated with conventional vegetable production. As this awareness continues to grow, so do the prospects for expansion of the EFPV market.

Keywords: consumer purchase decision, conjoint analysis, logistic regression, contingent valuation method, willingness to pay

KURZFASSUNG

Steigendes Umweltbewusstsein und wachsende Besorgnis der Verbraucher über gesundheitsgefährdende Rückstände in Nahrungsmitteln haben inzwischen auch fortgeschrittenere Entwicklungsländer erreicht. Diese Entwicklung gab Anlass zu einem DFG-geförderten Projekt über Produktions- und Vermarktungsperspektiven für rückstandsfreies, umweltfreundlich erzeugtes Gemüse („Environmentally Friendly Produced Vegetables“ EFPV) in Thailand. Gemüse wurde als Untersuchungsobjekt gewählt, weil es einerseits in der thailändischen Küche eine relativ große Bedeutung hat. Andererseits sind die Gemüseproduktion durch einen intensiven Einsatz von Dünge- und Pflanzenschutzmitteln und der Verbrauch durch einen hohen Anteil an frisch verzehrtem Gemüse gekennzeichnet. Folglich ist die potenzielle Gesundheitsgefährdung vergleichsweise groß.

Die vorliegende Arbeit untersucht die Nachfrageseite des Marktes auf Verbraucherebene. Zunächst wird eine traditionelle Marktbeschreibung vorgenommen, um einen Überblick über die Produktion, die Vermarktung und den Verbrauch von Gemüse im Allgemeinen und EFPV im Besonderen zu erstellen und die ausgewählten speziellen Fragestellungen zu begründen: Ermittlung der Bedeutung von Produkteigenschaften für den Kauf von EFPV, Identifikation von den Kauf von EFPV beeinflussenden Variablen und Abschätzung der Zahlungsbereitschaft der Verbraucher für EFPV.

Nach einer kurzen Darstellung der theoretischen Grundlagen des Kaufentscheidungsprozesses von Konsumenten werden die verwendeten methodischen Ansätze zur Lösung der spezifischen Fragestellungen erläutert: Conjoint Analyse zur Dekomposition von globalen Präferenzurteilen in wertbestimmende Eigenschaftsausprägungen, logistische Regression zur Erklärung der eigentlichen Kaufentscheidung und Kontingente Bewertung zur Ermittlung der Zahlungsbereitschaft für EFPV.

Die erforderliche Datengrundlage für die Anwendung der multivariaten Analyseverfahren wurde mit einer Befragung von 1 320 Verbrauchern in EFPV vermarktenden Einzelhandelsgeschäften in Bangkok, Chiang Mai und Khon Kaen geschaffen. Die Modalitäten dieser Erhebung werden im Einzelnen dargestellt, und die

Befunde mit beschreibenden methodischen Konzepten erläutert. Danach werden die Ergebnisse der anspruchsvolleren analytischen Ansätze aufbereitet. Ausgehend von theoretischen Erklärungsmodellen werden die statistischen Schätzmodelle entwickelt und die Schätzergebnisse interpretiert. Während die Spezifikation des Conjoint-Modells durch Befragungsergebnisse a priori festgelegt werden konnte, sind die endgültigen Spezifizierungen der Modelle zur Erklärung der Kaufentscheidungsprozesses und der Zahlungsbereitschaft iterativ bestimmt worden. Die Festlegung erfolgte dabei in einem Abwägungsprozess zwischen Variation der Spezifizierung, Beurteilung der statistischen und Bewertung der ökonomischen Ergebnisse.

Wichtige Erkenntnisse lassen sich wie folgt kurz zusammenfassen: bedeutendste **kaufrelevante Eigenschaften** sind erwartungsgemäß eine Garantie (Zertifikat) für ausgelobte Eigenschaften der EFPV und die Ausprägungen der Eigenschaften selbst. Die Zertifizierung sollte durch eine anerkannte - bevorzugt staatliche - Kontrollorganisation erfolgen. Unter den zugesicherten Eigenschaften genießen „frei von Pflanzenschutzmittelrückständen“ und „aus biologischem Anbau“ eine etwa gleiche, hohe Wertschätzung, während „konventionell erzeugt“ deutlich negativ besetzt ist. Die Höhe des Preises hat zwar einen erwarteten negativen Einfluss auf die Wertschätzung der Konsumenten, seine Bedeutung ist allerdings für die Gesamtbewertung von EFPV vergleichsweise gering. – Die **Kaufprozessanalyse** hat ergeben, dass im Zuge steigender Einkommen, eines zunehmenden Anteils älterer Menschen an der Bevölkerung und eines wachsenden Umwelt- und Gesundheitsbewusstseins eine Ausweitung des Konsums von EFPV in privaten Haushalten zu erwarten ist. Diese positiven Effekte dürften aber durch den gleichzeitig zunehmenden Außer-Haus-Konsum zumindest teilweise kompensiert werden. Einer solchen Entwicklung kann indessen wiederum mit einem gezielt auf Gaststätten, Kantinen und jüngere Konsumenten ausgerichteten Marketing entgegen gewirkt werden. – Die **Zahlungsbereitschaftsanalyse** hat schließlich ergeben, dass gewohnheitsmäßiges Verhalten - wie regelmäßiger Einkauf von EFPV, Einnahme von Mahlzeiten in der eigenen Wohnung, ausgeprägtes Gesundheitsbewusstsein, besondere Ernährungsgewohnheiten – einen positiven Einfluss auf die Zahlungsbereitschaft

haben. Andererseits ist erneut bestätigt worden, dass der Höhe des Aufpreises für EFPV keine entscheidende Bedeutung beigemessen werden kann.

Aus Marketing-Sicht erscheinen besonders wichtig: eine Auslobung von Eigenschaften ohne glaubwürdige Garantien sichert auf Dauer keinen Absatzerfolg; und die Höhe des Preises bzw. des Preisaufschlages gegenüber konventionell erzeugtem Gemüse ist zumindest kein entscheidender Hemmfaktor für eine fortschreitende Markterweiterung. Preissenkungen dürften deshalb den Absatz von EFPV auch kaum zusätzlich stimulieren, obwohl sie im Zuge des zunehmenden horizontalen Wettbewerbs zwischen den Einzelhändlern auftreten werden und aus Konsumentensicht selbstverständlich willkommen sind. Demgegenüber steht zu erwarten, dass eine Verringerung der hohen Anzahl derzeit existierender Produktmarkierungen bei gleichzeitiger Vereinheitlichung der Eigenschaften von EFPV auf Standardisierung hohem Niveau sowie strikte Kontrollen und Garantien für die zugesicherten Eigenschaften durch (wenige) glaubwürdige Organisationen den Absatz von EFPV deutlich erhöhen können. Zudem sprechen die Ergebnisse eindeutig dafür, dass eine allgemeine Aufklärung der Bevölkerung über die ernährungsphysiologischen Vorzüge von Gemüse und über umweltschonende Produktionsverfahren und deren positive Wirkungen auf Umweltmedien sowie auf Qualität und Sicherheit von Nahrungsmitteln eine empfehlenswerte Maßnahme zur Erhöhung des Verbrauchs von EFPV ist.

Schlagwörter: Kaufentscheidungsprozesse, Conjoint Analyse, logistische Regression, Kontingente Bewertung, Zahlungsbereitschaftsanalyse

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LIST OF ABBREVIATIONS AND ACRONYMS

ACFS	National Bureau of Agricultural Commodity and Food Standards
ACT	Organic Agriculture Certification Thailand
a.e.e.	all else equal –ceteris paribus
ANOVA	Analysis of Variance
cdf	Cumulative distribution function
CI	Confidence Interval
CODEX	Codex Alimentarius
CVM	Contingent Valuation Method
C	Hosmer and Lemeshow-test statistic
d.f.	Degrees of freedom
DOA	Department of Agriculture
DOAE	Department of Agricultural Extension
DM	Deutsche Mark
EFPV	Environmentally Friendly Produced Vegetables
etc.	et cetera
FAO	Food and Agriculture Organization
FiBL	Forschungsinstitut für biologischen Landbau (in German), Research Institute of Organic Agriculture
GAP	Good Agricultural Practice
GDP	Gross Domestic Product
GMP	Good Manufacturing Practice
GPP	Gross Provincal Product
HACCP	Hazard Analysis and Critical Control Point
HPP	Hygienic and Pesticide Free Vegetables for Export Pilot Project

IFOAM	International Federation of Organic Agriculture Movement
LINMAP	Linear Programming Methods
L	Likelihood Ratio
LnL	Log Likelihood
ML	Maximum Likelihood
MLE	Maximum Likelihood Estimate
MOAC	Ministry of Agriculture and Cooperatives
MOC	Ministry of Commerce
MONANOVA	Monotone Analysis of Variance
MOPH	Ministry of Public Health
MRL	Maximum Residue Limit
NESDB	National Economic and Social Development Board
NICs	Newly Industrializing Countries
No.	Number
NSO	National Statistical Office
NGOs	Non-Governmental Organizations
OAE	Office of Agricultural Economics
OLS	Ordinary Least Squares
PCC	Plant Protection Center
pdf	Probability density function
P-Value	Probability Value (The probability of getting a value of the test statistic as extreme as or more extreme than that observed by chance alone, if the null hypothesis H_0, is true.)
ROC	Receiver Operating Characteristic
SOEL	Stiftung Ökologie und Landbau (in German), Research Institute of Organic Agriculture

THB	Thai Baht
USD	US-Dollar
USDA	United States Department of Agricuture
WTO	World Trade Organization.
WTP	Willingness to Pay

LIST OF MEASUREMENT UNITS

1 rai = 0.16 hectare, or = 0.395 acre

1 hectare = 6.25 rai

1 acre = 2.5 rai

100 hectares = 1 square kilometre (km^2)

Average exchange rates used in the study (source: Bank of Thailand):

January1981-June 1997: 1 USD= 25 THB,1 DM = 13.5 THB

July 1997-May 2000: 1 USD = 38.1 THB, 1 DM = 20.5 THB

May2000-December 2005: 1 USD = 41.5 THB, 1 EUR = 49 THB

CHAPTER 1

INTRODUCTION

1.1 Problem Statement

For many years, farmers, manufacturers, distributors, retailers, and consumers in industrial countries have shown a growing interest in food production-marketing-systems other than the "conventional" type (DIMITRI and OVERHOLTZ, 2005; DIMITRI and GREENE, 2002; FU et al., 1999; WARGO, 1996). Initially, the development was supply driven: organic products were phased in by a small group of organic farmers who were concerned about the fact that conventional agricultural technology ("Good Agricultural Practice") is based on intensive use of intermediate inputs, especially chemicals, and consequently interfering with environmental media. More recently, however, consumers have become the driving market force. They increasingly "…insist on defining what is produced, how food production takes place, and with what effects" (USDA, 2001, p. 2). In this process, concern for the environment is still one buying motive. However, most consumers have shifted from buying non-conventionally produced food for altruistic reasons to those based more on self interest (DIMITRI and OBERHOLTZER, 2005; USDA, 2001). Food safety and health, taste, origin and traceability have gathered momentum, moving the focus on food quality in terms of nutrients and hazardous substances. The production-marketing-sector responded to this trend by successively switching from conventional agricultural production and food manufacture to more environmentally friendly systems with less potential health hazards. These range from integrated - using less chemicals - to genuine organic production systems relying on ecologically based practices such as cultural and biological pest management and virtually excluding the use of synthetic chemicals, antibiotics and hormones (USDA, 2006).

With a time lag of about two decades, environmental and health concerns resulting from conventional agricultural production systems have also reached the so-called Newly Industrialised Countries (NICs), and received increasing attention (ALI, 1998; ALI and TSOU, 1998; ALTEMEIER, 1995). This is especially true for Taiwan (FU et al., 1999) and more recently for Thailand, which is dealt with in the analysis presented here.

In the course of rapid industrialisation and economic growth, environmental deterioration in terms of air, surface and groundwater pollution, and soil contamination gathered importance in Thailand. Moreover, widespread and continuous over- and mis-use of chemical inputs, together with the adoption of modern agricultural production techniques not only aggravated the pressure on environmental resources but also caused contamination of agricultural produce and food. Over the last decade, for example, food-borne diseases from microbial and chemical sources have become a major threat to health. Such contamination might be a cause of cancer, which has been the most predominant reason of death in Thailand since 1999 (BUREAU OF HEALTH POLICY AND PLAN, 2002).

In the meantime, Thai consumers have realized the health problems connected with dangerous substances in fresh agricultural produce and manufactured food. Globalization, urbanisation and better education facilitate access to better information and improved knowledge about risks of residues, the benefits of micronutrients and a balanced diet and have triggered changing preferences in favour of products consumers believe to be safer. At the same time, income of Thai households significantly increased. Hence consumers have become not only willing to buy safer food but at the same time they are able to afford higher-priced healthier food.

Among the food items, vegetables are the major subjects of consumers' concerns for two reasons. On the one hand, conventional vegetable production systems intensively use pesticides and fertilizers causing great potential of health danger from chemical residues in the produce, especially in leafy vegetables. On the other hand, consumption of fresh (and again predominantly leafy) vegetables is traditionally very common in Thai society. However, consumption of fresh (uncooked) produce is more hazardous than consumption of cooked vegetables, because the cooking process at least partly removes residues. Additionally, in the course of socio-economic development, consumers' concerns about residues in vegetables are gaining importance over time as consumption generally shifts away from basic foodstuff like cereals or rice to fruits and vegetables, which have higher nutrient values.

During the 1990s, individual farmers in Thailand respond to the burgeoning demand for healthier food and started to launch a variety of "healthier", "environmentally

friendly produced" products, primarily vegetables. At the present time, the character of the market for "environmentally friendly produced vegetables" (EFPV) is no longer a tight niche market but a well-established although fragmented market encompassing products of quite different quality: organic (produced without any chemicals), pesticide-free (produced without pesticides but with fertilisers) and pesticide-safe (produced with less pesticides in order to reduce hazardous residues in the vegetables). According to recent statistics, EFPV is the most prosperous segment within the environmentally friendly produced food market in Thailand, covering about 80% of the total (PANYAKUL and SUKCHITRATTIKAN, 2003b). However, due to higher costs of production and pronounced degree of product differentiation, EFPV are more expensive than traditionally produced vegetables. Therefore, EFPV are normally not sold in the traditional markets but in large hypermarkets and supermarkets, and in special outlets, so-called green shops.[1]

Although some aspects of the market development and selected policies with respect to healthier food and vegetables have been addressed in the literature (ITHARATTANA, 1997; TITAPIWATANAKUN, 1998), there are virtually no in-depth analyses of these phenomena in Thailand – quite contrary to industrial countries.

In the light of the changes in food consumption and consumers' behaviour in Thailand and taking account of the enforced challenge to produce "safe" and "healthy" food and especially vegetables, the Faculty of Horticulture at Hannover University, Germany, launched a joint research project on environmentally friendly production systems[2], including economic issues of production and consumption. The analyses of consumer demand are presented here.[3] They aim at identifying possibilities and constraints in marketing EFPV, thereby filling the existing information gap in order to improve consumer oriented marketing activities for EFPV in Thailand.

[1] A green shop is a shop or store selling only natural products or less-chemical products such as foodstuff, clothes, and herbs. In Thailand, green shops started their businesses in 1990.

[2] Protected cultivation – an approach to sustainable vegetable production in the humid tropics, Phase I: 2001-2003, Phase II: 2004-2007

[3] The second economic research addresses production aspects of EFPV in Thailand and is carried out by B. HARDEWEG under the supervision of Prof. H. WAIBEL at the Institute of Economics in Horticulture at the Faculty of Economics and Mangement at Hannover University, Germany.

1.2 Research Objectives and Methods Used

In order to reach the overall objective we defined five main sub-goals, to be achieved in sequence:

(i) provide an overview of vegetable production, consumption, and marketing of EFPV including the relevant policy setting, in order to gain a general idea of the vegetable and EFPV marketing in Thailand;

(ii) examine positive and negative product attributes of EFPV important to consumers;

(iii) identify the driving forces behind the purchasing behaviour of different consumer groups;

(iv) evaluate consumers' WTP for EFPV and quantify its key influencing factors;

(v) elaborate on starting points for private and public strategies to support the marketing of EFPV.

The analyses are based on neo-classical theory, stating that income and prices in conjunction with individual preferences affect consumption, refined and enlarged by hypotheses taken from behavioral approaches to explain more sophisticated consumer decisions. Additionally, institutional economic aspects have been taken into account to evaluate policy implications and derive recommendations. Methodologically the research is based on traditional descriptive market investigation and reporting concepts to characterize the marketing environment. The analytical section relies on the application of multivariate methods in order to identify and quantify the different factors affecting consumer behavior.

A systematic description of the market for vegetables in Thailand is needed in order to realize the first sub-objective. The task has been carried out using official statistical data and other sources available. These include the opinions and assessments of experts – farmers, processors, retailers, and representatives of public and private organisations involved in the EFPV-production-marketing-system – as well as hard data on sales, provided by an executive of an international hypermarket chain.

Objectives (ii) to (iv) have been addressed by conducting relatively large consumer surveys to generate detailed information on consumers' socio-economic characteristics, attitudes, behaviour and willingness to pay, based on face-to-face consumer interviews in different types of outlets in three large cities in Thailand. The information collected has been processed by applying three multivariate analyses. Firstly, conjoint analysis has been used to determine the product attributes preferred by consumers. The results may contribute to design appropriate production and marketing strategies in accordance with consumer requirements, including certification issues, and they should also contribute to improved cost efficiency. Secondly, logistic regression has been applied in order to identify and quantify factors affecting consumer's purchase decision for EFPV, including those of non-buyers. This information will assist in the definition of specific market segments and may contribute to extending the market for EFPV. Thirdly, to assess consumer’s WTP for EFPV relative to conventional vegetables, the contingent valuation approach is used. The findings contain useful information for all actors in the production-marketing chain and may help to estimate the market potential.

Sub-objective (v) is achieved in two steps. Firstly, each of the gradually developed results is directly discussed with respect to possible marketing activities. Secondly, the summary of the findings of the research is used to coherently derive starting points for private and public actions that will improve the production and marketing of EFPV.

1.3 Organization of the Thesis

According to the objectives stated above, the thesis is organized around five chapters. Following this introductory chapter, chapter 2 provides the market description. An overview of the production, marketing and consumption of vegetables will be presented using official statistical data from Thai government agencies. Additionally, available literature on health and environment problems and consumer concerns has been reviewed in order to better understand the development of the market segment for EFPV.

Chapter 3 explains the framework comprising the theoretical concept of consumer behaviour and methodology. This chapter reviews the literature on consumer behaviour and develops the three core aspects dealt with in the thesis: product

attributes that attract consumers, the actual consumers decision to buy or to refrain form buying, and the WTP for EFPV. The methods selected to quantify these aspects - conjoint, logistic regression, and contingent valuation methods - are also explained and translated into the actual research.

Chapter 4 presents the empirical analyses in five sections: survey design and data collection, descriptive results from the survey, and analyses of consumer behaviour, including implications of the results for marketers. The data collection section describes the sampling strategy, sample size and discusses survey questions. The second section presents important descriptive results, whereas the third section to the fifth section are addressed to identify and quantify the importance of product characteristics (section 4.3), factors affecting purchase decisions (section 4.4), and determinants of WTP (section 4.5) generated by the multivariate analytical methods.

Finally, Chapter 5 summarizes the thesis and discusses the main findings with respect to future activities of producers, marketers, and public authorities.

CHAPTER 2

SITUATION OF VEGETABLE MARKETING IN THAILAND

This chapter provides a general background of role of the important vegetable sector, an overview of the production and consumption of vegetables and the increasing health and environment concerns in Thailand. This is useful in order to understand the existing marketing for EFPV. The chapter also presents the current market situation and background information about the marketing systems and prevailing demand structure for EFPV in Thailand. Finally, general problems of EFPV marketing are discussed.

2.1 Background

Thailand is a predominantly agrarian country with an important share in the world export market of about 2.2% or US$15.08 billion in 2003 (WTO, 2004). Thai people consider that agriculture is an important base of the Thai society, with the total area of holding for agriculture around 114,460,932 rai (or 183,138 km^2), about 35.7% of the total area of the country (NSO, 2005b). Moreover, the agricultural sector has generated food security and living incomes for the Thai people. There was an active population in the agricultural sector of about 45.27 % of the labor force (NESDB, 2000). Almost a half of Thai laborers earn their living from agriculture.

During the financial and economic crisis of 1997-1998, the Thai agricultural sector experienced an increase in export volume and income. Agriculture was the major sector providing foreign currency during that crisis and since. Table 2.1 shows the balance of trade value during 1993-2002. Before 1997, the overall balance of trade was negative while that of the agricultural sector was continuously positive. The 1997 financial crisis resulted in Thai Baht (THB)[1] depreciation, making the agricultural export sector more competitive and leading to an increase in the balance of trade value

[1] The currency of Thailand is the "Baht". Before the financial crisis that started in July 1997, the Baht was pegged at 25 to the US dollar. After the adoption of the floating exchange rate system on 2 July 1997, currency Exchange Rates fluctuates throughout the day, with trading on the market continuously. The average THB during July 1997-May 2000 was 38.1 THB per 1 US dollar. After the IMF program (since May 2000), the average exchange rate was 41.5 THB per 1 US dollar (BANK OF THAILAND, 2005).

of the agricultural sector of 364,863 million THB and 369,601 million THB in 1998 and 2002, respectively.

Table 2.1 Value of exports, imports and balance of trade, 1993–2002

(Million THB)

Year	Export		Import		Balance of trade	
	Total	Agricultural and product	Total	Agricultural and product	Total	Agricultural and product
1993	940,862	279,857	1,170,846	159,889	-229,984	119,968
1994	1,137,601	336,290	1,369,034	179,857	-231,433	156,433
1995	1,406,310	407,218	1,834,537	213,538	-428,227	193,680
1996	1,411,039	412,677	1,832,825	216,833	-421,786	195,844
1997	1,806,932	485,198	1,924,263	228,831	-117,331	256,367
1998	2,248,777	591,690	1,774,050	226,827	474,727	364,863
1999	2,214,249	556,498	1,907,391	228,097	306,858	328,401
2000	2,768,064	626,911	2,494,133	275,459	273,931	351,452
2001	2,884,703	685,675	2,755,308	321,231	129,395	364,444
2002	2,955,716	695,095	2,778,039	325,494	177,677	369,601

Source: NSO (2004)

Furthermore, the agricultural sector also played an important role in providing an unofficial social safety net that provided job opportunities for the newly unemployed during the crisis. The strong tie between workers in the manufacturing and service sectors and communities in the rural (agricultural) sector provided the job opportunities for unemployed workers migrating back to the countryside to secure essential income support (TUALANANDA, 2000).

The agricultural sector can be simply classified into six major sub-sectors; namely crops, livestock, fisheries, forestry, agricultural services and the processing of simple agricultural products. In 1980 the Gross Domestic Product (GDP) of Thailand was 913.73 billion THB and increased to 1,945.37 and 2,859.16 billion THB in 1990 and 1999 respectively (see table 2.2). The agricultural sector changed its share of the GDP (from 20.2 percent in 1980) to around 11 percent (see Figure 2.1). Among the sub-sectors, crop has the biggest share of agricultural GDP. Since 1980, the crop maintained its share of agriculture at 58-61 percent.

Table 2.2 Gross Domestic Production at 1998 Prices

(Millions of THB)

Year	GDP	Agriculture	Crop	Vegetable	Agri./ GDP	Crop/ GDP	Veg./ GDP	Crop/ Agri.	Veg./ Crop	Veg./ Agri
1980	913,733	184,576	113,768	14,332	20.2	12.5	1.6	61.6	12.6	7.8
1981	967,706	194,023	120,954	14,492	20.0	12.5	1.5	62.3	12.0	7.5
1982	1,019,501	198,825	123,193	14,542	19.5	12.1	1.4	62.0	11.8	7.3
1983	1,076,432	208,312	131,122	14,217	19.4	12.2	1.3	62.9	10.8	6.8
1984	1,138,353	217,518	139,171	15,102	19.1	12.2	1.3	64.0	10.9	6.9
1985	1,191,255	227,324	146,934	15,238	19.1	12.3	1.3	64.6	10.4	6.7
1986	1,257,177	228,191	141,776	13,951	18.2	11.3	1.1	62.1	9.8	6.1
1987	1,376,847	228,346	136,696	15,124	16.6	9.9	1.1	59.9	11.1	6.6
1988	1,559,804	252,346	157,783	15,446	16.2	10.1	1.0	62.5	9.8	6.1
1989	1,749,952	276,569	175,031	14,875	15.8	10.0	0.9	63.3	8.5	5.4
1990	1,945,372	263,607	160,195	16,851	13.6	8.2	0.9	60.8	10.5	6.4
1991	2,111,862	282,740	170,277	17,457	13.4	8.1	0.8	60.2	10.3	6.2
1992	2,282,572	296,277	177,015	17,803	13.0	7.8	0.8	59.7	10.1	6.0
1993	2,470,908	289,065	164,089	17,573	11.7	6.6	0.7	56.8	10.7	6.1
1994	2,692,973	303,376	171,164	18,514	11.3	6.4	0.7	56.4	10.8	6.1
1995	2,941,736	313,855	179,898	18,525	10.7	6.1	0.6	57.3	10.3	5.9
1996	3,115,338	326,836	192,117	19,384	10.5	6.2	0.6	58.8	10.1	5.9
1997	3,072,615	323,884	193,193	19,066	10.5	6.3	0.6	59.6	9.9	5.9
1998	2,749,684	318,953	192,324	20,252	11.6	7.0	0.7	60.3	10.5	6.3
1999	2,871,980	325,877	198,411	21,214	11.3	6.9	0.7	60.9	10.7	6.5
2000	3,008,401	346,856	214,493	20,867	11.5	7.1	0.7	61.8	9.7	6.0
2001	3,073,601	359,193	222,158	21,504	11.7	7.2	0.7	61.8	9.7	6.0
2002	3,237,559	366,166	223,369	22,003	11.3	6.9	0.7	61.0	9.9	6.0

Source: NESDB, (2002). National Income of Thailand 1980-2001 Edition (data in 1980-2000)
NESDB, (2004). National Income of Thailand 2003 Edition (data in 2001-2002)

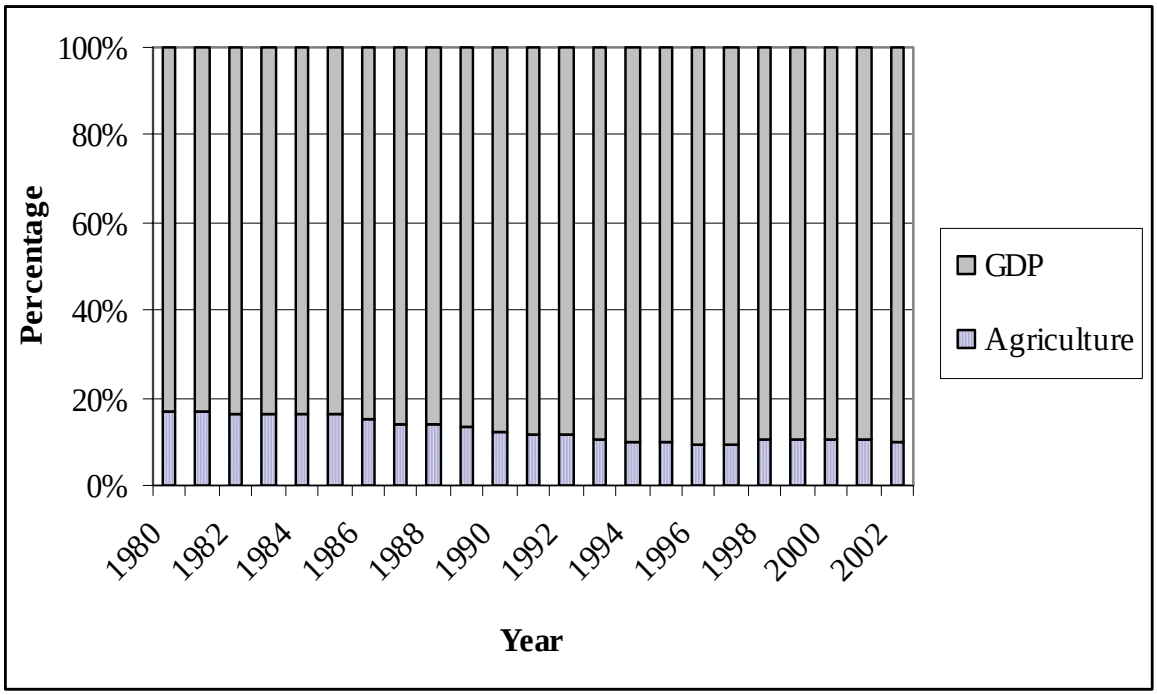


Figure 2.1 Agriculture share of GDP (at 1998 prices), 1980-2002

Source: NESDB (2002), NESDB (2004)

In the past, rice and fiber crop production have traditionally been the main staples in Thailand's agriculture. The Sixth National Economic and Social Development Plan (1987–1991) was the first plan that gave attention to the vegetable industries, providing support and assistance from the government simply because their potential marginal return per acreage was higher than that of rice and fiber crop (ISVILANONDA, 1992). Despite of support by government, the GDP proportion of Vegetable to Agriculture was slightly decreased from 7.8% in 1980 to 6.4% and 6.0% in 1990 and 2002 (see table 2.2). Meanwhile, the contribution of Agriculture to GDP decreased from 20.20% in 1980 to 13.55% in 1990 and 11.43% in 1999. Although the agricultural sector lost much of its important role in Thailand's overall economic picture in 2002 the GDP of Vegetables was about 22,003 million THB.

2.2 Vegetable Production

Every year there are about 70 kinds of vegetables produced in Thailand. However, only 50 types are commercially produced. These vegetables can be categorized into five groups:

- Leafy vegetables; for example Chinese cabbage, cabbage, Chinese kale, morning glory, spring onion, Chinese mustard, lettuce, etc.
- Fruit vegetables; for example watermelon, chilli, cucumber, pumpkin, tomato, wax gourd, angled gourd, snake eggplant, etc.
- Root and bulb; for example shallot, ginger, onion, white radish, carrot, etc.
- Inflorescence and stem vegetables; for example Chinese chive, cauliflower, asparagus, Roselle, broccoli, etc.
- Suds and pod vegetables; baby corn, yard long bean, corn, okra, French bean, sugar pea, etc.

These 50 kinds of vegetables made up an annual total of about five metric tonnes, generating around 5.2 million THB per year (DOAE, 2002). Because of the climate conditions, most of the growing areas are in the north and northeast. Mountainous areas in the northern and northeastern regions have a near sub-tropical climate that is suitable for the cool-season crops such as cabbage, Chinese cabbage, watermelon, and carrot etc. The agro-climate conditions prevailing in Thailand make it possible to produce vegetables throughout the year. Most of the leafy vegetables can be grown year round, for example Chinese kale, spring onion, Chinese mustard, coriander and morning glory. For fruit vegetables, there are only chilli, tomato, snake eggplant, and plate brush eggplant that can be grown throughout the year. Because leafy vegetables need less time to grow, the farmer can take advantage of multiple cropping and inter-cropping systems.

Despite the potential role of vegetables, the proportion of vegetables in the agriculture sector of around 6.4% has been unchanged during last two decades. The production of vegetables increased from 2,042,520 tonnes in 1993 to 4,924,535 tons in 2003 (see table 2.3). The main increase in production came from the expansion of the growing

area, which increased from 1,034,194 rai (or 1654.71 km^2) in 1993 to 2,884,160 rai (or 4614.66 km^2) in 2003. However, the yield decreased during the last decade from 1,974 kg/ rai to 1,707 kg/ rai.

Table 2.3 Harvested area, yield and production of vegetables, crop year 1993 - 2003

Year [1/]	Harvested area (rai)	Yield per rai (kg)	Production (tons)
1992/93	1,034,194	1,974	2,042,520
1993/94	2,246,458	1,842	4,139,784
1994/95	2,668,450	1,704	4,548,214
1995/96	2,596,437	1,748	4,540045
1996/97	2,949,863	1,775	5,238,596
1997/98	3,374,980	1,730	5,841,632
1998/99	3,435,293	1,670	5,740,256
1999/00	3,092,360	1,628	5,035,857
2000/01	2,759,713	1,648	4,550,608
2001/02	3,192,796	1,742	5,562,272
2002/03	2,884,160	1,707	4,924,535

Note: [1/]Crop year from May to April

Source: DEPARTMENT OF AGRICULTURAL EXTENSION, (2003b)

The expansion of vegetable production led to the inappropriate use of agro-chemicals and increased the cost of vegetable production (TANTEMSAPYA, 1995 and JUNGBLUTH, 1997). Usually, there are four main costs in vegetable production: labour, seed, fertiliser and pesticide. Phadungchom (1999), found that for vegetable production in the Nakhon Pathom province the pesticide costs amount to an average share of 19-24 percent of total variable costs, which was the highest the variable costs.

Chemicals for cultivation in Thailand are mostly imported. Table 2.4 shows the quantity and value of chemicals imported for agricultural uses between 1987 and 2000. The main agrochemicals[2] for crop are insecticide, fungicide and herbicide, making up about 95% of the total. Between 1987 and 2000, the quantity of imported agrochemicals rose steadily. In 2000, the value of the three main agrochemicals was

[2] Agrochemical classifies in 11 categories: insecticide, fungicide, herbicide, bio-pesticide, acaricide, rodenticide, Plant Growth Regulators, mollussicide, and miscellaneous.

7,108 million THB. Although it is difficult to identify the amount of chemicals usage for vegetable production, the increase in pesticide imports over the last fifteen years indicates a rise in the growth of pesticide intensive crops that may cause of an increasing in environmental contamination.

Table 2.4 Import quantity and value of chemicals for agricultural uses between 1987-2000

Year	Insecticide		Fungicide		Herbicide	
	Quantity (Tons)	Value (Million THB)	Quantity (Tons)	Value (Million THB)	Quantity (Tons)	Value (Million THB)
1987	5,881	806	4,530	288	3,967	570
1988	7,050	1,180	4,362	350	5,596	822
1989	6,937	1,239	4,724	367	6,747	1,151
1990	7,176	1,500	2,800	311	8,272	1,512
1991	5,560	1,275	2,087	371	7,071	1,228
1992	6,098	1,425	3,513	441	8,450	1,707
1993	5,305	1,281	3,988	438	9,056	1,788
1994	5,252	1,178	4,885	534	9,554	1,705
1995	6,573	1,644	4,828	603	11,934	2,044
1996	6,608	1,776	4,446	616	14,041	2,444
1997	6,239	1,755	4,015	627	12,946	2,472
1998	7,455	2,179	2,429	579	8,697	2,217
1999	8,924	2,015	3,118	558	9,740	1,973
2000	7,515	2,148	4,931	1,119	17,507	3,841

Source: HUTANGKABODEE and OYVIRATANA, (1997). (data 1987-1996)
OFFICE OF AGRICULTURAL REGULATION, (2001). (data 1997-2000)

As well as pesticides fertilizers are also intensively used in the production of vegetables. The Office of Agricultural Economics (OAE) (1996) predicted the demand for fertilizers for use in vegetable and flower production would be 513,083 tonnes in 2000. The production area of vegetables was about 2,884,160 rai in crop year 2002/03. Although there are no statistics detailing the quantities of pesticide and fertilizer used specifically in vegetable production, the overall data for pesticide import and demand for fertilizers provide some clue about the tendency towards intensive chemical usage.

Intensive usage of the chemicals in vegetable production leaves toxic residues in the environment that are potentially hazardous to farmers' health. Figure 2.2 shows the number of illnesses and deaths resulting from toxic residues in agriculture in 1990-2000. During the last decade the number of deaths has fluctuated around 32 people per year while the average number of illnesses is 3,520 people per year.

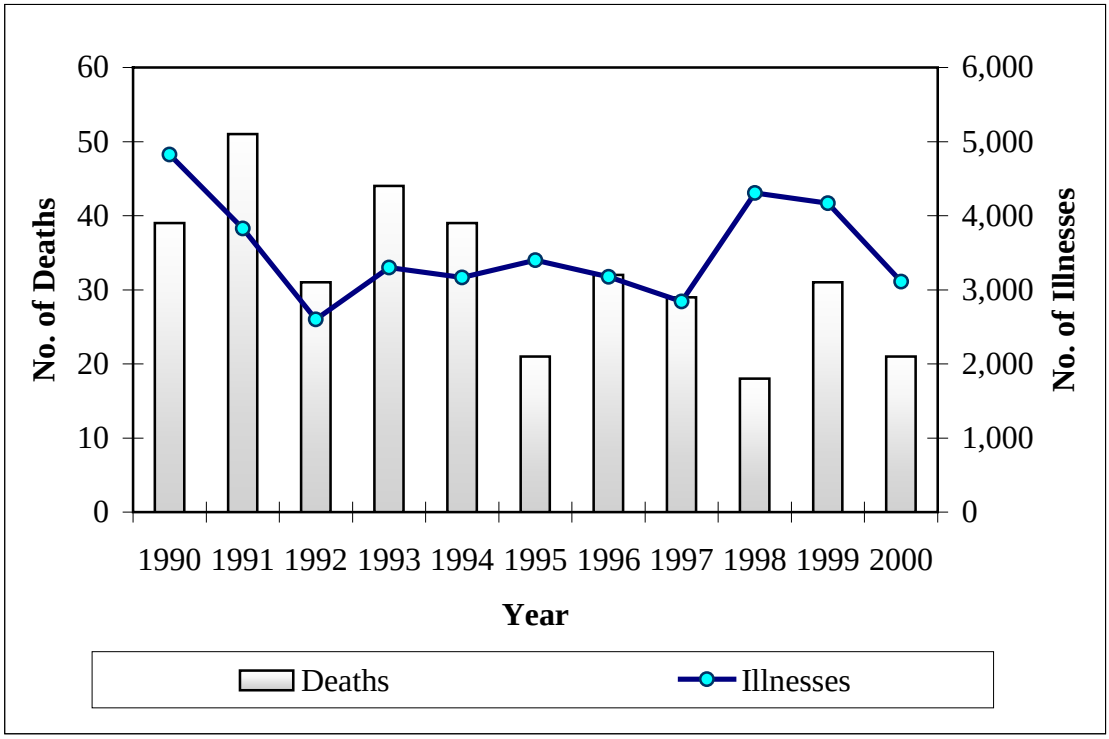


Figure 2.2 Number of illnesses and deaths caused by toxic residues in agriculture in 1990-2000

Source: DIVISION OF OCCUPATIONAL HEALTH (2001)

The three main insecticides used in Thai agricultural sectors are the chlorinated hydrocarbon, organophosphorus and carbamate compounds. All three compounds are considered particularly hazardous when improperly used in crops such as fruit and vegetables. In particular, Organophosphorus and carbamate compounds were found to be widely used and caused major poisoning in Thailand (FOOD AND DRUG ADMINISTRATION and THAI CENTER FOR ENVIRONMENTAL HEALTH, 2000; and JUNGBLUTH, 1996). Since 1992, the Division of Occupation Health has conducted health surveillance of populations that are at high risk of pesticide poisoning by carrying out blood testing as shown in table 2.5. According to this surveillance, the number of cases with a high risk of pesticide poisoning by organophosphorus

compounds and carbamate compounds during 1992-1998 showed a decreasing trend from 26.5% in 1992 to 17.4% in 1998. Despite this percentage decrease, the number of cases at high risk was still substantial in 1998 (72,606 people). All these statistics show the economic impact of intensive chemical usage in contributing to the high cost of vegetable production and the hazardous impact on the farmers' health.

Table 2.5 Occupational surveillance of populations at a high risk of pesticide poisoning by organophosphorus and carbamate compounds in 1992-1998

Year	**Number of screening**	**Number of cases having high risk of pesticide poisoning**	
		Number	Percent
1992	201,613	53,353	26.5
1993	512,820	93,769	18.3
1994	418,868	66,196	15.8
1995	487,503	89,745	18.4
1996	578,885	109,812	19.0
1997	562,841	103,517	18.4
1998	416,265	72,606	17.4

Source: FOOD AND DRUG ADMINISTRATION and THAI CENTER FOR ENVIRONMENTAL HEALTH. (2000)

2.3 Vegetable Consumption

After providing an overview of the important role of the vegetable sub-sector in the Thai economy, the vegetable production and intensive chemical usage, this section examines vegetable consumption by means of a discussion of the changes in household structure, food consumption and expenditure on vegetables as a proportion of household spending.

2.3.1 Household structure

The changing pattern of family structures in Thailand is a widely accepted fact, and the extended families of traditional society are being gradually replaced by the nuclear families of modern society (PHANANIRAMAI, 1991). During the last three decades, the average household size has declined, which is a normal characteristic of modern democratic society. Figure 2.3 shows the average household size from census data for the period 1975 to 2002. Thailand has been through the baby boom period of the 1960's and 1970's. Thai fertility has declined dramatically from 3.0 children per woman in 1970-1980 to 1.9 children per woman in 1990-1995 (a drop of 71%) and 1.8 children per woman in 2000 (SOONTHORNDHADA, 2005). Accordingly, the average household size declined from 5.5 to 3.9 and 3.5 in 1975, 1992 and 2002, respectively.

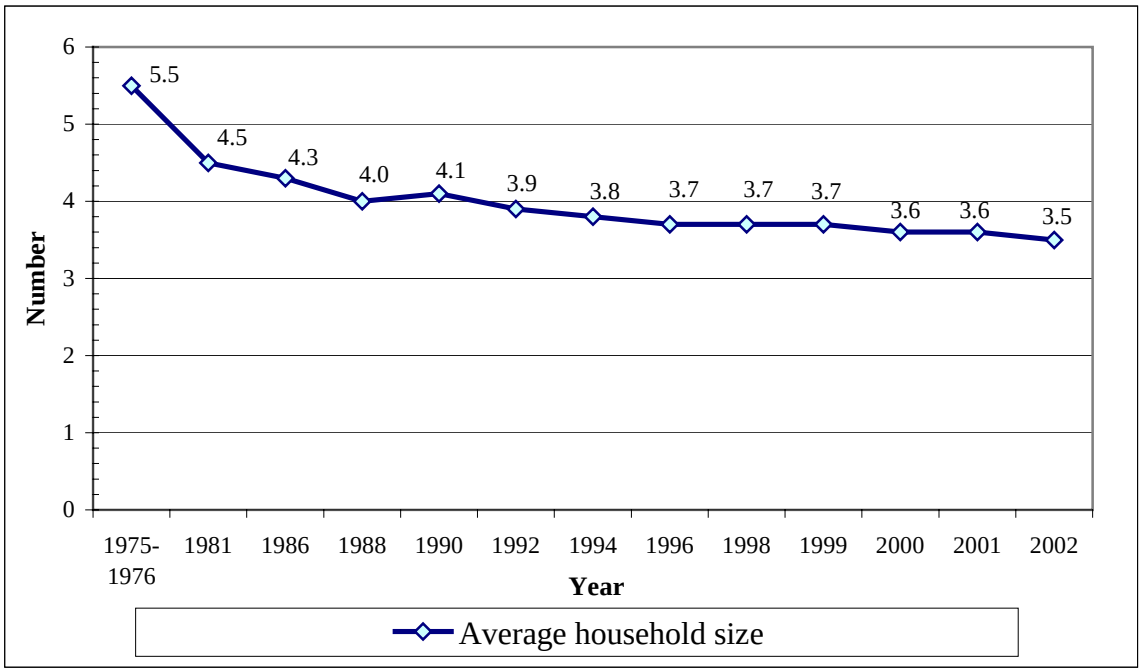


Figure 2.3 Average household size: 1975-2001

Source: NSO (2002) and NSO (2003)

In 2002, the number of households nationwide was about 17,882,700. The populous area of 5.7 million (31.6%) was the northeastern region, with an average of 3.7 persons per household. The central and northern parts of country each had approximately the same number of households of about 3.4 million (19.1% and 19.4%) with an average of 3.4 and 3.2 persons per household, respectively. In Bangkok and vicinity (including Nonthaburi, Prathum Thani and Samut Prakan), the dispersion of households was more dense, with 3.1 million (17.4%) with an average of 3.3 persons per household. In the south, there were only 2.2 million households (12.5%) with an average of 3.8 persons per household. (see table 2.6) The differences in household size might have varying implications in socio-economics and consumption.

Table 2.6 Number and size of households in 2000 and 2002 by region

Region	**No. of Households in 2000**		**No. of Households in 2002**	
	Number (%)	Size	Number (%)	Size
Bangkok and vicinity [1/]	3,104,400 (18.0)	3.2	3,112,500 (17.4)	3.3
Central [2/]	3,304,400 (19.1)	3.5	3,413,900 (19.1)	3.4
North	3,271,500 (19.0)	3.4	3,476,400 (19.4)	3.2
Northeast	5,393,300 (31.2)	3.9	5,654,000 (31.6)	3.7
South	2,196,200 (12.7)	3.8	2,225,900 (12.5)	3.8
Whole Kingdom	17,269,800 (100.0)	3.6	17,882,700 (100.0)	3.5

Note: [1/] Bangkok Metropolis, Nonthaburi, Pathum Thani and Samut Prakan
[2/] Excluding Bangkok Metropolis, Nonthburi, Pathum Thani and Samut Prakan

Source: NSO (2001) and NSO (2003)

2.3.2 Household income, food consumption and expenditure on vegetables

Considering household income, it was found that households nationwide earned an average of 13,736 THB per month per household in 2002. Looking at each region, it was discovered that households in Bangkok and vicinity earned an average of 28,239 THB per month per household. Households in the central, north, northeast and south

parts of the country earned about 14,128 THB, 9,530 THB, 9,279 THB and 12,487 THB per month per household respectively (see table 2.7). Overall average expenditure was around 10,889 THB a month per household. Of this, the major expense was 35.5% or 3,521 THB for food, beverages and tobacco. The other 21.8% or 2,155 THB was for accommodation and household goods (NSO, 2003). Bangkok and vicinity had far higher expenditures than those in other regions: about 21,087 THB per household, followed by households in the Central, Southern and North part of Thailand, with monthly expenditure of 11,227 THB, 10,701 THB and 7,747 THB per household respectively. Among those, the Northeast had a lower expenditure than other regions at approximately 7,550 THB per month per household.

Table 2.7 Average monthly total income, total expenditure consumption expenditure, expenditure on vegetables by region in 2002

(Unit: THB/ household)

Region	Total Income	Total Expenditure	Consumption Expenditure	Expenditure on Vegetables
Bangkok and vicinity [1/]	28,239	21,087	18,311	226
Central [2/]	14,128	11,227	9,964	245
North	9,530	7,747	6,777	258
Northeast	9,279	7,550	6,741	243
South	12,487	10,701	9,558	232
Whole Kingdom	13,736	10,889	9,601	242

Note: [1/] Bangkok Metropolis, Nonthaburi, Pathum Thani and Samut Prakan
[2/] Excludes Bangkok Metropolis, Nonthburi, Pathum Thani and Samut Prakan

Source: NSO (2003)

In analyzing consumption patterns, it was found that the average expenditure on vegetables nationwide was 242 THB per household per month. The North region had the highest vegetable expenditure of about 258 THB per month per household. People in Bangkok and vicinity spent less on vegetables than other regions with 226 THB per household per month. The proportion of expenditure on vegetables compared to the total expenditure on food prepared at home varied between 8.41% and 12.84% in 2002. Table 2.8 shows that vegetable expenditure in every region decreased between 1998 and 2002. The proportion of expenditure on vegetables nationwide decreased from 13.47% (318 THB) in 1998 to 10.27% (242 THB) in 2002. Despite this, there

was a slight increase in some regions (North and Northeast) between 2000 and 2002. This trend might be due to reduction of income during the economic crisis, as people reduced their expenditure on vegetables, as discussed later.

Table 2.8 Average monthly expenditures on food and vegetables by region, between 1998-2002

(Unit: THB)

Region	1998		2000		2002	
	Food [1/]	Vegetables (%) [2/]	Food [1/]	Vegetables (%) [2/]	Food [1/]	Vegetables (%) [2/]
Bangkok and vicinity	2,388	288 (12.06)	2,259	232 (10.27)	2,519	226 (8.97)
Central	2,516	362 (14.39)	2,078	230 (11.07)	2,434	245 (10.07)
North	2,222	338 (15.21)	1,774	201 (11.33)	2,002	258 (12.89)
Northeast	2,283	299 (13.10)	1,737	159 (9.15)	2,278	243 (10.67)
South	2,512	303 (12.06)	2,112	192 (9.09)	2,757	232 (8.41)
Whole Kingdom	2,361	318 (13.47)	1,941	197 (10.15)	2,356	242 (10.27)

Note: [1/] Expenditure on food prepared at home and excluding beverages
[2/] % Expenditure share of vegetables in food

Source: NSO (2003), NSO (2001), and NSO (1999)

When comparing vegetable expenditure with the other groups, the vegetable expenditure was the sixth ranking overall. Exceptions are the northern and northeastern regions, which have vegetable expenditure ranking about third and fourth respectively. Bangkok has consumption patterns different from the others with a higher consumption of milk and fruits, while the other regions consumed more grains and cereals (see table 2.9).

Table 2.9 Average monthly household expenditure and percentage of food prepared at home by region in 2002

(Unit: THB)

Expenditure group	Bangkok	Central	North	Northeast	South	Whole Kingdom
Food prepared at home	2,519	2,434	2,002	2,278	2,757	2,356
Percentage	(100)	(100)	(100)	(100)	(100)	(100)
Grains and cereal products	316	374	404	550	454	438
Percentage	(12.54)	(15.37)	(20.18)	(24.14)	(16.47)	(18.59)
Meat and poultry	389	414	387	478	440	429
Percentage	(15.44)	(17.01)	(19.33)	(20.98)	(15.96)	(18.21)
Fish and seafood	303	324	242	393	495	350
Percentage	(12.03)	(13.31)	(12.09)	(17.25)	(17.95)	(14.86)
Milk, cheese and eggs	330	265	212	211	319	255
Percentage	(13.10)	(10.86)	(10.59)	(9.26)	(11.57)	(10.82)
Oil and fats	39	56	39	36	55	43
Percentage	(1.55)	(2.30)	(1.95)	(1.58)	(1.99)	(1.83)
Fruits and nuts	482	285	178	125	318	249
Percentage	(19.13)	(11.71)	(8.89)	(5.49)	(11.53)	(10.57)
Sugar and sweets	101	148	93	72	140	104
Percentage	(4.01)	(6.08)	(4.65)	(3.16)	(5.08)	(4.41)
Vegetables	226	245	258	243	232	242
Percentage	(8.97)	(10.07)	(12.89)	(10.67)	(8.41)	(10.27)

Source: NSO (2003)

During the last decade, the average expenditure on vegetables as a proportion of the total expenditure on food prepared at home fluctuated. Figure 2.4 shows these figures for 1992-2004. The expenditure on food prepared at home varied between 1,633 and 2,554 THB while the vegetable expenditure varied between 147 and 318 THB. So, both the total and vegetable expenditures increased together. As shown in Figure 2.4, there is a remarkable peak in vegetable and food expenditure in 1998, the year after the economic crisis. The pattern of expenditure on both food in total and vegetables seems to have been related to economic factors.

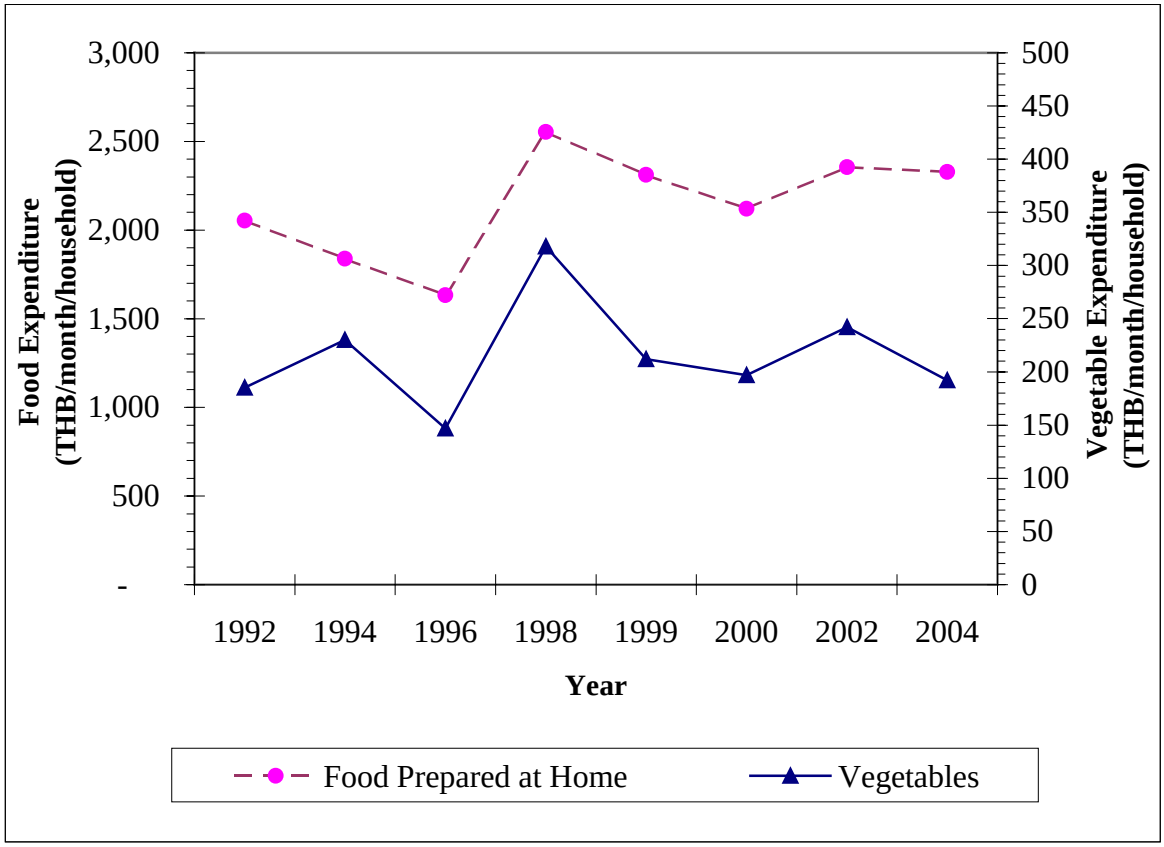


Figure 2.4 Average monthly expenditure on food prepared at home and vegetables per household in 1992-2004

Source: NESDB(2004), NESDB(2000), NSO (2005b), NSO (2003), NSO (2002), NSO (2001), NSO (2000), NSO (1999), NSO (1997), NSO (1995), and NSO (1993)

The rise in economic development has had a negative impact on the vegetable expenditure share (ISVILANONDA and SCHMIDT, 2002). Prior to the economic crisis, the expenditure share of vegetables to food prepared at home was 9.01% (185 THB) in 1992 and decreased to 9.00% (147 THB) in 1996 (see Figure 2.5). When economic crisis hit the country in July 1997, the THB depreciation had a wide effect on the economy in Thai society. The growth rate of real GDP contracted by more than 10% in 1998 (NSO, 1999). In contrast to economic growth, in 1998 the expenditure share of vegetables to food prepared at home increased by 12.45% (318 THB). Economic recovery after the crisis might also relate to the subsequent decrease in the expenditure share of vegetables to food prepared at home.

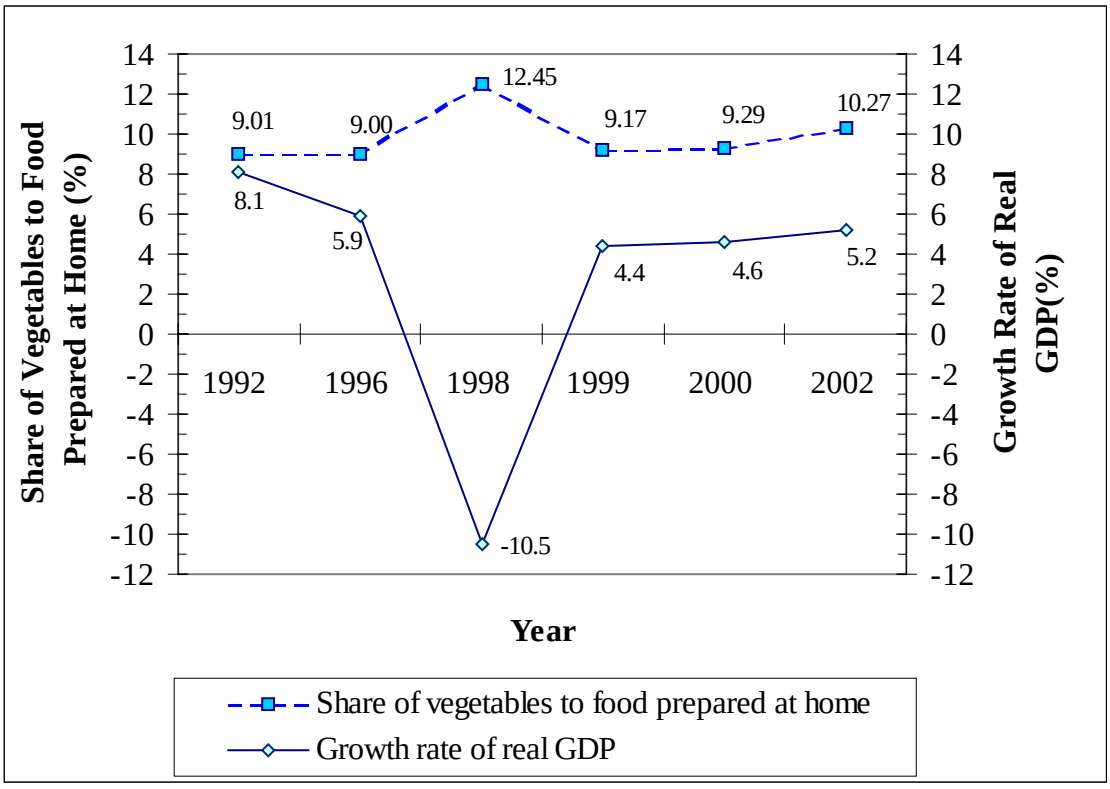


Figure 2.5 Growth rate of real GDP and share of vegetables to food prepared at home between 1992-2002

Source: NSO (2003), NSO (2001), NSO (2000), NSO (1999), NSO (1997), and NSO (1993)

Economic factors related to per capita income and prices directly affect the absolute quantity of vegetables consumed (ISVILANONDA, 1992). In general, the total consumption correlates positively with income but exhibits an inverse relationship with prices. ISVILANONDA (1992), using socio-economic survey data estimated the income elasticity of demand and price elasticity for vegetables were 0.006 and –0.167 in 1988, respectively. These results suggest that income has limited effect on the consumption pattern of vegetables and the price has an inverse relationship with the small amount of vegetable expenditure.

A decade later, ISVILANONDA and SCHMIDT (2002) studied the vegetable consumption expenditure by using the socio-economic survey data of 23,549 households in 1998. They found that the variations in vegetable expenditure and its structure were associated with different residences of households, different levels of income, and different characteristics of households. This study indicated that urbanization and high

education resulted in the consumption of relatively less vegetables in a daily diet. Interestingly, the estimated Engel elasticity for all vegetables from this research is positive and less than one (0.3260). The interpretation of the elasticity magnitude is that an increase in food prepared at home expenditure of 1 percent is seen to entail an increase in the vegetable expenditure of 0.326 percent, meaning that 32.6 percent of additional food expenditure goes towards vegetables.

2.3.3 Per capita availability of vegetables

Almost 95% of the total vegetable production (or 4.8 million tonnes) during 1998-2000 was provided for domestic consumption. The per capita annual vegetable availability in Thailand[3] represents the quantity of vegetables which could reach the people. During 1983-1985, average per capita vegetable availability was 57.7 kg per year (or 158 g/day); and up to 50.1 kg per year (or 137 g/day) during 1989-1991. However, the per capita annual vegetable availability increased to 68.3 kg per day (or 187 g/day) and 78.3 kg per year (or 215 g/day) during 1995-1997 and 1998-2000 respectively, meaning that people had more opportunity to consume vegetables (see table 2.10).

Table 2.10 Per capita availability of vegetables in Thailand

Year	**Production**[1/] (ton)	**Export** [2/] (ton)	**Import**[2/] (ton)	**Net availability** (ton)	**Population**[3/] (person)	**Per capita availability** (kg)
1983-1985	2,977,000	66,786[4/]	4,438[4/]	2,914,652	50,502,000	57.7
1986-1988	2,270,333	130,228[4/]	5,941[4/]	2,146,046	53,406,667	40.3
1989-1991	3,009,000	211,365[4/]	7,110[4/]	2,804,746	56,017,667	50.1
1992-1994	2,972,333	211,869[4/]	11,128[4/]	2,771,592	58,058,000	47.7
1995-1997	4,405,000	330,217	32,965	4,107,748	60,130,930	68.3
1998-2000	5,108,907	330,100	48,054	4,826,861	61,668,875	78.3

Source: [1/] DOAE (2001a)
[2/] DOAE (2001b)
[3]/ NSO (2001)
[4/] SOOTSUKON et al. (2001)

[3] Per capita availability = $\frac{\text{Production - Export + Import}}{\text{Population}}$

The third national nutrition survey of Thailand 1986 (Referred in SOOTSUKON, et al., 2001: p 437) found that Thai people consumed an average of 742 g of all food every day, including an average about 106 g/day of vegetables, or 14% of the total food consumption (by weight). Table 2.11 shows that cucumber 12.13 g/day, Chinese cabbage 7.77 g/day, string beans 7.29 g/day, Chinese Mustard 7.21 g/day and bamboo shoots 6.61 g/day were the top five of vegetables consumed in 1986.

Table 2.11 Consumption of major vegetables

(Unit: g/day)

Food Item	Urban	Rural	Overall
1 Cucumber	9.68	13.67	12.13
2 Chinese cabbage	9.67	6.58	7.77
3 String beans	7.15	7.37	7.29
4 Chinese mustard	6.67	7.54	7.21
5 Bamboo shoots	8.64	5.35	6.61
6 Eggplant	5.27	5.73	5.56
7 Angle gourd	4.21	3.31	3.60
8 Papaya (raw)	1.21	5.07	3.58
9 Bean sprouts	3.69	3.24	3.41
10 Chinese kale	4.87	2.38	3.34
11 Mushroom	0.96	3.53	2.53
12 Wax gourd	2.28	2.64	2.50
13 Mustard	3.52	1.86	2.49
14 Cauliflower	3.35	1.69	2.23
15 Onion	2.42	1.99	2.16
16 Chili	2.29	1.88	2.10
17 Jack fruit (young-raw)	0.24	2.73	1.77
18 Tomato	2.43	1.30	1.74
19 Pumpkin	1.44	1.19	1.28
20 Coriander	0.49	1.26	0.96
21 Peas	1.63	-	0.63
22 Asparagus	1.14	-	0.44
23 Garlic and ginger	0.14	0.51	0.37
24 Snake gourd	0.44	0.21	0.30
25 Spinach	0.29	0.07	0.16
26 Others	23.41	24.43	24.15

Source: Department of Health under Ministry of Public Health, and School of Public Health, Mahidol University (1995) referred in SOOTSUKON, et al. (2001): p 438

2.4 Market Development of EFPV

The previous sections present the important role of vegetable sector in Thai Economy. Because of more concern about health and environmental problems, since the 1990s people have turned their interest to safer food as well as EFPV as discussed in chapter 1. At the early stage the EFPV market has expanded rapidly by government policy as examples shown in USA, EU and Japan. But the government support would not last long so that at the later stage the market has to be pushed by their consumer demand. The market of EFPV in Thailand has also shown the same trend. This section describes the EFPV production, market situation, labels, certificate and price premium.

2.4.1 Production of EFPV

In the course of the growing market of organic (and green) products, production of EFPV increased remarkably. According to the SOEL-Survey (February 2004), the land area devoted to organic production is more than 24 million hectares in approximately 100 countries of the world (see more detail in Appendix 2). Almost half of the organic land area in the world is located in Australia, with about 10 million hectares. In Asian countries, the total organic area is almost 880,000 hectares (or 2.6%) and organic farming in Thailand is ranked 71st in the organically global area with 3,993 hectares (WILLER and YUSSEFI, 2004: p 15).

In Thailand, the production of EFPV has increased significantly since the Eighth National Economic and Social Development Plan (NESDP) (1997–2001). This policy action also included an agricultural development program. The overall philosophy of the plan was ‘to improve quality of life, competitive production in harmony with natural resources and the environment’. Its aim was that at least 20% of national agricultural land or around 25 million rai should be under its defined Sustainable Agricultural Development Scheme. The plan emphasizes sustainable agriculture, including ‘natural farming, organic farming, integrated farming, and agro-forestry (JENSEN and PANYAKU, 2000: p 3).

According to official statistics, the Organic Crops Institute under MOAC reported a rapid increase in organic crop area from 3,245 rai (or 519.2 hectares) in 2002 to 25,409 rai (or 4065.4 hectares) in 2005 (see table 2.12). Currently, the organic land area in Thailand represented about 0.04% of the total farmland (PANYAKUL and

SUKJITRATTIKAN, 2003a: p 61). The number of farmers or producers who applied organic management was 1,255. However, the number of certified crops or products was less, only about 949 because some individual producers are organized into producer groups (PANYAKUL, 2001: p 19).

Table 2.12 Production area of organic crop

Year	Area (rai)	Number of farmers or producers	Number of certified crops or products
2002	3,245	113	13
2003	8,397	417	211
2004	20,127	818	518
2005	25,409	1,255	949

Source: Organic Crops Institute (2005)

Vegetables make up the second most important organic crop produced in Thailand. Figure 2.6 shows the share of organic production area allocated for four crops: 65% for rice, 16% for vegetables, 11% for fruit, and 8% for herbs and tea. Although, as illustrated in table 2.12, almost 75% of organic rice produced was exported to Europe, USA and Japan, the share of organic vegetable sales shows that the main market for organic vegetable is still domestic.

Besides organic vegetables, there are other kinds of so-called environmental friendly vegetables: natural product, and less-chemical product, which are supposed to have contaminating pesticide residue lower than the maximum level. At this time it appears that official data on the production area for EFPV production is not available. Similarly to organic vegetables, the main market for EFPV is also domestic.

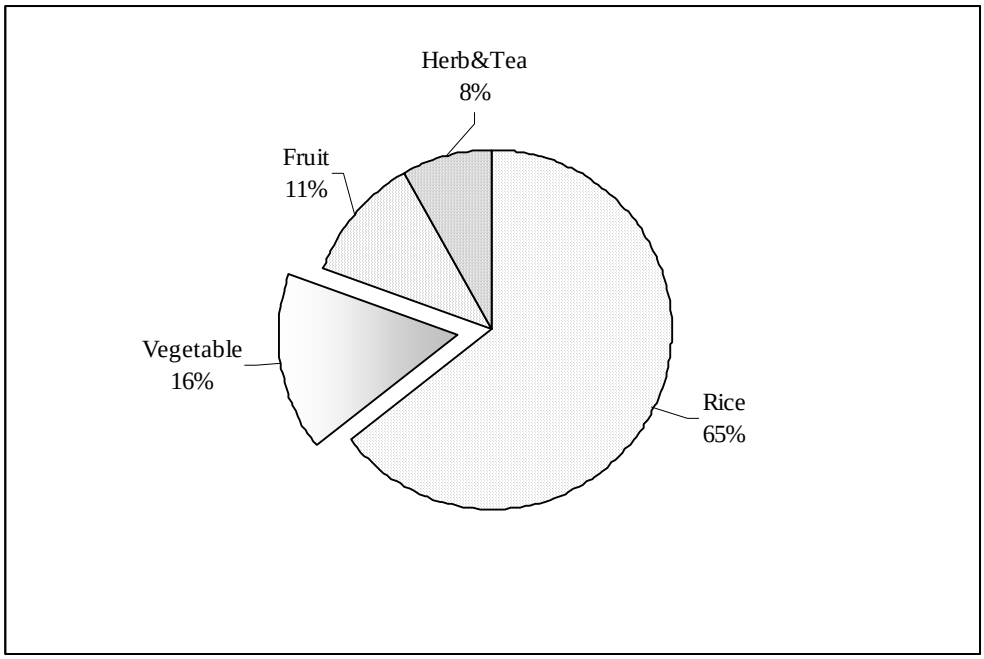


Figure 2.6 The share production area of organic vegetables in 2005

Source: Organic Crops Institute (2005)

2.4.2 Marketing situation

Since the mid-1990s, health and environmental issues have received much attention, reflecting the rise of social concern and awareness of health and environmental problems around the world. A large market for "natural product", "green product" (grown with reduced use of chemical pesticides and fertilisers) as well as "organic product" is anticipated. The international trade of organic products grew rapidly over the last few years. The Foundation Ecology & Agriculture (SOEL) and the Research Institute of Organic Agriculture (FiBL) have collected data about organic farming worldwide. This report indicated a strong increase in the values from an estimated US$10 billion in 1997 (WILLER and YUSSEFI. (Eds.), 2004: p 21; and YUSSEFI and WILLER (Eds.), 2003: p 22).According to the latest survey (in 2004), the world market for organic products (in 16 European countries, USA and Japan) was valued at US$17.5 billion in 2000, US$21 billion in 2001 and US$23 billion in 2002.

In Thailand, the market for environmental friendly products has also been growing rapidly recently, similarly to the world market. The marketing development of natural or green products originated from the first small retail businesses in 1990

(KONGPRASERT, 2003: p 11). The retail shops that sell the environmentally friendly products are called “green shops”. As the demand for environmental friendly product increased, so did the number of green shops. During the most popular period in 1999 , the maximum number of green shops reached 119 (PANYAKUL and SUKJITRATTIKAN, 2003b: p 131). However, after the economic crisis in 1997, the number of shops decreased dramatically. Only 33 medium and large entrepreneurs using the modern retail systems survived until 2004. Based on data available recently, the total value of organic products in 2002 was 2,909 million THB (see table 2.12). As shown in table 2.13, export is the main market for organic rice products, which contribute about 75% of the total product value. While the main market for vegetables, fruits, and herb is domestic, which accounts for about 88% of the total value (2,779 million THB) of vegetables, fruits, and herbs produced.

Table 2.13 Quantity and value of organic products in 2002

Product	**Quantity** (tons)	**Domestic market** (million THB)	**Export market** (million THB)	**Total value** (million THB)
Rice and field crop	8,350.49	23.43	68.99	92.42
Vegetables, fruits, and herb	63,182.92	2,779.71	36.95	2,816.66
Total	71,533.41	2,803.14	105.94	2,909.08

Source: PANYAKUL and SUKJITRATTIKAN (2003b): p134

The market channels for environmentally friendly products, especially EFPV, have changed during last five years, from the early movers, the green shops, to supermarkets and hypermarkets. Because these are new market channels, EFPV has rapidly expanded and become more widely available to consumers. Space on the shelves for EFPV in supermarkets and hypermarkets has increased rapidly. The data from a hypermarket in Figure 2.7 shows that the ratio of EFPV sales to conventional vegetable sales is rapidly increased from 3.4% in 1999, 11.7% in 2000 to more than 30% in 2001. Although the data is from a hypermarket, due to the widespread and a large number of supermarkets and hypermarkets, the character of the market has not changed from dominating green shops to larger stores. In general super and hypermarkets tend to offer products specially labeled in accordance with their

marketing policy based on the concept of buyer's own brand. Therefore: packaging, labelling has evolved and led to a wide range of product-assortment of differentiated goods

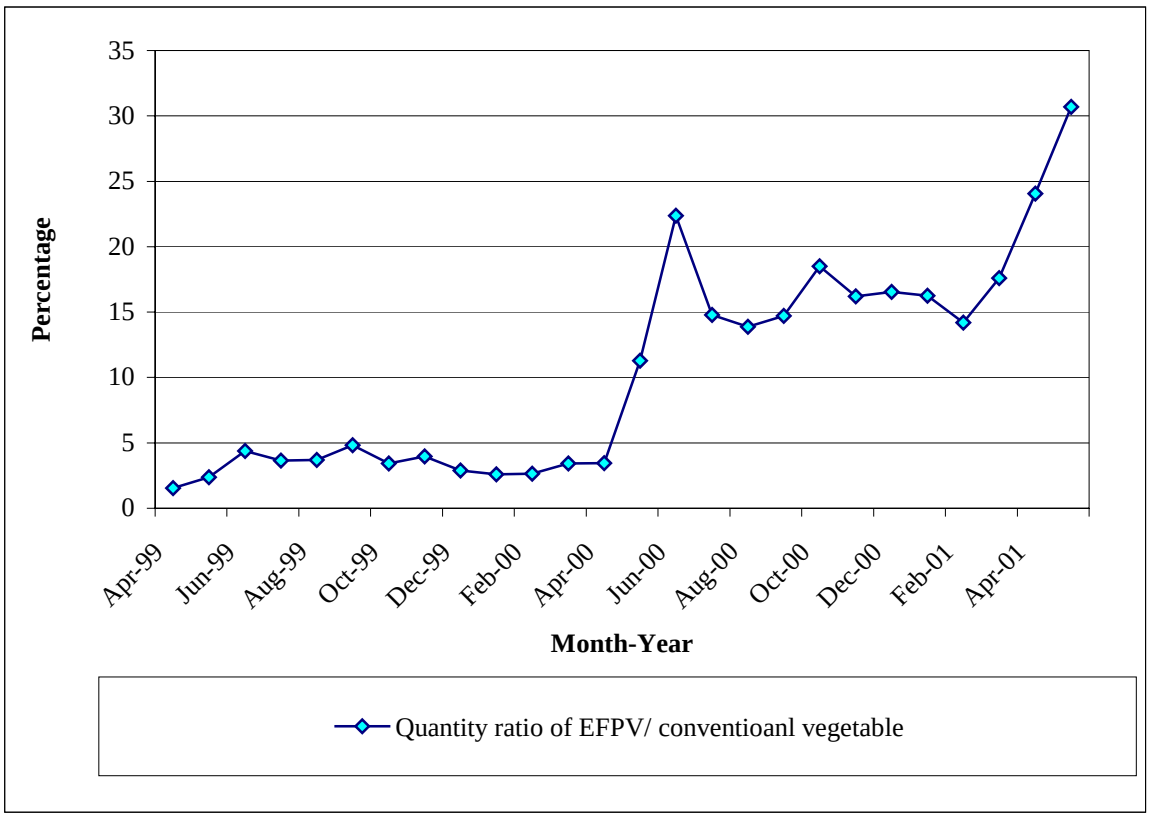


Figure 2.7 The share of EFPV to conventional vegetable sales in hypermarket

Source: Data from one hypermarket (with 11 branches) by personal contact

2.4.3 Different advertising labels, standards and certificates

Owing to supply side development, the market is flooded with new label and new brand products. Therefore, consumers are sometimes confronted with many varieties of labels and brands in markets. Mostly, the EFPV is presented in a package with the brand name and advertising labels, for example: "hygienic vegetable", "pesticide-safe vegetable", pesticide-free vegetable", "healthy vegetable", "netting vegetable", "organic vegetable", etc. All of these labels inform consumers about different production process and the level of safety. In addition to varieties of labels and brands presented on the package, various certificates are issued by four government bodies: (DOA, DOAE, MOPH and ACFH) and one non-government organizations (ACT).

The certification logo is presented on the package in order to guarantee and promote (advertise) the products.

Since the 1990s, many organizations in Thailand embodied the principles of environmental friendly farming in standards in order to support the marketing and to assure buyers that labeled products have been produced by the approved methods. The labels on EFPV packages show not only the various brands and different type of product, but also certificates issued by governmental or private bodies. Behind every certificate there is a set of standards and they are all different. The purpose of certification is to foster the confidence of consumers and to enhance trade in EFPV.

The certificates can be classified according to the issuing bodies as following.

Logo (a)

Department of Agricultural Extension (DOAE)

Name: Toxic residue-free vegetables
Established: 1993
Type of vegetable: pesticide-safe vegetables, pesticide-free vegetables.
Certified objects: fruit and vegetable
Number of Members: 3,614 (5,220.7 rai) in 2000
Standard: applied GAP
Chemical fertilizer and pesticide use: acceptable
Certification: no re-certification (registration only)
Inspection: using GT pesticide test kit, sampled by MOPH for double checking
Note: no longer appear in the market

Logo (b)

DOAE's official seal/logo

This is not the certificate logo. The group of farmers used this logo on packages to give a slightly official impression.

The certificates for EFPV were started in 1993 by DOAE under the MOAC. DOAE has the project 'Hygienic-production'. This program was set up to help small farmers to develop biological pest control, which refers to Good Agriculture Practice (GAP).

Moreover, the project aims at setting up small-farmer groups and starting a community learning process: training programs in demonstrated fields, giving input packages (seeds, nylon nets, etc.), using a GT pesticide test kit[4] to test pesticide residue, use of the label 'hygienic' (see Logo (a)) and the DOAE's official seal/logo (see Logo (b)). A pesticide can be used if necessary, but it was intended that the pesticide residues were safe for consumption (below the MRL of the Thai National Standards Codex). These logos appeared in the market in 1993. After being accepted by DOAE, the farmer has a long-term approval for using the logos, with periodic inspection at the provincial level by DOAE's officer and technology transfer centers. In 2000, there were 3,614 farmers joining the project, which covered 5,220.7 rai of production area.

Logo (c)

Department of Agriculture (DOA)

Name: Hygienic Fresh Fruit and Vegetable Production Pilot Project

Established: 1994

Type of vegetable: Hygienic vegetables, pesticide-free vegetables

Certified objects: fruit, tea and vegetable

Number of Members: 364 (37,424 rai) in 2003

No.of vegetable growers: 200 (8,526.4 rai) in 2003

Standard: refer to FAO CODEX, applied GAP

Chemical fertilizer and pesticide use: acceptable

Certification: 12 member committee meeting monthly, re-certification annually

Inspection: Field visit during application, Chromatographic residue test before certification, random sampling once a year

Note: After restructuring of the MOAC in 2003, this certified body was changed.

[4] The GT test Kit was invented by Gobthong Thoophom from the Public Health Ministry. The principle of the GT test kit is based on measuring the inhibition of the enzyme cholinesterase, which detects most of the pesticide used: organophosphororus and carbamates compounds (does not cover some herbicides, organo-chlorides, and pyrethroids). The GT-test kit is capable of detecting whether or not substances in the sample inhibit the enzyme. The results are produced very rapidly (few hours) and at a very low price (see more detail at http://www.gttestkit.com/gttestkit_eng/index.htm).

Under MOAC, DOA is another agency that also encourages farmers to produce EFPV. DOA has a project that offers assistance to farmers by providing net-houses to grow vegetables without pesticide spraying. The program has been launched to encourage not only production, but also to facilitate marketing. DOA has another project called 'The Hygienic and Pesticide Free Vegetables for Export Pilot Project' (HPP). This project has been in operation since 1991, under it the pesticide residue in an end product is tested to ensure that the product does not contain pesticide residues above Maximum Residue Limits (MRL) in accordance with Codex Alimentarius (CODEX) standard of the Food and Agriculture Organization (FAO). When the product passes the test, DOA issues the farmer a certificate and allows them use the logo of DOA (Logo (c)). This logo appeared in market in 1994. The approval of the certificate was re-issued on a year-by-year basis. In 2003, this project had 364 participants, and covered 37,424 rai that produced fruit, tea and vegetables. There were 200 vegetable growers, covering 8,526 rai.of production area.

Logo (d)

Department of Agriculture (DOA)

Name: Organic produced
Established: 2000
Type of vegetable: organic vegetables
Certified objects: rice, fruit, tea and vegetable
No. of members: 1,255 (25,409 rai) in 2005
No.of vegetable growers: N/A
Standard: Organic Thailand standard
Chemical fertilizer and pesticide use: disallow
Certification: by provincial DOAE's officer, annual re-certification
Inspection: site visit

In 2000, the trend of organic product demand (in both local and international markets) was continuing to increase at a rate of 20 percent every year (DOA, 2000). While the consumption of the organic goods has expanded, consumers require safer vegetable and protection of the environment at the same time. DOA realized that it was necessary to develop the standard of organic products in Thailand in order for the Thai organic product to be accepted in the international market. The first draft standards for

organic crop production were prepared by three organizations: Thailand Institute of Science and Technology Research under the Ministry of Commerce (MOC), Export Promotion Department under MOC, and DOA under MOAC. The standards were formulated for compliance with international standards such as the U.S. Organic standards (the Organic Food Production Act-OFPA), the European Union standard in the EEC No. 2029/91, and the International Federation of Organic Agriculture Movement (IFOAM). The final draft standards of organic products were reviewed in public hearings, revised, approved, and promulgated by the Organic Products Research and Development Committee of the Department of Agriculture in October 2000. In 2005, there were 1,255 growers, covering 25,409 rai of farmland, who registered with the Organic Thailand.

Logo (e)

The National Bureau of Agricultural Commodity and Food Standards (ACFS)[5]

Name: Food Safety (or just "Q sign")

Established: 2003

Type of vegetable: pesticide-safe vegetables, pesticide-free vegetables, organic vegetables, food safety

Certified objects: crop (rice, corn, mushroom, fruit, and vegetable), fishery, input (bio fertilizers, organic fertilizers, and soil amendments), entrepreneurs

Number of Members: crop producers 814 in 2003

No.of vegetable growers: 437 in 2003

Standard: GAP, Good Manufacturing Practice (GMP), Hazard Analysis and Critical Control Point (HACCP), MOPH CODEX, Organic Thailand, ACT

[5] The ACFS was established on October 9,2002 under Section 8 F of the National Administration Act B.E. 2534. The additional content was under provision of National Administration Act B.E. 2543 (Fourth Edition). This is to designate the ACFS as a focal organization to control agricultural products, food, and processed agricultural products by certifying and enforcing standards from food producers to consumers, to negotiate with international partners in order to reduce the technical barriers to trade and to improve and enhance competitiveness of Thai agricultural and food standards.
(see more detail at http://www.acfs.go.th/introduce/index.php)

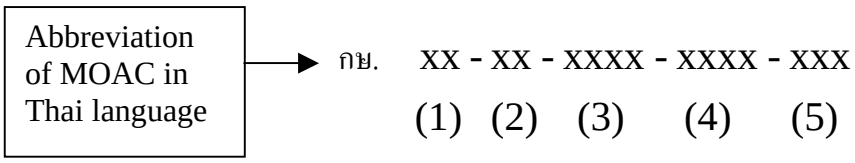
Chemical fertilizer and pesticide use: depend on type of product and standard

Certification: 4 year-certification

Inspection: site visit, annual inspection

To harmonize into one unified logo, the National Bureau of Agricultural Commodity and Food Standards (ACFS) was established on October 9,2002. ACFS serves as a focal organization to control agricultural products, food, and processed agricultural products by certifying and enforcing standards from food producers to consumers in order to ensure fair practice and recognition both locally and internationally. The ACFS logo (see Logo (e)) was first appeared in the market in 2003.

The ACFS code comprises five groups of codes (number) under logo "Q": code (1) is the certification body; code (2) is the type of certifications; code (3) is the adopted standards; code (4) is the name of entrepreneur or farm; and code (5) is the name of the product.



Under the single ACFS logo, there are various bodies certifying many kinds of products using a variety of standards, such as GAP, GMP, HACCP, MOPH CODEX, Organic Thailand, and ACT. Although the approval period of the certificate is four years, after approval it will be kept under surveillance every year and monitored at least four times during the first year.

The members of DOAE (Logo (a)) and DOA (Logo (c)) (pesticide-safe vegetables) programs were transferred to the ACFS system and started to use an ACFS logo in 2003. For crop production, there was a total of 814 members in 2003. More than half of them were vegetable growers (DOAE, 2003a).

Logo (f)

Department of Medical Science (MOPH)

Name: Certification of Internal Residue Testing System
Established: 1999
Type of vegetable: pesticide-safe vegetables
Certified objects: internal quality control system
Number of Members: 9 entrepreneurs (1 restaurant)
Standard: Codex's MRL (MOPH)
Chemical fertilizer and pesticide use: acceptable
Certification: site visit 2 times per year
Inspection: using GT test kit for double checking

Besides MOAC, MOPH is another organization that is responsible for testing the chemical residue in food (daily produce) to ensure public health and consumer safety. Using a different approach from MOAC, MOPH places an emphasis on the internal quality control systems of growers to guarantee that the end product will be safe for their consumers by inspecting their product regularly. MOPH has a project named "Certification of Internal Residue Testing System", which certifies the residue testing system of growers. The project encourages the growers of vegetable produce or vegetable processors to have their own system for monitoring the level of toxic residues in their products. Before growers join the project, the MOPH officers offer assistance in setting up the residue testing system using the GT pesticide test kit. After being approved, the grower has one-year approval and certificate logo (see Logo (f)) from MOPH. This project started since 1999. In 2002, MOPH approved nine members of which three were vegetable producers: Doi Kham, KC fresh and Vegetable Basket.

Logo (g)

Organic Agriculture Certification Thailand (ACT)

Name: Organic Agriculture Certification Thailand
Established: 1995
Type of vegetable: organic vegetable
Certified objects: crop product (rice, fruit, tea, herb and vegetable), wild product (wild honey, bel fruit, Rang Jud herb), handling and processing
No. of Members: 32 individual growers, 15 groups of grower, 9 processing operators, 2 wild production operators
(17,987.5 rai, conversion 11,720.7 rai)
No.of vegetable growers: 165 growers
(808.5 rai, conversion 808 rai)
Standard: ACT Organic Agriculture Standards
(ref. IFOAM's norm)
Chemical fertilizer and pesticide use: disallow
Certification: annual re-certification, applying for international accreditation
Inspection: site visit, annual field inspection
Note: ACT is only one third party certification body in Thailand that is accredited by the IFOAM

The Organic Agriculture Certification Thailand (ACT) is an independent organization operated by Non-Government Organizations (NGOs): academic institutions, consumer organizations and a green shop network. With regard to organic products, ACT is the onlyThai private certification body that certifies and issues certificates to farmers and food processors. Although ACT was established in 1995, it was only accredited by the IFOAM in 2001. This accrreditation means that ACT standards has been recognised internationally and ACT operation, as well as ACT certified products, should be accepted by foreign certification bodies in other countries (ACT, 2003). ACT certified 32 individual growers, 15 grower groups (1370 growers) nine processing units and two wild production operators. The certified field area covers 29,708.21 rai (organic field

area 17,987.5 rai and in-conversion field area 11,720.7 rai). Among these growers, there are 165 vegetable producers covering 1,616.5 rai (organic field area 808.5 rai and in-conversion field area 808 rai) (ACT, 2005). The logo of ACT (see Logo (g)) was not well-known in Thailand because it was rarely seen in the domestic market. Almost 90% of the certified product is Jasmine rice exported to Europe. In 2001, the ACT logo first appeared in the domestic market on the packaging of organic vegetables: namely, Thai Organic Farm[6] ("Rai Pluk-Rak" in Thai language).

Logo (h)

Charoen Pokphand Group (CP)[7]

Name: CP guaranteed

Established: n.a.

Type of vegetable: pesticide-safe vegetables

Certified objects: vegetable

Standard: unclear

Note: This certificate is used for only CP products. It was first seen in the market in 2000.

All certificates discussed so far are issued by four different government organizations and one NGO. Even though the govermnent has already established ACFS to unify the certifying and enforcing standards, there are still some certifying logos issued by private companies. Normally those companies that issue the logos are very well known agricultural producers. These logos are just marketing tactics to make their consumers feel confident in their products without advising the public about their standard of quality control. Consumer confidence in the logo actually depends on their confidence in the company. These logos are not considered to be a third party certificate.

[6] Thai Organic Farm, "Rai Pluk-Ruk", was established in 2000 as the biggest organic vegetable farm in Thailand (with 60 rai of production area) that has been certified by Organic Agriculture Certification Thailand accredited by IFOAM. Thai Organic Farm or Thai Organic Food Company Limited is the first leading organic vegetable supplier in the domestic market. Their products are displayed in over 20 branches of Bangkok's five major supermarkets in Thailand. http://www.thaiorganicfood.com/

[7] The Charoen Pokphand Group (CP) had its beginnings as a seed supplier in Thailand in the early 1920's. CP started small as family company, today, professionally managed by experienced world-class professional executives, employees a staff of more than 100,000 in 20 countries around the world. CP holds a significant share in Thailand's vegetable and flower seed market, and exports seeds to other Asian markets. For the domestic markets, CP has developed environmentally safe products and promotes production methods with efficient use of chemical compounds (see more detail at www.cpthailand.com).

For example, Logo (h) is the CP's logo, which simply assures consumers that the labeled CP product is safeDespite there are many varieties of certificates in the market, based on different sets of standards, -the purchasing decision of a consumer mainly depends on the consumer's confidence in that product. The varieties of information on a package, which should help consumer purchase decisions, put consumers in a state of confusion and uncertainty instead. To reduce the consumer uncertainty caused by different and not straightforward understandable loges/certificates used by producers and traders, Thai government has already react to this information overflow problem by establishing ACFS in 2002.

Although varieties of different labels and certification standards was investigated in section 2.4.3, to better understand the various actors involved, especially their different objectives and applied instruments to promote EFPV, thereby getting a better feeling of the prevailing production marketing chain, intensive interviews were conducted with responsible personals. After consultation with experts from DOA, DOAE, MOPH and Organic Agriculture Certification Thailand (ACT) in order to clearly understand the different labeling of EFPV, some conclusions can be drawn about the meaning of four EFPV types, which may confuse consumers (shown in table 2.14):

"*Pesticide-safe*" vegetables and "*Hygienic*" vegetables are those produced by reduced pesticide usage; or the pesticide can be used if necessary, but it is intended that the level of pesticide residues (below the Maximum Residue Limit: MRL[8]) are safe enough for consumption. Chemical residues from chemical fertilizers are not considered in these product types.

"*Pesticide-free*" vegetables are those grown without the use of any pesticides.

"*Chemical-free*" vegetables are grown without applying (using) any pesticides or chemical fertilizers.

[8] MRL" is the maximum concentration of a pesticide residue (expressed as mg/kg), recommended by the Codex Alimentarius Commission to be legally permitted in or on food commodities and animal feeds (FAOSTAT, 2005).

"*Organic*[9]" vegetables are grown in a natural way without the use of synthetic chemicals or artificial fertilizers. Moreover, farmers pay more attention to all processes of production and post-harvest, improve and maintain soil fertility with organic material, and maintain the ecosystem in their farm.

Table 2.14 Comparison of EFPV

Input	Pesticide-safe	Pesticide-free	Chemical-free	Organic
Chemical fertilizer	✓	✓	×	×
Insecticide	✓	×	×	×
Fungicide	✓	✓	×	×
Herbicide	✓	×	×	×
Plant Growth Regulators	✓	✓	×	×
GMO seed	-	-	-	×

Note: ✓ - Input can be applied for growing. × - Input cannot be applied for growing.
Source: Discussion with the officer of DOA, DOAE, MOPH and ACT

2.4.4 Market channels of the EFPV

In the previous section, the discussion of the various activities in the production and marketing has revealed quite interesting influence on the process of marketing EFPV. Another important activity in the marketing system for EFPV is the flow of produce from producers to consumers or market channels. The market channels for EFPV have been developed outside the existing sales paths for conventional vegetables. These are specialized channels that focus on communication between producers and consumers who are the most interested in the products. They mainly comprise special retail channels continuously represented at supermarkets, hypermarkets and green shops.

Currently, there is no obvious wholesale market for EFPV. The marketing channels for EFPV from farmers to consumers in Thailand are varied. Referring to Figure 2.7, there are six channels of vegetable transmission as follows;

[9] Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony (ORGANIC TRADE ASSOCIATION, 2003).

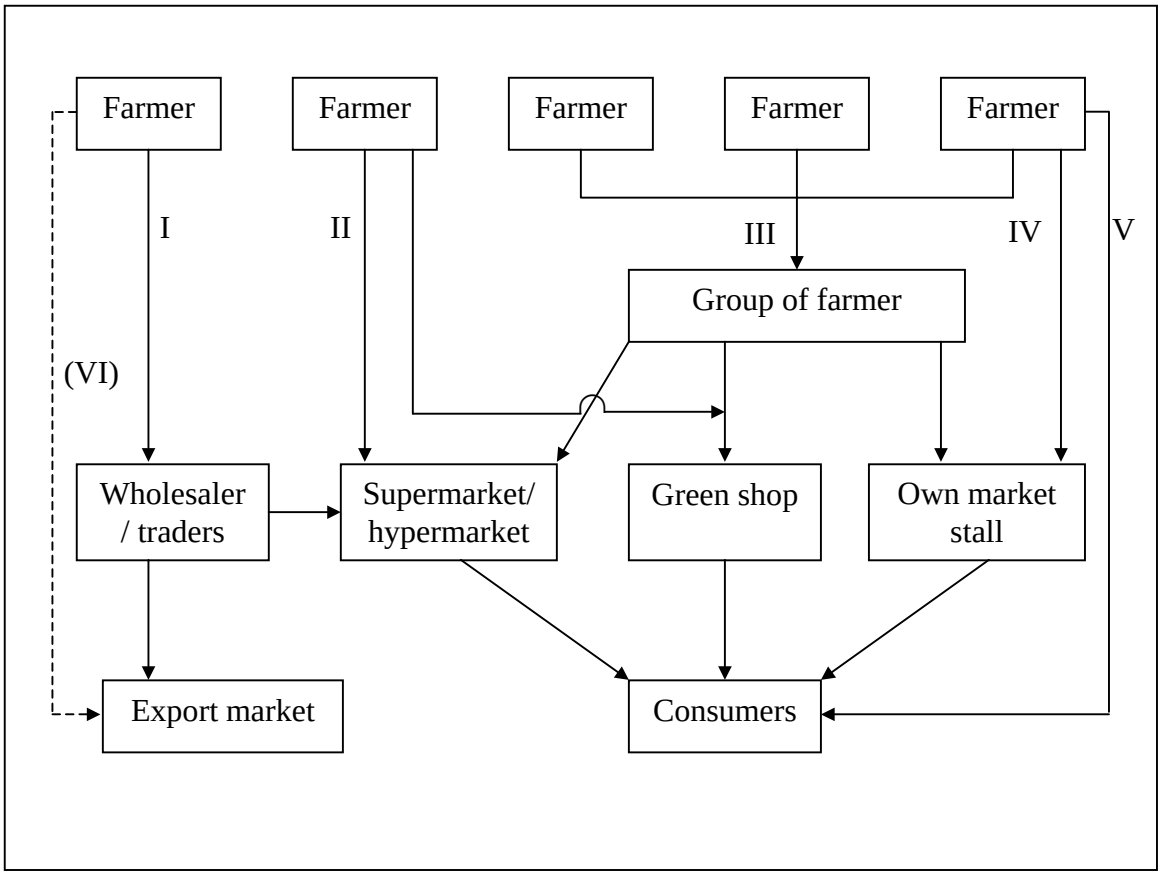


Figure 2.8 Market channel of EFPV

Source: Own presentation

Type I

The farmers sell their product to traders who come to buy the vegetables at their farms. In this case the price and the payment will be on a day-by-day basis. The farmers' income varies depending on the vegetable price each day. However, the middlemen will sell the product to supermarkets or hypermarkets according to a contract agreement that uses a guaranteed price. But the payments are normally delayed due to the supermarket system. This channel originated from wholesalers or traders who would like to have large-scale products sold every day.

Type II

Farmers with larger-sized farms sell their products directly to supermarkets, hypermarkets and green shops in order to gain more profit. While, farmers who are a long distance from such shops and markets would have contracts with suppliers to those retailers. Price is fixed and based on the agreement between farmer and the suppliers.

Type III

In this case, farmers are gathered into a group in order to join together in grading, packaging and marketing. The advantage of the joined group is that there are more varieties of products to sell, and might be more economies of scale. The farmers are the members of a voluntary group who will negotiate with retail shops on their behalf. Normally, the farmers in this situation have small-sized farms and no skill in marketing, and the group sends the product to supermarkets, hypermarkets and green shops. In this case the groups also have their own shops or stalls in the markets so they can sell the product directly to the consumer at a retail price.

Type IV

Farmers have their own market stalls and sell the products directly to consumers. The farmers generally bring their products to nearby markets and sell them to retailers or directly to consumers in their locality. Most of the produce is consumed within the province. In this case, farmers produce EFPV with a knowledge of the market demand and also have their own markets.

Type V

Type V is similar to Type IV but the farmers sell their product directly to consumers without any stalls. They deliver their products to the consumers' houses every week via organizations such as "Vegetable Basket[10]" and "Green Net Cooperative[11]". Consumers can order vegetables via the Internet. This type is a new channel of EFPV in Thailand.

Type VI

Export channel: farmers sell their products to foreign markets by direct contract with wholesalers or retailers in the host country or through intermediaries.

The EFPV market is still considered to be a niche market in Thailand. Because the produced and distributed quantities are small when compared with the conventional

[10] Vegetable Basket Co.,Ltd. is the company that grow and deliver organic vegetables directly to consumer's door since October 1999. www.vegbasket.in.th

[11] Green Net Cooperative is the first organic fresh produce wholesaler in Thailand that opened first trading in 1993. Green Net also is the one of Alternative Agriculture Network that has been pioneering several organic agriculture initiatives in Thailand, including the founding of national organic certification body (now the "Organic Agriculture Certification Thailand –ACT).

product in general, it turns out that most of the consumers buy EFPV from supermarkets, hypermarket and green shop. According to table 2.15, almost 91% of stores that sell both EFPV and conventional vegetables are supermarkets and hypermarkets. While they are the important source of distribution, green shops sell only EFPV. Although the EFPV market is only a small segment of the large general vegetable market, EFPV is available in more than 339 retail stores for consumers in both urban and rural areas of Thailand as shown in table 2.15. The majority (64%) of the stores selling EFPV are located in Bangkok, which is the capital and biggest city in Thailand with the population of 6.3 million.

Table 2.15 Name and number of main stores selling EFPV in Thailand

Name	Total stores	No. of stores in Bangkok
Supermarket	156	134
TOPs	87	69
Food Lion	37	35
Jusco	10	10
Foodland	8	7
Villa Market	8	8
The Mall	6	5
Hypermarket	150	66
Carrefour	22	18
BigC	45	22
Macro	29	8
Lotus	54	18
Green shop	33	19
Lemon Farm	7	7
Aden shop	8	2
Golden Place	3	2
Others (not model trade chain)	15	8
Total	**339**	**219**

Source: From survey in 2004

Recent trends of consumers' behaviour in urban areas show an increasing demand for buying household foods in supermarkets and discount stores. WIBOONPONGSE and SRIBOONCHITTA, (2004) found that the share of food sold through modern retail systems is 35% of total retail food sales. Urban consumers fully adopted the one stop

shopping habit at supermarkets and hypermarket. This seems to open up new opportunities for EFPV growers to participate in this area too.

Different types of selling channels indicate the different competitions in terms of marketing efforts. Both conventional vegetables and EFPV are found side-by-side on the shelves of supermarkets and hypermarket as competitors, while the green shop sells only EFPV and guarantees the origin of products to consumers. Because of being confidential information, the volume and value of the sales for EFPV has not been revealed. However, supermarket and hypermarket represent systematic large scale of market distributors for EFPV. With a large number of stores and locations in urban centre, these stores can be easily reached by a large number of consumers.

2.4.5 Price premium of EFPV

The previous sections have shown that there are many activities in the production marketing chain targeted on marketing EFPV. Besides production, labels, certificate and market channels, another important element in the marketing that directly affects the consumer decision is price.

With special niche market channels, the price of EFPV is generally higher than that of conventional vegetables, amounting to a price premium. The more the price premiums of EFPV diminish, the more consumers are likely to purchase EFPV. At the same time, the high price premium and profitability is an incentive for growers to produce EFPV. Relative changes of supply and demand will help determine whether price premiums and higher profitability will continue for farmers and businesses.

During 1999-2001, the average price premiums of EFPV (Chinese Kale, Chinese Cabbage, Cabbage, Water Spinach), which were collected from the hypermarket, varied between 34% and 154% as show in Figure 2.9. After the promotion was facilitated by certification labels and Government activities in 2000, the price premiums of EFPV tended to decline.

Figure 2.9 Average price premiums of EFPV (Chinese Kale, Chinese Cabbage, Cabbage, Water Spinach) in hypermarket during January, 1999-April, 2001

Source: Data from one hypermarket (with 11 branches) by personal contract

2.4.6 Consumers' confusion and confidence

Due to the wide variety of labels, certificates and standards, consumers are very often confused when purchasing EFPV. The necessary information has to be provided for the consumer to justify the purchasing decision. Not only the well-informed consumer, but also the passing casual consumer should be able to understand the label without any deception (BECKER (Ed.) 2000: p 29). Besides concise and understandable labels, another factor that affects purchasing is the consumer's *confidence* in the quality of product.

During 1994 to 2000, the Food and Drug Administration and Department of Medical Sciences under MOPH sampled and tested conventional vegetables (200 samples) and EFPV (228 samples) for pesticide residues[12]. The results are summarised in table 2.16. In the case of conventional vegetables the number of samples having pesticide contamination increased from 48.15% in 1994 to 68.18% in 2000. The proportion of samples having residues exceeding MRL was 16% on average. In the case of EFPV (with EFPV labels) the average number of samples having pesticide contamination was 44.74 %. The proportion of samples having residues over MRL is 8% on average. These results show that some EFPV produce is not safe for consumption.

The increasing discovery of pesticide residues in the supposedly pesticide-reduced vegetables gradually erodes consumer confidence in EFPV. Although the number of tested sampler may not be large enough (200 samples for the conventional vegetable and 228 samples for EFPV), the results in table 2.16 reflect the problem of dishonest or incompetent producers and non-approved quality control processes of. These major problems have a negative impact on consumer confidence and EFPV market development in Thailand.

[12] The samples tested for pesticide residues were from supermarkets in Bangkok and its metropolitan area. There were four kinds of EFPV: Chinese kale; Chinese cabbage; Chinese mustard; and cabbage. The test for three compounds of residues: organophosphorus, carbamate, and pyrethroids, was conducted at the laboratory of the Department of Medical Sciences. Due to the method of testing pesticide residues using High Performance Liquid Chromatography, there were limitations in the sampling number (FOOD AND DRUG ADMINISTRATION and DEPARTMENT OF MEDICAL SCIENCES, 2000, p17).

Table 2.16 Pesticide residues in conventional vegetables and EFPV in Bangkok, between 1994-2000

Unit: sample
(Percentage)

Year	Conventional vegetables			EFPV		
	Samples analyzed	Samples having pesticide contamination	Samples having residues over MRL	Samples analyzed	Samples having pesticide contamination	Samples having residues over MRL
1994	-	-	-	38	15 (39.47)	4 (10.53)
1995	27	13 (48.15)	2 (7.41)	29	10 (34.48)	2 (6.90)
1996	49	30 (61.22)	10 (20.41)	22	12 (54.55)	2 (9.09)
1997	-	-	-	36	8 (22.22)	0 (0.00)
1998	37	22 (59.46)	2 (5.41)	16	1 (6.25)	0 (0.00)
1999	43	29 (67.44)	7 (16.28)	47	30 (63.83)	5 (10.64)
2000	44	30 (68.18)	11 (36.67)	40	26 (65.00)	6 (12.50)
Total	200	124 (62.00)	32 (16.00)	228	102 (44.74)	19 (8.33)

Source: FOOD AND DRUG ADMINISTRATION and DEPARTMENT OF MEDICAL SCIENCES (2000)

2.5 Constraints on EFPV Market Development

Because of more concern about health and environmental problems and safe food consumption, more consumers adopted one stop shopping habit at modern trade stores and more public support in production and marketing for EFPV, the shelf space for EFPV in supermarkets and hypermarkets have increased rapidly during last five years. These seem to be high market potential for both producers and marketers to enter into the valuable chain. However, there are some obstacles remained to sustainable market development for EFPV.

The general constraints on market development for EFPV can be summarized using the basic elements ("4P's"[13]) of the marketing plan. Firstly, product: the limitation of production in both quantity and quality is still a problematic factor for market development. Producers have to deliver a product that consumers want to buy. The main problems often encountered on the production side are lack of product varieties, lack of continuity of EFPV supplies and failure to match up with consumer demand (PANYAKUL and SUKJITRATTIKAN, 2003b: p 136).

Secondly, pricing: the price should be high enough to cover costs and give the producer a profit but -at the same time- low enough to attract consumers. Although a price premium for EFPV is tending to decline, the price of EFPV is still generally higher than that of conventional vegetables. At present, research on EFPV marketing in Thailand lacks comprehensive data related to consumer behavior especially when assessing the value of willingness to pay (JENSEN, E. S. and PANYAKUL, V. 2000: p 16). To support and promote EFPV marketing, the consumers' willingness to pay is one of the most important factors used to maintain the balance between supply and demand. Because no one knows either the reasonable market-clearing price of EFPV or the consumers' willingness to pay, the strategies developed to promote the EFPV market could lead producers into a wrong direction. For instance the lower price strategy will not increase EFPV sales if the consumers' willingness to pay is already higher than the existing price. On the other hand, the middle men will put pressure on

[13] Four basic elements of marketing plan (or so-called the marketing mix) are composed of well-integrated strategy for product, price, place and promotion (CRAVENS, 1997, p. 17-20).

growers to reduce the production cost, which is harmful for the product development in terms of both quality and production expansion.

Thirdly, placement: the market for EFPV is a small segment compared with that for conventional vegetables. Having specialized channels (only sold at supermarket, hypermarket and green shop) could be a problem when demand for EFPV exceeds the supply of the sale channels. Therefore, the consumers' needs become the crucial information to enable marketers to harmonize the supply with the demand.

Finally, promotion: consumers have to be made aware of product differentiation. Currently, consumers are confronted with a flood of labeling and certificates. The various certificates and labels of EFPV have been originated in order to distinguish EFPV from conventional vegetables. Sometimes, consumers are confronted with too many varieties of labels and brands in markets. The varieties of information on the package, which should help consumers with the purchase decision, instead can put them in a state of confusion and uncertainty. Additionally, reports about unsafe EFPV, dishonest producers, and non-approved quality control processes add to the reduction in consumer confidence. Thus, to promote EFPV, an understanding of consumer confidence in the various certificates is an important piece of information.

From the marketing perspective, when the information about consumer demands and behaviours is unavailable, it is difficult to promote or expand the market channels. Consequently, this study places emphasis on directly collecting data from consumers (via surveys) in order to understand the consumers' decision process. Three different multivariate methods have been used to analyse the survey data: conjoint analysis, logistic regression and contingent valuation method, which will be presented in the following chapter.

Understanding consumer demand is beneficial to both private sectors (producers and market directors) and Thai government. Producers are able to provide consumers the products they demand. Market directors are able to launch strategies concerning the basic elements (4P's) of a marketing plan to increase sales or reduce marketing costs. The Thai government can adopt policies that support sustainable growth of the EFPV market.

CHAPTER 3

THEORETICAL AND ANALYTICAL FRAMEWORK

Results from the preceding market survey may serve as a practical starting point to sketch in general problem areas of marketing EFPV. They are, however, not sufficient to illuminate specific possibilities and constraints from the final demand perspective – and hence to solve sub goals (ii) to (v) of the research project (see chapter 1). For these purposes we conducted a relatively large consumer survey, based on the established theory of consumer behaviour and accounting for the requirements of the analytical tools selected to identify and quantify the most important factors affecting the demand for EFPV in Thailand. The theoretical approach and the multivariate methods adopted are briefly reviewed in the following sections of chapter 3. The data collection procedure and the empirical analysis of the in-depth survey are presented in chapter 4 (Empirical Analyses).

3.1 Theory of Consumer Behaviour

Marketing is the sum of activities involved in directing the flow of goods and services from producers to consumers. From this point of view, the analysis of consumer behaviour is one of the most important areas of marketing. It is fundamental for private (and public) participants in the marketing process to know what, why and how consumers make their purchase and consumption decisions in order to better adjust the supply of goods and services to changing consumer preferences.

The theory of consumer behaviour is used to explain, "…the processes involved when individuals or groups select, purchase, use, or dispose of products, services, ideas, or experiences to satisfy needs and desires" (SOLOMON, 2002, p.5). Quite similar to the neoclassical approach, the theory of consumer behaviour is an individual concept, but it includes far more factors that influence the decision process of consumers to buy or not to buy (WALTERS, 1978, p.13).

Generally speaking, consumer behaviour focuses on the psychology behind the marketing and the marketing environment. Figure 3.1 contains a systematic representation of the different determinants of a consumer purchase decision, which is placed in the centre of the wheel. Any decision of the individual consumer to purchase or to refrain from purchase is the result of the joint effect of the total of so-called *basic* and *surrounding* factors, arranged as an inner and an outer layer around the centre respectively.

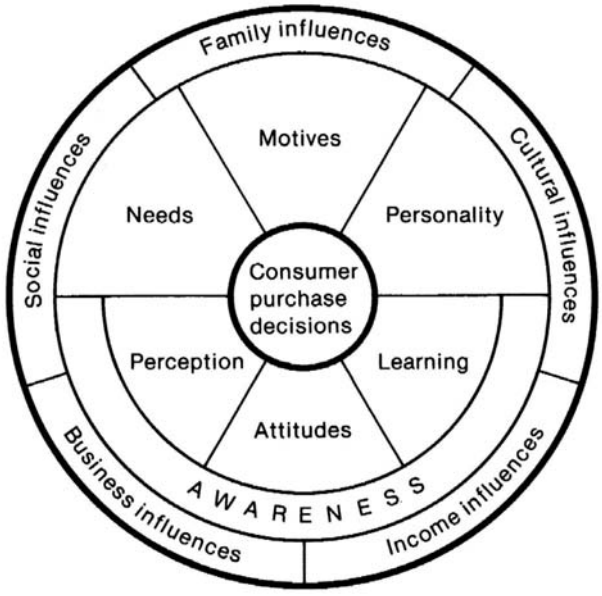


Figure 3.1 Consumer purchase decisions
Source: WALTERS (1978), p.17

The *basic determinants* comprise four central variables controlling the internal thought processes of an individual consumer: her needs, motives, personality, and awareness (inner circle of the wheel in figure 3.1). *Needs* is defined as any physical or emotional basic requirement of the individual, whereas *motives* induce people to act in a particular way – i.e. target-oriented - on their needs. With respect to food, for example, the physiological motive "health" may cause the individual to buy EFPV. *Personality*, on the other hand, encompasses the manifold specific characteristics and qualities, or traits, of an individual, including gender, age etc. ("internal self"). A consumer's individual interests in and her knowledge of a good or service is summarized under *awareness*. This basic determinant, in turn, is subdivided into three different components: perception, attitude, and learning. *Perception* is defined as the ability to

understand or interpret observed goods and services, and *learning* means any change in the consumer's thoughts, responses, and experience. Finally, *attitude* is used to characterise a consumer's way of thinking about groups of innate human feelings or points of view or her behavioural pattern. In any case, to understand and explain a consumer's behaviour requires the evaluation of all the different aspects of the four basic determinants at work.

Actually, however, a consumer purchase decision is not only determined by the *basic determinants* but additionally and simultaneously by the *surrounding determinants*, arranged in the outer layer of figure 3.1. These *surrounding determinants* can be described as the compound effects on individual decisions stemming from interactive communication processes with other members of the society. WALTERS distinguishes among five broad *surrounding determinants*: *family influences*, (non-family) *social influences*, *business influences*, *cultural influences,* and *income influences*. "The family is a major influence on the consumption behaviour of its members" (SCHIFFMAN and KANUK, 1997, p.369). *Family influences* emerge from diverging preferences or priorities of family member(s) who provide information about a product potentially to be purchased. On the other hand, *social influences* result from interactions among members of a given social class sharing specific values, attitudes and behavioural patterns. Members of the same social class tend to show more closely related behaviour as compared to people from different social classes. Quite analogically, we may observe similar decisions of consumers having experienced comparable contacts with business firms through advertisements or direct sales activities (*business influences)*. Last but not least, an individual's thought processes and behaviour are additionally affected by *cultural influences*, which refer to knowledge, beliefs, art, law, morals, customs, and other capabilities and habits acquired by a person as a member of the society (LOUDON and BITTA, 1993, p.84). Finally, *income* exerts an influence on consumer's demand: as stated by neoclassical theory, it restricts the purchase possibilities.

In the final analysis, any consumer purchase decision is embedded in a dynamic feedback system of external inputs (stimuli and experience), the actual purchase decision as described above, and two consecutive output aspects of the process – to buy or not to buy, and the assessment of the degree of satisfaction or dissatisfaction

associated with the decision made. Following the current rule the consumer's decision process starts with the recognition of some need caused by a complex of stimuli (see figure 3.2). In a second step, the consumer starts to search for available internal and external information and possible solutions to satisfy that need. The internal search is based on the knowledge from memory or experience, whereas the external search consists of information collected from the family, social class membership, marketplace, etc. It is important to note that different consumers use different evaluation criteria depending on their individual array of basic and surrounding influences. On the other hand, the extent of information gathering depends on the good's characteristics. The routine purchase of a low-priced search good (e.g. bread) may be based on the old information chunk (NELSON, 1970). However, in case of the purchase decision for a high-priced credence good (e.g. house, second-hand car) the consumer will most likely consider the *basic* and *surrounding determinants* intensively before deciding on where, when and how to buy the product (DARBY AND KARNI, 1973).

The third step is the post-purchase stage, following the decision. The consumer will evaluate the outcome of consumption or use. The degree of satisfaction or dissatisfaction will activate feedback and cause an update of information, knowledge and experience, and hence will affect future purchasing decisions. If the consumer is satisfied with the product, she probably will buy it again. On the other hand, if the consumer is dissatisfied with the outcome of her decision, she will not repeat buying but will start the decision making process from the very beginning.

The investigation of consumer demand for EFPV in Thailand presented here is performed to find out crucial factors that influence consumers' purchase decisions for EFPV and to understand the decision process. Compared to conventional vegetables, EFPV have new and different characteristics such as pesticide-safe, packaging, certificate, and brand name.

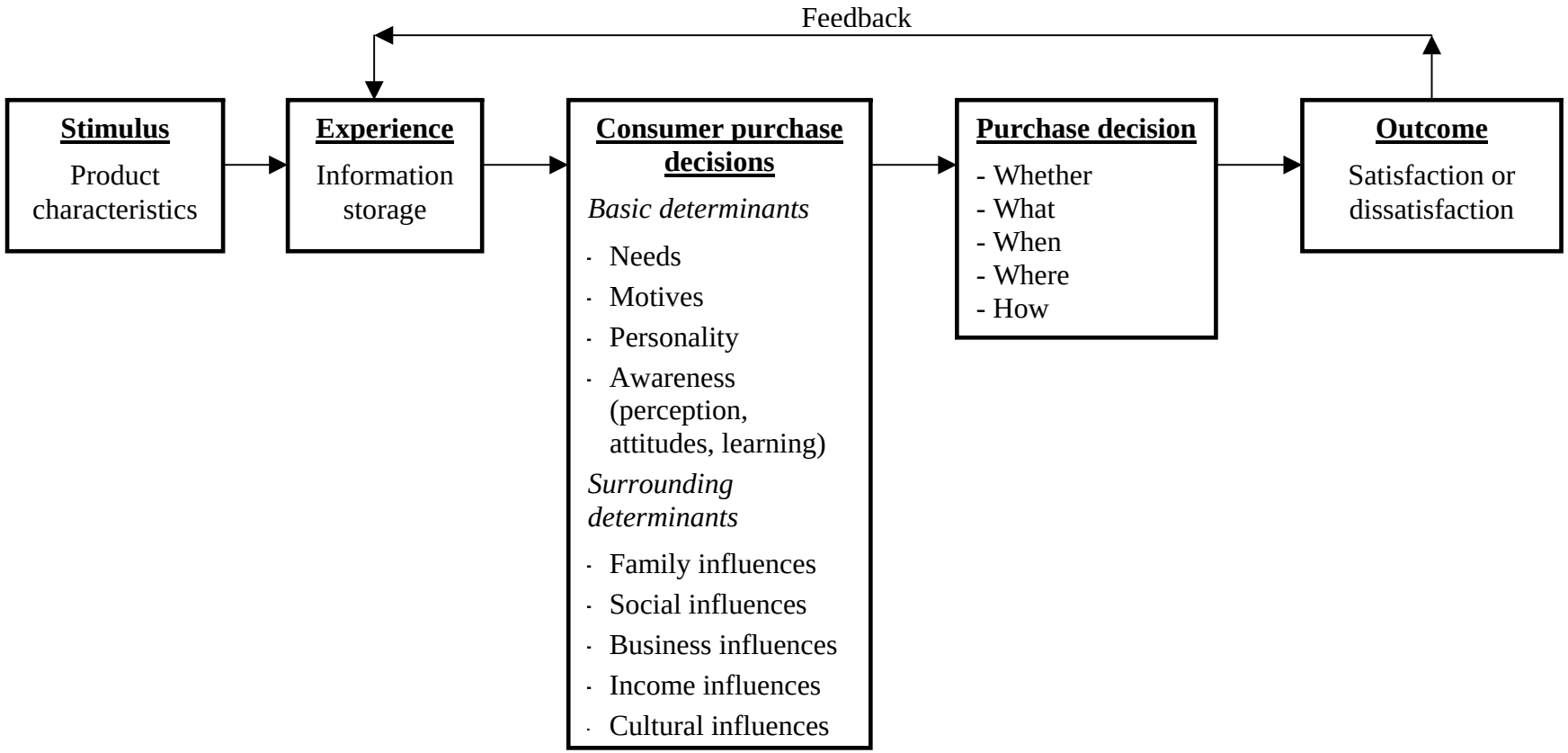


Figure 3.2 Process of consumer behaviour

Source: adapted from WALTERS (1978), p.17-19

According to the theory of consumer behaviour, the individual consumer will realise and evaluate these differences, and will check and probably alter the purchase decision taking account of the enlarged available information set. If the consumer engages in EFPV purchase, she will compare the outcome – the personal benefit – with past experience, and the result will induce an adjustment of experience and knowledge. A consumer, who is positive about a higher benefit from EFPV, will most likely buy again, otherwise most likely not. On the other hand, if the consumer refuses the initial purchase of EFPV, the chance remains for a decision to buy later on, when basic or surrounding determinants have changed their joint effects, e.g. due to new (unfavourable) information on conventional vegetables or new (favourable) information about EFPV.

3.2 Methodology

The theoretical considerations in the preceding section have elucidated the various factors affecting a consumer's purchase decisions. Moreover, they revealed that consumer purchase decision-making is a dynamic process, interlinking the numerous factors at work: stimuli, experience, basic and surrounding determinants of a decision, the actual result of the decision, and its evaluation. From this it follows that the application of the theoretical concept to the empirical problem at hand requires first of all the collection of specific information on the factors most likely at work. In the research presented here, this task has been accomplished by the consumer survey discussed later in chapter 4. However, data generation and description on its own will not lead to explanation. To this end, three different multivariate methods have been used to analyse the survey data in detail (see figure 3.3): conjoint analysis was applied in order to identify and evaluate the product characteristics relevant to the purchase decisions, logistic regression has been carried out to determine the relevant basic and surrounding factors influencing the probability to buy EFPV and to estimate their importance for the purchase decision, and, finally, the contingent valuation method has been used to calculate consumers' WTP for EFPV. The selected methods are discussed in more detail in the following sections of section 3.2.

3.2.1 Conjoint analysis

Conjoint analysis is a multivariate technique used to evaluate consumer preferences. The method relies on the assumption that a product consists of a utility generating bundle of attributes having different levels (see e.g. WAUGH, 1928; THEIL, 1952; LANCASTER, 1966). In other words, any consumer will assess the total value of a given product by combining the individual values ("part-worths") provided by the particular level of each product-attribute relevant to consumers (HAIR et al., 1998, p.392). The conjoint analysis is used to identify and evaluate those product characteristics that attract consumers. Analytically, the method decomposes the preference structure reported in a choice experiment into its constituent parts or elements – the product attributes.

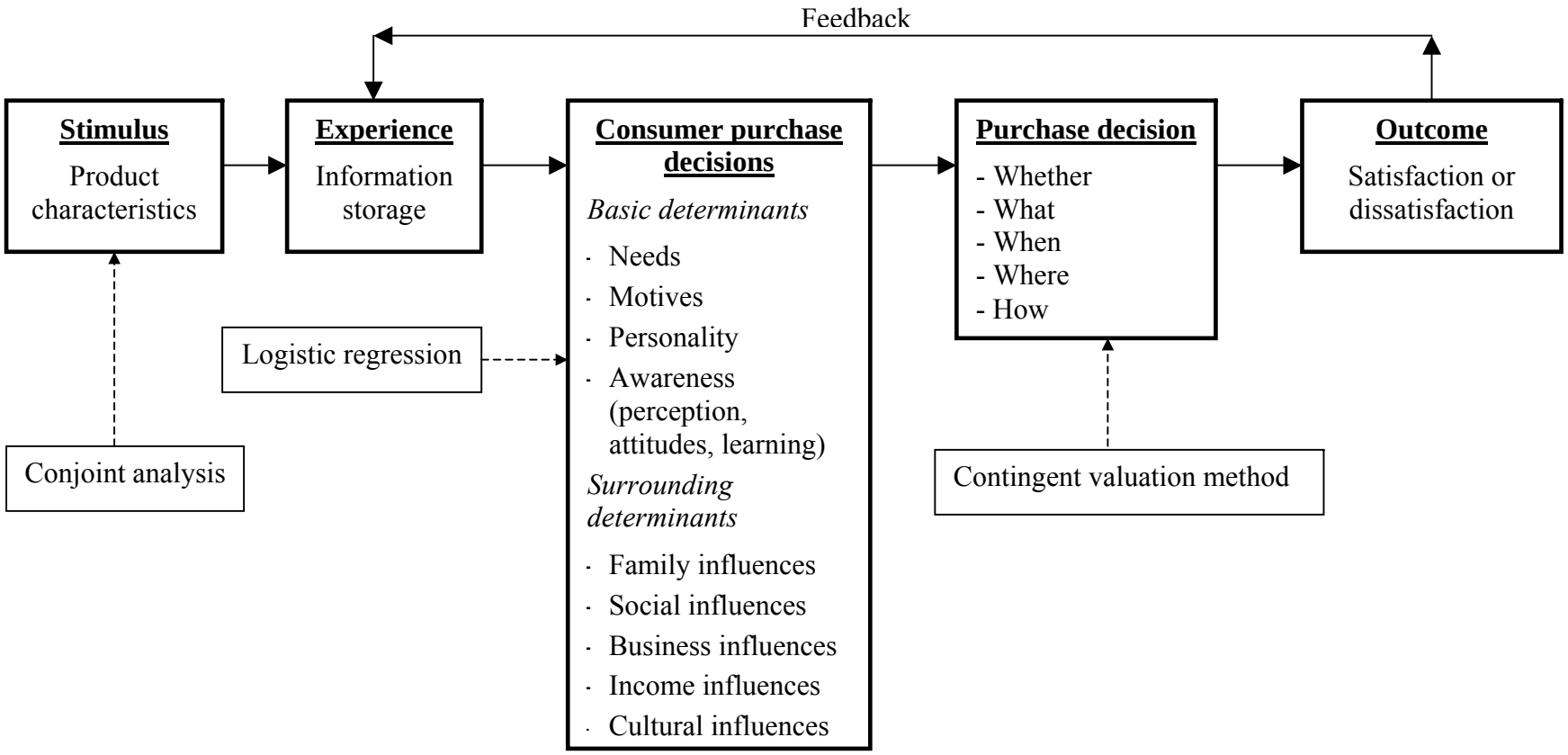


Figure 3.3 Methodological framework for analysing the process of consumer behaviour

Source: adapted from WALTERS (1978), p. 17-19

Conjoint analysis was introduced in marketing research by GREEN and RAO in the early 1970s (GREEN and RAO 1971). The seminal theoretical contribution to conjoint analysis, however, was made already earlier by LUCE, a mathematical psychologist, and TUKEY, a statistician (LUCE and TUKEY, 1964, ref. in CARROLL and GREEN, 1995). Currently, conjoint analysis and the related technique of experimental choice analysis represent the most widely applied methodologies for measuring and analysing consumer preference: WITTINK and CATTIN, e.g., reported as many as 1,062 commercial projects over just the five-year period from1981 to 1985 (WITTINK and CATTIN, 1989).

Running a conjoint analysis requires a series of survey data to be generated by an experimental choice design. The experiment is performed for a number of varieties of a differentiated product, the varieties diverging with respect to certain attributes and corresponding attribute-levels. The survey participants are confronted with a selection of these products and asked to give their preference rankings for the objects presented.

The collected data are subsequently analysed by the selected conjoint method. The analysis generates utility functions for each respondent by means of utility scores, called “part-worths”, for the different attributes. Applying highly fractionated designs, conjoint analysis is able to estimate part-worths for numerous attributes and their combinations. The most often used techniques for obtaining part-worths are Monotone Analysis of Variance (MONANOVA), Linear Programming (LINMAP), and Ordinary Least Squares (OLS). Among these methods, the OLS approach has been found to perform better than other methods. Moreover, OLS has the advantage of being easier to apply and the interpretation of the results is straightforward (CARMONE et al., 1978; CATTIN and BLIEMEL, 1978; JAIN et al.,1979; SPSS, 1997, p.4). It produces a set of additive part-worth estimates representing the marginal preference of each respondent for each level of the different sets of product attributes defined by the design.

The initial economic model set up for an individual consumer, to evaluate the partial utilities of the relevant components of an object which the consumer is empirically valuing by one overall value, may be written as follows (UNIVERSITAETS-RECHENZENTRUM TRIER, 1997):

$$W_r = \beta_0 + \sum_{i=1}^{I} u_{i\ell(r)} \tag{3.1}$$

This equation defines the individual's overall value ("total utility") W of the specific product variety r as the sum of the partial values (part-worths) u associated with the levels ℓ(r) of the relevant attributes i = 1,2,…,I of the product r at issue. The index ℓ(r) denotes the product-specific level ℓ of the attribute i at product r. The constant term β_0 represents the value of a (hypothetical) product with part values summing up to zero. It may be looked upon as the utility for the "bare bones version" of the varieties to be compared. The relationship between the part-worths and the levels of attributes may have different functional forms. Assuming again a linear functional form for convenience, the part-values u will vary directly proportionally with the levels of the attributes x, and we may represent the part-values by the approximation:

$$u_{i\ell(r)} = \beta_i \, x_{i\ell(r)} \tag{3.2}$$

Hence, the value of a given product as seen by a given consumer is decomposed in the following way:

$$W_r = \beta_0 + \sum_{i=1}^{I} \beta_i \, x_{i\ell(r)} \tag{3.3}$$

In the survey performed for the research presented here, every respondent was asked to rank R = 9 different products characterised by I = 3 different attributes, having three different levels each. For estimation purposes, the attribute-levels have been transformed into three (9x3) matrices $\mathbf{D}_i$ of attribute-level-specific 0-1-variables. Elements in any of the i matrices of dummy-variables are set equal to 1 in case the corresponding level of the associated attribute is prevalent; otherwise they are set equal to zero. Consequently, the coefficients $\boldsymbol{\beta}_i$ in the model are attribute-specific vectors, each vector being composed of three elements representing the effects of the levels defined for the attribute at issue. Accounting for this adjustment, the theoretical model adjusts to:

$$W_r = \beta_0 + \sum_{j=1}^{3} \beta_{1j} D_{1j} + \sum_{k=1}^{3} \beta_{2k} D_{2k} + \sum_{m=1}^{3} \beta_{3m} D_{3m} \tag{3.4}$$

Given a data set on the levels for the attributes and the consumer-specific overall values for the different products, we may estimate the parameters in principle by applying the OLS method. However, we are faced with two problems[1]. Firstly, we collected data for only nine different products per person, but the model contains ten unknown parameters – one constant plus three different levels of three different genuine parameters $\beta_1, \beta_2, \beta_3$. In order to remove this constraint, the parameter space is generally restricted by assuming identical parameter sets for all (in our case generally more than 1,300) consumers in the survey, i.e. by implicitly applying the concept of the "average consumer". Hence, adding an error term and using matrix-notation, the model applied reads as follows:

$$\boldsymbol{W} = \boldsymbol{D}'\boldsymbol{\beta} + \boldsymbol{\mu} \tag{3.5}$$

$\boldsymbol{W}$ = (P x 1)-vector of overall values, comprising the rankings for the (R) different products by the (N) respondents included in the survey (P=N*R)

$\boldsymbol{D}$ = (10 x P)-Matrix of (3) different levels of (3) different attributes measured in terms of 9 Dummies and the unit vector to represent the bare bones-version of the good for the total of rankings of all respondents

$\boldsymbol{\beta}$ = (10 x 1)-vector of parameters, representing the constant term (utility of the "bare bones version" of the product) plus the total of 9 level-influences of the attributes (part-worths)

$\boldsymbol{\mu}$ = (P x 1)-vector of residuals, capturing the effects of other factors of minor importance

The second problem results from a characteristic of the OLS method: OLS presupposes metrically scaled endogenous variables. However, in consumption analysis we often generate non-metric data – ordinal-scaled ratings (scores,) and/or

[1] Obviously, there is a third problem involved, resulting from the fact that we selected a limited number of nine product variants from the full set of 27 theoretical combinations of three attributes having three levels each. However, experience has revealed that a reduction of the full set to a manageable number of products in the comparison test is necessary in order to prevent overstrain of the respondents, at the same time satisfying the criteria of parsimonious number of parameters to be estimated. In empirical analyses, this task is performed by a so-called "orthogonal design", allowing for a statistically independent selection of principal effects (UNIVERSITAETS-RECHENZENTRUM TRIER, 1997)

rankings - for the variable to be explained. In the research presented here, for example, we asked consumers to rank the products defined by different levels of the different attributes consistently according to their preferences. Hence, the total value of a product is an ordinal-scaled number and from a methodological point of view, the data should have been analysed by non-metric regression techniques (e.g. MONANOVA). However, many studies on the performance of different methods applied to non-metric data have strongly shown that the metric OLS method and non-metric techniques generate essentially identical results (GREEN AND KRIEGER, 1993, p.478). Therefore, and because the interpretation of the OLS results are straightforward, the part values in the conjoint analysis presented later in chapter 4 have been estimated by the OLS method as provided by the SPSS program package[2].

3.2.2 Logistic regression

The knowledge of attributes and their levels in creating consumer utility is important for suppliers in order to customize products, i.e. to supply products (in our case vegetables) with attributes (e.g. low chemical residues) and corresponding levels (e.g. pesticide safe or organic) matching consumers' desires. However, this on its own will not guarantee purchase, which is only one possible outcome of the binary choice between purchase and refraining from purchase. Therefore, the second analytical task is to identify the factors affecting the decision making process: which are the determinants that cause consumers to buy or to refrain from buying?

The problem to be solved needs a method that is able to explain a binary endogenous variable (yes/no) by a set of covariates that determine the outcome of the decision. A typical method used to tackle dichotomous endogenous variables is logistic regression, which was introduced by TRUETT, CORNFIED, and KANNEL in 1967 (HOSMER and LEMESHOW, 1989). There are two main reasons for using the logistic regression approach in economics research. Firstly, the logistic function used is extremely flexible and easily applicable, and secondly the interpretation of the results is straightforward and meaningful (HOSMER and LEMESHOW, 2000, p.6). From a methodological point of view the logistic ("logic") model, is a special case of the Generalised Linear Model,

[2] Actually, as exemplified in chapter 4, the results from OLS and MONANOVA did not differ significantly. Hence the OLS method has been used for the interpretation of the results and is straightforward.

and the parameters can be estimated by maximizing the probability of obtaining the observed set of data using the maximum likelihood estimation method (HOSMER and LEMESHOW, 1989, p.8).

In the primary model, Y_i is the binary response of an individual or an experimental unit that can take on one of two possible values, denoted by Y = 1 if the event happens (e.g. purchase of EFPV) and Y = 0 if the event does not happen (refrain from purchase). Suppose $\boldsymbol{x}$ is a vector of explanatory variables of the decision and $\boldsymbol{\beta}$ is the vector of slope parameters, measuring the impact of changes in $\boldsymbol{x}$ on the probability of the decision to buy or not to buy, we may write Y_i as a linear function of $\boldsymbol{x}$ and some error term ε_i.

$$Y_i = \boldsymbol{\beta}'\boldsymbol{x}_i + \varepsilon_i \qquad (3.6)$$

where $\boldsymbol{\beta}' = [\beta_0, \beta_1, \beta_2, \ldots, \beta_k]$, $\boldsymbol{x}_i = \begin{bmatrix} 1 \\ x_{i1} \\ x_{i2} \\ \vdots \\ x_{ik} \end{bmatrix}$, and ε_i is the error term.

In order to simplify notation, we use $\pi(x) = E(Y \mid \boldsymbol{x})$ to represent the conditional mean of Y given certain values of $\boldsymbol{x}$. The probability of the binary response is defined as follows:

If $Y_i = 1$; $P(Y_i = 1) = \pi(x)$ (3.7)

$Y_i = 0$; $P(Y_i = 0) = 1 - \pi(x)$ (3.8)

If $E(\varepsilon_i) = 0$, the expected value of the response variable is

$$E(Y_i) = 1[\pi(x)] + 0[1 - \pi(x)] \qquad (3.9a)$$

$$= \pi(x)$$

This implies that

$$E(Y_i) = \boldsymbol{\beta}'\boldsymbol{x}_i = \pi(x) \qquad (3.9b)$$

Hence, the expected response given by the response function $E(Y \mid x) = \boldsymbol{\beta}'\boldsymbol{x}_i$ is just the probability that the response variable takes on the value 1 (MONTGOMERY, PECK and VINING, 2001, p.444).

In the linear regression model Y = E($Y \mid \boldsymbol{x}$) + ε, the error term expresses an observation's deviation from the conditional mean. Generally we assume that the deviation is caused by the many other influencing factors of only marginal importance, i.e. ε is normal with zero mean and constant variance. Given this assumption, the conditional distribution of the outcome variable for given values of $\boldsymbol{x}$ will also be normal with mean E($Y \mid x$), and constant variance.

However, the linear probability model produces problems, for the dependent variable is dichotomous, and the corresponding distribution describes the distribution of the errors expressed in terms of the dichotomous outcome variable. Hence the error term $\varepsilon_i = Y_i - \boldsymbol{\beta' x}_i$ must take one of the following two possible values, depending on the value
of Y_i:

If $Y_i = 1$; $\varepsilon_i = 1 - \boldsymbol{\beta' x}_i = 1 - \pi(x)$ (3.10)

$Y_i = 0$; $\varepsilon_i = - \boldsymbol{\beta' x}_i = - \pi(x)$ (3.11)

Consequently, the error variance is

$$\sigma_{Yi}^2 = \mathrm{E}\{[Y_i - \mathrm{E}(Y_i)]^2\} \quad (3.12a)$$

$$= [1 - \pi(x)]^2 \pi(x) + [0 - \pi(x)]^2 [1 - \pi(x)] \quad (3.12b)$$

$$= \pi(x)[1 - \pi(x)] \quad (3.12c)$$

The derivation shows that ε_i has a distribution with mean zero and variance equal to $\pi(x)[1 - \pi(x)]$. Hence, ε_i cannot be even approximately normally distributed, In fact, the conditional distribution of the binary variable Y follows a binomial (Bernoulli) distribution with probability given by the condition mean, $\pi(x)$ (HOSMER and LEMESHOW, 2000, p.7).

The specific functional form of the logistic regression model is as follows:

$$\pi(x) = \frac{1}{\left[1 + \exp(-\beta_0 - \beta_i x_i)\right]} \quad (3.13a)$$

In the case of one regressor only, this "logistic distribution function" (3.9a) is an S-shaped cumulative distribution as shown in figure 3.4. Its main characteristic is that the function restricts the estimated probabilities $E(Y_i)$ for any given value of x_i to lie between 0 and 1. This reveals that in principle any proper continuous probability function will suffice to give this result, and in many analyses the normal distribution has been used, leading to the so-called "probit model". However, it is very difficult to justify the choice of one distribution or another on theoretical grounds, and in most applications it seems not to make much difference which one was selected. (GREENE, 2000, p.815)[3].

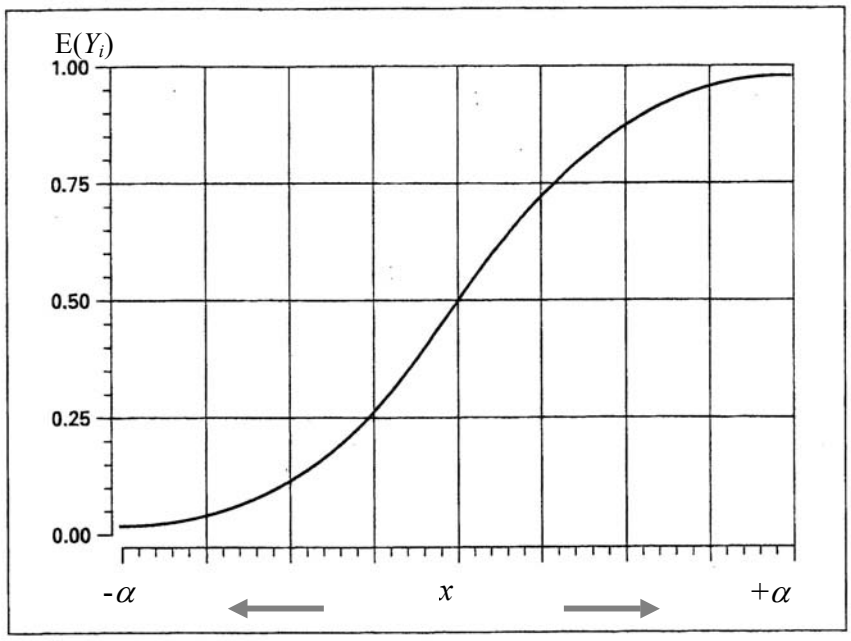


Figure 3.4 Typical function graph for logistic regression (one regressor)
Source: adapted from GREENE (2000), p.216

In empirical econometrics it is quite common to apply the logistic distribution function for its mathematical convenience and the ease of interpretation of the results. For the sake of this convenience, the logistic model has also been selected in this study.

[3] The logit distribution is similar to the normal but descends more slowly. Hence, for center values of the distribution, say $\boldsymbol{\beta}'\mathbf{x}$ between –1.2 and +1.2, the two distributions tend to give similar probabilities, but the logit model tends to give larger probabilities to $Y = 0$ when $\boldsymbol{\beta}_i\mathbf{x}_i$ is extremely small (and smaller probabilities to $Y = 0$ when $\boldsymbol{\beta}_i\mathbf{x}_i$ is very large) than the normal distribution (GREENE, 2000, p.815).

By expanding the fraction in (3.13a) by $\left[\exp(\beta_0 + \beta_i x_i)\right]$ the following equivalent representation of the logistic model is straightforward:

$$\pi(x) = \frac{\left[\exp(\beta_0 + \beta_i x_i)\right]}{\left[1 + \exp(\beta_0 + \beta_i x_i)\right]} \qquad (3.13b)$$

This equation is easily linearised by taking logarithms on both sides (3.13b). This procedure is called logit-transformation and the result gives the "logit model" or - equivalently – "logistic probability unit":

$$\text{logit}(\pi(x)) \equiv \log\left(\frac{\pi(x)}{1-\pi(x)}\right) = \beta_0 + \beta_i x_i \qquad (3.14)$$

The fraction in brackets on the right hand-side, $\pi(x) / [1-\pi(x)]$, is the "odds", which is the relation of the probability of observing Y=1 (in the study presented here the probability of buying EFPV) and the complementary probability of observing Y=0 (the probability of refraining from buying EFPV). Equivalently, $\log[\pi(x)/ (1-\pi(x))]$ is the log-odds or logit. The logit (log odds) has the advantage over the odds-ratio of being a linear function of the regressors on the right hand side of the equation, and it is useful to realize that an increase of any of the independent variables by one unit will cause an increase in the logit by the associated β_I when the same scale factor applies to all slopes in the model. The logit ($\pi(x)$) is continuous, and may range from $-\infty$ to $+\infty$ depending on the range of $\boldsymbol{x}$ (HOSMER and LEMESHOW, 2000, p.6). The terms β_0 and β_i in this model represent the unknown parameters that are to be estimated based on data obtained on the $\boldsymbol{x}_i$ and on Y_i. As is usually done, the estimation of the coefficients is based on the method of maximum likelihood, treating each observation as a single draw from the Bernoulli (binomial) distribution (GREENE, 2000, p.820).

Similarly to linear regression models, there are various statistics that have been proposed to assess the statistical significance of the logistic regression results (GREENE, 2000, p.820-834, and passim). In the analyses presented here, the overall goodness of fit has been evaluated by means of the likelihood ratio test, based on the ratio between the likelihood function $\hat{L}_R$ of the "restricted" estimation evaluated at the parameter estimates $\hat{\beta}_0$ and $\hat{\beta}_i$ of the logistic regression, and the likelihood function

$\hat{L}_U$ of the "unrestricted" model without regard to the genuine parameter constraints, evaluated at the value of the constant term of this estimate (GREENE, 2000, p.152-154)[4]:

$$L = \frac{\hat{L}_R}{\hat{L}_U} \tag{3.15}$$

The likelihood ratio must be between 0 and 1, for the likelihood for the restricted estimate will never exceed the likelihood of the unrestricted estimate. The formal test procedure is performed by calculating the transformation:

$$-2 \ln L = -2(\ln\hat{L}_R - \ln\hat{L}_U) \tag{3.16}$$

Under regularity, the large sample distribution of this transformation is chi-squared, with degrees of freedom equal to the number of restrictions imposed.

Additionally, we used the logarithms of the likelihood functions in order to calculate the following statistic:

$$R^2_{\text{Logistic}} = 1 - \frac{(-2\ln\hat{L}_U) - (-2\ln\hat{L}_R)}{-2\ln\hat{L}_U} \tag{3.17}$$

which gives numerical values between 0 and 1 and may be interpreted similarly to the traditional descriptive coefficient of determinant R^2 in regression analysis.

In order to test the significance of individual parameters of the logistic function we used the Wald test statistic (W), which is calculated by the SAS program for the total set of parameter estimates – providing an alternative to the likelihood ratio test just described – as well as for every single parameter. The test statistic W is – quite similarly to the likelihood ratio test statistic – an asymptotically chi squared distributed with degrees of freedom identical to the number of constrained parameters. In the case of a single parameter, W is chi squared with one degree of freedom, which is the distribution of the square of the standard normal test statistic in linear regression

[4] $\hat{L}_U$ and $\hat{L}_R$ are the variances of the residuals of the "unrestricted" and the "restricted" model . – The terms "restricted" and "unrestricted" used are somewhat misleading, for the parameters of the "unrestricted" model are actually restricted to zero. Therefore, this model is sometimes more precisely quoted as "model under the Null" ($H_0 : \beta_i = 0$), and the model including explanatory variables is named "free estimate" indicating that the values of β_i are determined by the estimation method in order to generate the best fit of the data without any a priori constraint (see e.g. HANSEN, 1993, p.426)

models. Due to this similarity, in empirical econometrics we generally apply W in order to test the significance of a single parameter in logistic regressions.

Finally, additionally to the significance tests we attempted to assess the predictive capability of the fitted logistic regressions by calculating a series of so-called classification tables. A classification table contains the summary of cross-classifying the observed outcome variables Y_i (buying or not buying) with the predicted dichotomous variable whose values are derived from the estimated logistic probabilities (HOSMER AND LEMESHOW, 2000, p.156). The 2x2 classification table separates accurately and inaccurately "buying" from accurately and inaccurately "not buying". However, to find the derived dichotomous variables we need the definition of a cut-point c and comparison of each estimated probability (continuously between 0 and 1) to c. If the estimated probability exceeds c, the derived variable is set to 1, otherwise it is equal to 0. Subsequently, the special rate of correct predicted action "buying" ("sensitivity") and correct predicted failure "not buying" ("specificity") may be calculated in order to give an idea about the accuracy of predictions. The result, however, depends on the definition of the cut-point, which is most often set to 0.5. A more complete description of classification accuracy is obtained by calculating and plotting the probability of detecting true signals (sensitivity) and false signals (1-specificity) for an entire range of different cut-points between 0 and 1. The area under the plot (under the Curve of Receiver Operating Characteristic: ROC-Curve) provides a measure of the model's ability to discriminate between the individuals who buy and those who don't buy (HOSMER AND LEMESHOW, 2000, p.160-164)[5] which is the likelihood that a consumer who buys EFPV will have a higher probability than a consumer who refrains from buying. As a general rule, HOSMER AND LEMESHOW give the following rule of thumb-classification of the area ROC under the curve ((HOSMER AND LEMESHOW, 2000, p.162):

- $ROC = 0.5$ suggests no discrimination (the curve is the bisecting line),
- $0.7 \leq ROC < 0.8$ is considered acceptable discrimination,
- $0.8 \leq ROC < 0.9$ is considered excellent discrimination.
- $ROC \geq 0.9$ is considered outstanding discrimination.

[5] If the objective were to define an optimal cut-point from the classification point of view, one might select the simultaneous maximum of sensitivity and specificity. (ibid).

A more sophisticated approach to evaluate the predictive power of the logistic model is to apply the so-called Hosmer-Lemeshow-test statistic C (Hosmer and Lemeshow, 2000: 147-156). The test statistic is based on the grouping of estimated probabilities, usually in terms of the g=10 percentiles of the observations, ordered from the lowest to the highest estimated probabilities to buy ("deciles of risk"). The statistic C is obtained by calculating the Pearson chi-square statistic from the ($g \times 2$, in our case 10×2) observed and estimated expected frequencies (in our case of buyers and non-buyers). C is an asymptotically chi-square distributed with (10-2=8) degrees of freedom (provided the allocation of observations to the individual groups is sufficiently high, normally exceeding five observations, as is required for chi-square tests in general).

3.2.3 Contingent valuation method

Contingent valuation method (CVM) is a well-known technique used to evaluate WTP for public, particularly environmental, goods not directly traded in markets: the value of environmental amenities, recreation, wildlife, natural resource damage or degradation, and the like (e.g., BELZER and THEROUX, 1997; FU et al., 1999; HANEMANN et al., 1991). More recently, however, there is an extensive and growing literature applying CVM to food safety issues (e.g., BUZBY et al., 1997; HALBRENDT et al., 1997; FU et al., 1999; BOCCALETTI and NARDELLA, 2000; NAYGA et al., 2004). This diffusion of CVM to new research fields is due to the general approach of CVM, which is applicable in many situations: to replicate real purchasing decisions and to use individuals' responses to hypothetical choices among product/price combinations to evaluate their WTP (FU et al., 1999, p.221).

The principal prerequisite for CVM is a precise and realistic definition of the set of products and their attribute levels to be valued in order to ensure sufficient information on the products, and thus to prevent wrong judgements and wrong decisions caused by wrong perceptions (ibid; JUNG, 1995, p.35). In the research presented here, this central requirement is at least partly fulfilled by slowly increasing the information open to the public on health concerns and vegetables from different production systems: consumers are in a learning process to balance potential threats to their health against special product attributes in daily food selection. Additionally, the field interviewers were instructed to offer more detailed information on the attributes and the different

levels during the personal interviews in order to upgrade and harmonise the level of information among respondents. On the other hand, the inherent potential bias of WTP estimates for public goods caused by the introduction of specific financial instruments (e.g., user fees versus taxes) is actually irrelevant in our case. The reason is that consumers would certainly have to bear the price premium for a higher quality of food. Hence, they should be aware of their individual budget restrictions when responding. Finally, however, the risk of strategic behaviour and the potential for generating hypothetical answers to hypothetical questions does definitely remain – but according to the literature, this problem tends to be overestimated (JUNG, 1995, p.36; CUMMINGS et al., 1986, p.26).

With respect to the survey designs applied in empirical analysis, we may employ two different approaches. On the one hand, the so-called open-ended question format is used: the respondent is asked to specify the maximum amount of money she would be willing to pay for a well defined good, e.g., "What is the most that you would pay to buy…?" Alternatively, the respondent is asked a series of dichotomous choice questions (in terms of bids, i.e. amounts of money) until some point estimate of WTP is reached (HANEMANN et al., 1991). Neither design is easy for the respondents. They carry a high risk of eliminating respondents or generating "no responses" when interviewees are not very familiar with the objects to be valued and/or if an anchor price for some basic variety of the good is not at hand. Therefore, so-called closed-ended designs have been developed, relying on bounded dichotomous choices, the bounds being defined by specified amounts of money (bids). If the good is valued equal or more highly than the threshold amount of money (bid), the person answers "Yes", otherwise "No". Hence, a dichotomous choice design ensures that the field investigator quotes specific prices, and the respondent has time to think about the bid and decide on acceptance or rejection in the same way she is used to in a habitual purchasing decision process (CALIA and STRAZZERA, 1999, p.6). With regard to existing dichotomous choice designs we may, again, generally differentiate among three approaches depending on the number of bidding rounds: single-bounded, double-bounded, and the generalisation of multiple-bounded dichotomous choice CVM. In the single-bounded approach, introduced by BISHOP and HEBERLEIN in the late 1970s, only one dichotomous choice question is asked, and the amount of money is treated as the

threshold (BISHOP, R. and HERBERLEIN, T., 1979, quoted in HANEMANN et al.,1991; HANEMANN and KANNINEN, 1996). The double-bounded approach is an enhancement proposed by HANEMANN in the 1980s, asking the respondents to engage in a second round of bidding (HANEMANN, 1985; CARSON et al., (1986), quoted in HANEMANN et al., 1991): participants respond to a first bid and are subsequently faced with a second (lower or higher) bid depending on the acceptance (second bid higher than the first one) or rejection of the first bid (second bid lower than the first one). HANEMANN et al. and others have shown that adding a second round significantly improves the statistical efficiency of dichotomous choice CVM (HANEMANN et al., 1991; KANNINEN, 1993; BOYLE et al., 1996; SCARPA and BATEMAN, 2000; CALIA and STRAZZERA, 1999). The third class of bounded dichotomous choice CVMs, the multiple bounded approaches, define a sequence of more than two bids. However, the application is much more demanding on researchers as well as respondents.

In the empirical WTP analysis for EFPV in the Thailand survey presented in chapter 4, we decided on the double-bounded CVM, which is more efficient than the single-bounded approach. In the following section, however, we start by reviewing the single-bounded CVM in order to explain the basic idea. The double-bounded approach is subsequently derived.

Single-bounded approach

The regression models discussed in the following paragraphs are strongly influenced by CAMERON (1988), who has used the so-called censored regression (or, in reference to TOBIN who first applied this model in 1958 the tobit-model) to estimate WTP. The censored normal-regression model is defined as follows (CAMERON, 1988; GREENE, 2000, p.905-912):

$$Y_i = \boldsymbol{x}_i'\boldsymbol{\beta} + \varepsilon_i \qquad (3.18)$$

In this equation, the endogenous variable Y_i is the WTP of the *i*th respondent, which is assumed to depend on a set of different individual socio-economic characteristics contained in the vectors x_i' (i=1, 2, 3,…,n). $\boldsymbol{\beta}$ is the vector of coefficients measuring the influences of the exogenous variables on the WTP. The error term ε_i is assumed to be distributed independently with cumulative distribution functions $G(\varepsilon_i)$, with zero mean and variance equal to σ^2(or ~N(0, σ^2)). However, in the tobit model, the endogenous variable is censored, i.e. values in a certain range are all transformed to (or reported as) a single value. In our case the endogenous variable is reported as "Yes" or "No" to a certain amount of money B_I, presented in the (first and sole) dichotomous choice question. Similarly to the logistic model, conventional regression methods fail to account for the dichotomy, and the technique used to estimate the censored model is again the MLE-method (Greene, 2000, p. 906-911).

The MLE function to be maximised is derived as follows. Let $\boldsymbol{x_i'\beta}$ denote the right hand side of the regression approach, and let I_i denote the indicator dummy variable defined as follows:

Yes: $I_i = 1$, if $Y_i > B_I$ (3.19)

No: $I_i = 0$, otherwise (3.20)

then $\Pr(I_i = 1) = \Pr(Y_i > B_I)$ (3.21a)

$= \Pr(\varepsilon_i > B_I - \boldsymbol{x_i'\beta})$ (3.21b)

Standardizing the variables of the inequality expression in Pr(.) by dividing by the standard deviation σ of the error term, the probability of observing $I_i = 1$ is given by:

$$\Pr(I_i = 1) = \Pr(z_i > ((B_I - \boldsymbol{x_i'\beta})/\sigma) \quad (3.21c)$$

$$= 1 - G((B_I - \boldsymbol{x_i'\beta})/\sigma) \quad (3.21d)$$

However, similarly to the dichotomous logistic model, the censoring of the endogenous variable introduces a distortion into conventional statistics (GREENE, 2000, chapter 20). Due to the censoring characteristic, we cannot estimate the model by the OLS method, but we can derive the following appropriate log-likelihood function for the single-bounded dichotomous choice model and estimate the interesting parameters $\boldsymbol{\beta}$ along with the standard deviation σ by MLE-methods (CALIA and STRAZZERA, 1999):

$$LnL = \sum_{i=1}^{n} \{ I_i \ln[1 - G((B_I - x_i'\beta)/\sigma)] + (1 - I_i) \ln[G((B_I - x_i'\beta)/\sigma)] \} \quad (3.22)$$

Double-bounded approach

The double-bounded CVM proposed by HANEMANN in 1985 extends the single-bounded to a double-bounded approach (HANEMANN, 1985; HANEMANN et al., 1991). The double bounded dichotomous choice CVM starts with an initial bid; and the respondent can answer with either "yes" or "no". Again, let B_I denote the amount of money for the first bid. If the respondent answers "yes" to this first bid (B_I), a second bid (B_U) follows, offering some higher amount ($B_U > B_I$), the so-called "upper bound". If the respondent answers "no" to the first bid (B_I), then the second question offers a second bid (B_L) being somewhat lower than the first bid ($B_L < B_I$). This is called the "lower bound" (see figure 3.5).

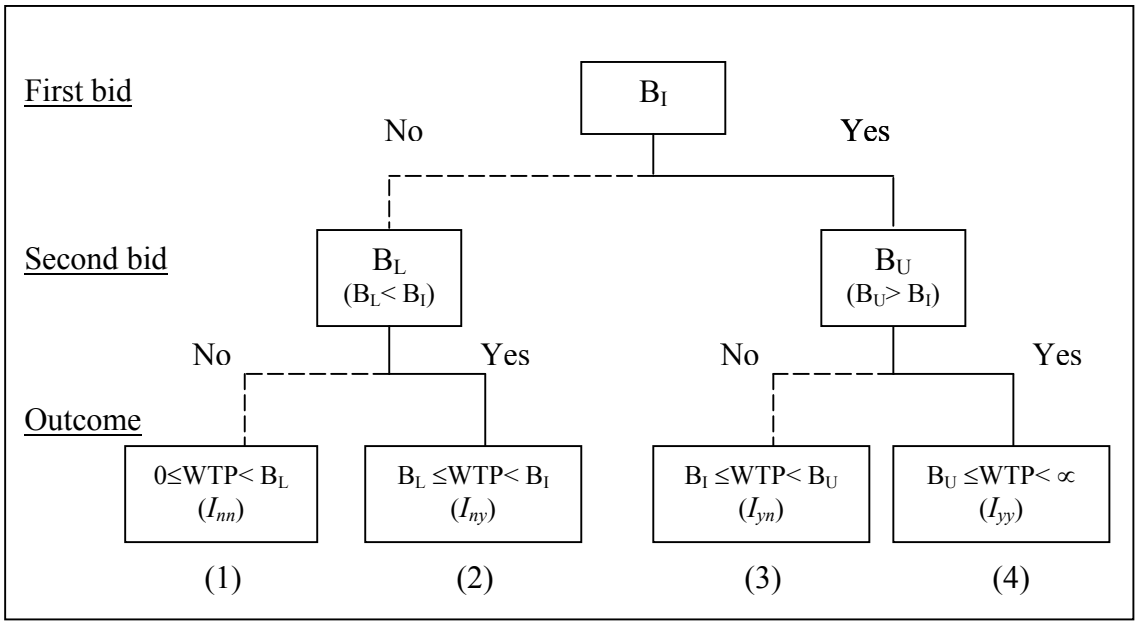


Figure 3.5 The possible outcomes of double-bounded dichotomous choice CVM

Source: Own representation

Consequently, there are not only two (single-bounded), but four possible outcomes from the double-bounded approach, characterised by four different intervals (figure 3.5):

(1) "no", followed by "no" (I_{nn}): the WTP is zero or lower than B_L,

(2) "no", followed by "yes" (I_{ny}): the WTP is at least equal to the lower bound, but less than B_I,

(3) "yes", followed by "no" (I_{yn}), WTP is between B_I (included) and B_U (excluded) and

(4) both answers are "yes" (I_{yy}), WTP is equal or higher than B_U.

The variable *I* will indicate which of the four possible outcomes is observed.

From a probability point of view, this result corresponds to partitioning the underlying probability density function into four discrete sections, represented by the areas (a), (b), (c), and (d) respectively (figure 3.6).

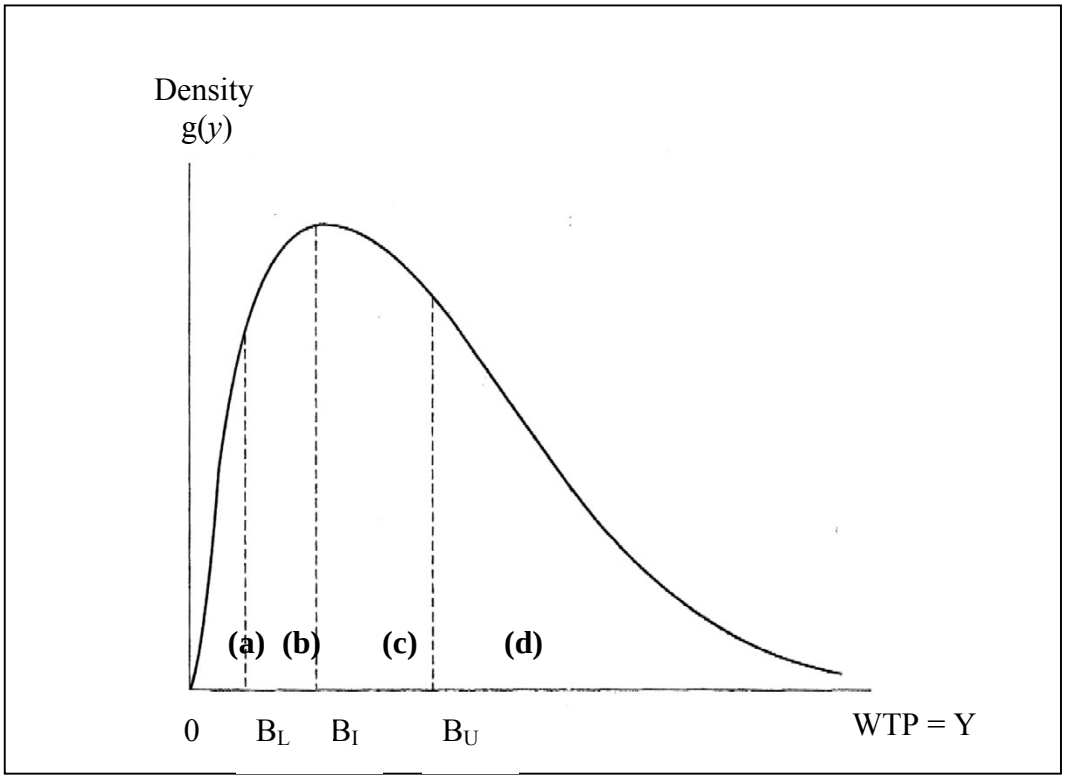


Figure 3.6 Probability density function (PDF) of WTP
Source: Own representation

Denoting the appropriate probabilities for the four outcome variables by G(B.), the four sections of the PDF will read as follows (HANEMANN and KANNINEN, 1996, p.63-64.; SUKHAROMANA, 1998, p.38-41):

$$P^{nn} \equiv \Pr\{\text{no/ no}\} = \Pr(Y_i < B_L < B_I) = G(B_L) \quad (3.23)$$

$$P^{ny} \equiv \Pr\{\text{no/ yes}\} = \Pr(B_L \leq Y_i < B_I) = G(B_I) - G(B_L) \quad (3.24)$$

$$P^{yn} \equiv \Pr\{\text{yes/ no}\} = \Pr(B_I \leq Y_i < B_U) = G(B_U) - G(B_I) \quad (3.25)$$

$$P^{yy} \equiv \Pr\{\text{yes/ yes}\} = \Pr(Y_i \geq B_U > B_I) = 1 - G(B_U) \quad (3.26)$$

Equation (3.23), for example, defines the probability for Y (i.e. WTP) to be located in the first range (area (a) in figure 3.6). The lower bound of this range is some non-negative value, say zero, and the upper bound of the range is identical to the lower bound of the second bid (B_L). Actually, the lower bound itself is excluded because the

first bid was rejected. On the other hand, Equation (3.26) defines the probability for Y (WTP) to be located in the fourth range given by area (d) in figure 3.6. In this case, the WTP will lie within the interval equal to the upper bound (B_U), accepted in the second round bid, and some higher value, say infinity. Bearing in mind that some WTP is a certain event (WTP = 0 is included, i.e. the cumulative probability for any WTP adds up to 1), the interpretation of the other equations is straightforward.

The WTP function is set up by multiplying the four different probabilities of each individual. Taking logarithms, the log-likelihood function is equal to the sum of logarithms of the probabilities for all respondents:

$$ln\,L = \sum_{i=1}^{n} [\, I_{nn}\, ln\, P_i^{nn} + I_{ny}\, ln\, P_i^{ny} + I_{yn}\, ln\, P_i^{yn} + I_{yy}\, ln\, P_i^{yy}\,] \qquad (3.27a)$$

In this function, the four possible responses: I_{nn}, I_{ny}, I_{yn}, and I_{yy} are measured by indicator dummy variables, being equal to 1 in case the appropriate range is valid, otherwise it is zero. For example, I_{nn} equals 1 when the respondent answers "no" to both questions, and zero otherwise.

Using the regression model and notation introduced in the section deriving the single-bounded approach (equation 3.18 to 3.22), the log-likelihood-function is rewritten as follows:

$$ln\,L = \sum_{i=1}^{n} \left\{ \begin{array}{l} I_{nn}\, ln\left[G\left(B_L - \boldsymbol{x\beta}/\sigma\right)\right] + I_{ny}\, ln\left[G\left(B_I - \boldsymbol{x\beta}/\sigma\right) - G\left(B_L - \boldsymbol{x\beta}/\sigma\right)\right] \\ + I_{yn}\, ln\left[G\left(B_U - \boldsymbol{x\beta}/\sigma\right) - G\left(B_L - \boldsymbol{x\beta}/\sigma\right)\right] + I_{yy}\, ln\left[1 - G\left(B_U - \boldsymbol{x\beta}/\sigma\right)\right] \end{array} \right\} \qquad (3.27b)$$

The parameters of this log-likelihood function can be estimated by the MLE method subject to a specified probability distribution (GREENE, 2000, p. 856, 912).

When applying this approach to empirical data, it is necessary to define allocation rules for the WTP collected in the double-bounded choice CVM to the different probability intervals. In general, the observations are assigned in the following way for estimation purposes (SAS, 2001, p.1770; table 3.1):

Table 3.1 The way of specifying censoring

Lower Bound	Upper Bound	Comparison of bounds	Utilisation of the variable
Not missing	Not missing	Equal	No censoring
Not missing	Not missing	Lower < upper	Censoring interval
Missing	Not missing		Upper used as left censoring value
Not missing	Missing		Lower used as right censoring value
Not missing	Not missing	Lower > upper	Observation not used for estimation
Missing	Missing		Observation not used for estimation

Source: SAS (2001), p.1770

If the two values (lower and upper bounds) in a survey turned out to be the same, the actual response value is used as the observation in the estimation (no censoring). If both values are present but the lower is less than the upper bound of the range, the values are assigned to the appropriate censored interval. If the lower value is missing, but the upper bound exists, the upper bound of the range is used as a left-censored variable. Accordingly, if the upper value is missing, the lower value is taken as a right-censored value. Finally, if both values are available, but the lower value exceeds the upper value or both values are missing, the observation is not used in the estimation. However, in these cases prediction remains possible as long as none of the covariates is missing.

In the research presented here, we generally comply with the SAS rule with one exception: in the case in which the lower bound was available, but the lower bound was missing (in principle leading to left censoring) we treated the variable as interval censored. The reason is that in our case of WTP there is a natural lower bound (zero) for the WTP. Therefore, the pattern of interval-censored information on the PDF of WTP in our research is (table 3.2):

Table 3.2 The pattern of interval-censored information

Responses		Interval information	Data type
First bid	**Second bid**		
no	no	$0 \leq WTP < B_L$	Interval censored
no	yes	$B_L \leq WTP < B_I$	Interval censored
yes	no	$B_I \leq WTP < B_U$	Interval censored
yes	yes	$WTP \geq B_U$	Right censored

Source: Own compilation

Analogously to the class of logit/ probit-models, various distributions have been proposed and applied in empirical research to represent the probability function of WTP, e.g. lognormal, Weibull, loglogistic, and the like (HANEMANN AND KANNINEN, 1996). In this study, we selected the most often used log-normal distribution (SUKHAROMANA (1998); GREENE, 2000, chapter 19 and 20). The log-likelihood function is estimated by the program Life Regression Model (LIFEREG) in the SAS program package.

CHAPTER 4

EMPIRICAL ANALYSES

After having reviewed the theoretical and methodological concepts selected to analyse consumers' purchase decisions for EFPV, the present chapter turns to the empirical analyses and discusses the results produced. The presentation of the analyses is divided into five sections, followed by a short summary of the main findings.

The first section, 4.1, comments on the consumer survey carried out in order to generate the necessary database for more sophisticated analyses, and section 4.2 summarises the main descriptive findings. The following sections 4.3 to 4.5 then elaborate on the three different aspects of a consumer's decision-making process developed in chapter 3. The analytical investigation starts in section 4.3 by presenting the results of two different conjoint experiments carried out in order to quantify the part-worths of some defined levels of selected vegetable attributes preferred by the respondents. The analysis of preferences is followed by the specification and estimation of a logistic regression model to explain the role of basic and surrounding determinants in consumers' purchase decision for EFPV (section 4.4). Section 4.5 assesses the WTP for EFPV by employing a double bounded dichotomous choice CVM.

4.1 Survey Design and Data Collection

4.1.1 Design of the questionnaire

Following the theoretical concept developed in chapter 3, the information needed comprises roughly three different aspects: (1) *product characteristics* and associated knowledge, attitudes and preferences of consumers, including the observational data from the experiment designed to run conjoint analysis, (2) *basic and surrounding determinants* of the purchase decisions of customers in order to allow for separation of typical buyers from typical non-buyers of EFPV by means of logistic regression, and (3) *consumers' WTP* for EFPV, addressed by a double-bounded dichotomous choice experiment to be statistically evaluated by CVM.

However, experience has shown that the structure of a questionnaire should not simply follow the research questions, but must also take tactical and psychological considerations into account. Hence, as is commonly done, the actual sequence of questions has been arranged in a different way[1]:

Our *questionnaire* starts with an initial question asking the interviewee whether she is used to buying vegetables. This was done to ensure some minimum knowledge by consumers and prevent pure guesses. At the least, respondents should be familiar with purchasing vegetables; hence, consumers who said they were not accustomed to vegetable buying were eliminated (question 1).

The *first section* of the questionnaire addresses behavioural aspects of vegetable consumption and purchase (questions 2 – 7), followed by questions intended to reveal the (relative) importance of selected factors affecting the purchase decision of the respondent and to identify the relevance of pesticide residues and assess coping strategies of the customer (questions 8-22). Subsequently, two questions concerning the knowledge and role of certificates have been included (questions 23-24), leading over to the conjoint experiment (question 25). The final part of the first section turns to the time consuming double-bounded dichotomous choice experiment and tries to evaluate respondents' attitudes towards special aspects of chemical use in agricultural production and chemical residues in food and vegetables (questions 26-27).

The *second section* of the questionnaire has been designed to collect socio-demographic and socio-economic characteristics, e.g. household size, marital status, education, income and the like (questions 28-36). Finally, respondents were invited to comment unaided on the market prospects for EFPV from their personal point of view (questions 28-37).

Concerning the interrogative form, most questions are in the closed format, usually in terms of dichotomous choice questions (yes/no-answer) or multiple choice questions allowing for selection of one out of a given set of answers or calling for ratings or rankings. The closed format is typically used in large-scale face-to-face interviews in

[1] The questionnaire addressed Thai consumers, and we hired and trained Thai students to assist as enumerators. Therefore the original version of the questionnaire is in Thai. In order to ensure transparency, an English translation of the questionnaire is attached in appendix 3.

order to reduce interviewer-bias, to avoid asking too much of the respondents, and last not least to ease processing and statistical analyses. However, there are also some open format questions giving leeway for well-considered reflections (see appendix 3).

The initial version of the questionnaire was discussed with colleagues from Kasetsart and Hannover University and pre-tested by a survey of 30 face-to-face interviews so as to identify and change improper questions or improve those capable of being misunderstood. Furthermore, the pre-test phase was used to define the attributes and to select the different levels to include in the conjoint experiment. Similarly, the findings of the pre-survey helped to assess the initial bidding points and the upper and lower bounds in the second round of the contingent valuation experiment.

4.1.2 Data collection

The *consumer survey* was conducted in three larger cities of Thailand. Hence, from a g*eographical* point of view, we ignored rural areas and focused only on urban areas. This was done for several reasons. Firstly, the market review (chapter 2) revealed that EFPV are sold at a premium, which can hardly be afforded by the rural poor, having average incomes significantly below the national average. Secondly, in rural areas subsistence in terms of food from home gardens still plays an important role in consumption. And finally, until now EFPV are not actually offered by the traditional stalls in the local markets, who are the virtually exclusive vendors in rural areas. Taking account of these characteristics and in order to detect possible regional differences in consumer behaviour at the same time, three cities were selected as collecting areas: Bangkok (capital city of Thailand in the Central region), Chiang Mai (larger city in the North), and Khon Khaen (larger city in the North-East). The North and North-East are the most important areas of vegetable production in Thailand, whereas – quite understandably - the major wholesale markets reside in the city and on the outskirts of Bangkok in the Central region. In this respect, the selected regions for consumer analyses match the interest of the second tandem project on production aspects of the production-marketing system of EFPV in Thailand carried out at the Institute of Economics in Horticulture, Faculty of Economics and Management, Hannover University (HARDEWEG AND WAIBEL, 2002).

Within these three cities, we generally selected *three different sampling points* at which customers were interviewed: hypermarkets, supermarkets, and green shops[2]. Actually, these are the only outlets that sell EFPV. That is, at the time being, even in Bangkok EFPV are not offered by the typical, and still important, stalls in a defined market space, food courts, night markets, and small food retailers. On the other hand, *hypermarkets and supermarkets* provide consumers with both conventionally produced vegetables and different types of EFPV. Hence, at least some customers in these shops should have recognised the spreading product differentiation that was under way. By contrast, *green shops* specialise in selling natural products (food, herbs, and clothes) only, and with respect to vegetables they concentrate on organic or at the least chemical-reduced vegetables. Therefore, customers of green shops generally should be very familiar with food-safety issues and, moreover, they should be well informed about health risks from chemical residues.

To allow for sufficiently accurate estimation, the *sample size* plays an important role in any survey design. In principle, larger samples are preferred in statistical analyses in order to increase potential statistical significance. However, different research questions and different methods require different sample sizes to generate economically reasonable and statistically significant results. Also, in empirical research budget, time and other restrictions limit the potential number of interviews carried out. From an MLE method point of view, the sample size for the analyses intended in this research should definitely exceed 100, which is the lower limit to generate reliable estimates by MLE methods according to a rule of thumb. However, LONG, e.g., argues that empirical research should aim for significantly more data (up to 500) to assure satisfactory MLE results (LONG, 1997:54). On the other hand, due to the generally large variance of WTP responses, most contingent valuation studies in the literature report sample sizes between 600 and 1,500 respondents to obtain results of sufficient quality (MITCHELL AND CARSON, 1990: 224-228). In double bounded dichotomous choice models, though, the variance is limited by the bidding points.

[2] From a theoretical point of view it would have been interesting to also include customers from fresh markets, who are most likely not very familiar with EFPV, and we did actually run a trial in Khon Khaen. However, one interview took about 20 minutes and we needed a table to arrange the conjoint and contingent valuation experiments. By contrast with the other outlets selected, it was neither possible to stop and ask customers on turbulent fresh markets for 20 minutes nor to install a table. Hence we had to drop the fresh markets.

Balancing the various arguments, we decided on a sample size total of about 1,200, and in the end we completed a total of 1,320 interviews. The sample was split into three sub-samples to include the three cities selected: about 600 in Bangkok and about 300 each in Chiang Mai and Khon Kaen (table 4.1). The larger sample for Bangkok was determined with a view to the large proportion and high number of higher educated middle and higher income class inhabitants. These consumers are assumed to be most likely to be interested in pesticide residues and food safety issues and in principle capable of accepting the price premium for EFPV. Ex post, it turned out to have been definitely the right decision: firstly, the number of outlets offering EFPV for sale was limited in Chiang Mai and Khon Kaen (see table 2.15, section 2.4.4: almost 65% of the main stores offering EFPV were in Bangkok); secondly, several store managers in these two cities were reluctant to co-operate in the survey[3]; and thirdly, the numbers of consumers in the shops turned out to be significantly lower compared to the outlets in Bangkok. Increasing the sample size in the two regional cities would have caused an undue extension of the sampling period and would have led to excessive costs.

The *sampling procedure* itself may be characterised as *purposive sampling*, i.e. we asked customers available and ready to participate in the survey at the different sampling points. The total of 1,320 face-to-face interviews was conducted during the period from 14 December 2001 to 4 February 2002 (26 man-days). These comprised 634 respondents in Bangkok, 301 in Chiang Mai, and 385 in Khon Kaen. In each city, the interviews were conducted at the selected locations; the actual breakdown is given in table 4.1.

[3] This, for example, was the reason why we failed to include supermarkets in Khon Kaen.

Table 4.1 Number of respondents classified by locations and stores

Store		Location			Total
		Bangkok	Chiang Mai	Khon Kaen	
Supermarket	- TOPs	285	142	-	427
Hypermarket	- Carrefour	283	138	-	421
	- BigC	-	-	324	324
Green shop	- Aden	66	21	45	132
Fresh Market		-	-	16	16
Total		634	301	385	1,320

Source: Consumer survey

The selection of *sampling points* was handled in a way comparable to the selection of the sampling units. However, we tried to include stores in different quarters of the cities, but at the same time we had to request consent by the store managers to carry out the survey in their business premises. Hence it was again a more or less purposive sampling approach.

Given the large number of interviews and intending to limit the survey to a reasonably short period, we recruited students from the local universities to assist in data collection. The *enumerators* were carefully trained in advance and permanently supervised during the survey.

4.2 Descriptive Results

As a first step in the analyses, the data collected were edited in order to provide information on socio-demographic and socio-economic characteristics of the respondents (4.2.1). The section is followed by a descriptive summary of behavioural aspects of the interviewees (4.2.2).

4.2.1 Socio-demographic and socio-economic characteristics

Self-assessment shows that the respondents essentially purchase the vegetables for household consumption (appendices 4 and 6). Not surprisingly, the majority of respondents in the survey are *female* (86%), and almost two thirds are *married*. The *age distribution* ranges between 11 and 75 years with relatively balanced frequencies between 21 and 60 years. This age group covers just under 90% of total respondents. The mean age in the whole survey is 36 years, differing only slightly among the regions.

With respect to *education* the sample is dominated by individuals having a high level of education on the average: slightly more than 54% of the respondents reported a Bachelor's degree or higher (appendix 4). The largest share was reported for Bangkok (60%), and the lowest for Chiang Mai (46%). Accordingly, the most common occupation was white-collar with about 45% of the total sample (table 4.2). Comparing occupation with gender characteristics suggests that a very high proportion of female respondents are white or blue collar employees. This is quite abnormal in comparison with the country's average. However, from the outset the sample was expected to be biased towards higher education and occupation due to the special collection areas (cities) and survey points selected (hypermarkets, supermarkets, green shops).

The average survey *household size* is 4.7 persons, i.e. far higher than the national average (NSO: 3.6, table 4.3 and section 2.3.1, table 2.6). The same is true for the sub-samples: the average household size in Bangkok is 4.9 (NSO 3.3), North 4.3 (NSO: 3.2), and Northeast 4.6 (NSO: 3.7). A straightforward explanation for the large size is currently not available. However, the simultaneously reported low number of children per household suggests that the specifications include servants and/or other relatives.

Table 4.2 Socio-economic characteristics of the survey (question 32-34, appendix 3)

Socio-economic characteristic	Total		Bangkok		Chiang Mai		Khon Kaen	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Q32: Education								
- No schooling	7	0.5	5	0.8	1	0.3	1	0.3
- Primary school (4 years)	78	5.9	39	6.9	18	6.0	21	5.4
- Primary school (6 years)	77	5.8	30	5.3	26	8.7	21	5.4
- Secondary school (9 years)	74	5.6	36	6.3	21	7.0	17	4.4
- Secondary school (12 years)	119	9.0	43	7.6	46	15.3	30	7.8
- College	242	18.4	98	17.3	50	16.6	94	24.4
- Bachelor's degree	605	45.9	307	54.1	122	40.5	176	45.7
- Master's degree or higher	110	8.3	73	11.5	16	5.3	21	5.5
- Other	8	0.6	3	0.5	1	0.3	4	1.1
No. of observations	1,320	100.0	634	100.0	301	100.0	385	100.0
Q33: Occupation								
- Housewife	190	14.6	111	17.6	40	13.6	39	10.5
- Student	145	11.2	36	5.7	20	6.8	89	24.1
- White collar	580	44.8	323	51.2	124	42.0	133	35.9
- Blue collar	336	25.9	131	20.7	107	36.3	98	26.5
- Retired	23	1.8	15	2.4	3	1.0	5	1.4
- Unemployed	22	1.7	15	2.4	1	0.3	6	1.6
No. of observations	1,296	100.0	631	100.0	295	100.0	370	100.0
Q34: Household size (average)	(4.66)		(4.86)		(4.29)		(4.63)	
- 1 person	20	1.5	12	1.9	6	2.0	2	0.5
- 2-4 persons	694	52.6	312	49.2	181	60.1	201	52.2
- 5-7 persons	498	37.7	240	37.9	101	33.6	157	40.8
- More than 8 persons	108	8.2	70	11.0	13	4.3	25	6.5
No. of observations	1,320	100.0	634	100.0	301	100.0	385	100.0

Table 4.2 Socio-economic characteristics of the survey, continued (question 34-35, appendix 3)

Socio-economic characteristic	Total		Bangkok		Chiang Mai		Khon Kaen	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Q34: Number of children (average)	(0.30)		(0.28)		(0.26)		(0.36)	
[up to 5 years]								
- No child	1,012	76.6	497	78.4	235	78.1	280	72.7
- 1-2	298	22.6	133	20.9	65	21.6	100	26.0
- 3-4	10	0.8	4	0.7	1	0.3	5	1.3
No. of observations	1,320	100.0	634	100.0	301	100.0	385	100.0
Q35: Household income levels [per month]								
- Less than 8,000 THB	87	6.6	14	2.2	31	10.3	42	10.9
- 8,001-20,000 THB	340	25.8	113	17.8	93	30.9	134	34.8
- 20,001-40,000 THB	380	28.8	175	27.6	84	27.9	121	31.4
- 40,001-70,000 THB	266	20.1	158	24.9	54	17.9	54	14.0
- 70,001-100,000 THB	93	7.0	65	10.3	15	5.0	13	3.4
- 100,001-200,000 THB	84	6.4	67	10.6	8	2.7	9	2.3
- More than 200,000 THB	42	3.2	31	4.9	10	3.3	1	0.3
- No answer	28	2.1	11	1.7	6	2.0	11	2.9
No. of observations	1,320	100.0	634	100.0	301	100.0	385	100.0
Average income per month								
- per household	46,780		60,126		39,033		30,660	
- per person having income	20,943		26,377		18,166		13,842	
- per person	10,885		13,488		9,464		7,671	

Source: Consumer survey

The collected data on *income distribution* reveal a wide range of monthly income per household, e.g. 80% of the reported household income in the overall survey is between 8,000 and 100,000 THB per month (40 THB = 1 US dollar, approximately). The income distributions for the whole survey, as well as for the sub-samples, show the well known skewness, with high frequencies for low income classes – more pronounced for the North (Chiang Mai) and Northeast (Khon Kaen), and less distinct for Bangkok. However, the household income level in the survey is significantly above the official NSO data for 2002 (see section 2.3.2, table 2.7): according to NSO, the average income for the Kingdom was 13,700 THB (our survey averages 20,900 THB). For Bangkok and Vicinity NSO was 26,800 THB (survey for Bangkok 46,780 THB), for the North 9,500 THB (survey for Chiang Mai 18,200 THB) and for the Northeast 9,300 THB (our survey for Khon Kaen 13,800 THB). The comparatively high income figures for survey households can be understood by recognising the pronounced inequality of income between the rural poor in the regions and the evolving middle and higher income classes in the cities, due to the relatively high educational level of the survey respondents. Additionally, the selected sample points are outlets for high priced quality products. Consequently, interviewees will most likely belong to the middle and higher income classes of the trading area.

4.2.2 Aspects of vegetable consumption attitudes, habits, and behaviour

In order to generate more background information on consumer attitudes, habits and behaviour, we collected information about their total food consumption, vegetable consumption expenditure, vegetable shopping habits and shopping behaviour in general (appendix 3, questions 1 - 7). Additionally, we tried to assess attitudes towards risks caused by chemical residues and associated coping strategies (questions 9 – 12). In this context, respondents were especially asked about EFPV: about their knowledge of EFPV, their EFPV-purchasing behaviour and the reasons behind it (questions 13 – 21). Similarly, we addressed knowledge and attitudes towards labelling (questions 22 – 25). A summary of the findings on all these aspects is presented in the next sections of section 4.2. In contrast, the results with respect to the relative importance of vegetable attributes (question 8) are discussed in connexion with the conjoint experiment (section 4.3); and the double-bounded dichotomous choice question approach is dealt with in section 4.4 (contingent valuation).

4.2.2.1 Consumers' attitudes, habits and behaviour towards vegetables

In the hope that figures covering a shorter time period are easier to recall and therefore more reliable, we tried to assess the respondents' household *food consumption expenditure* by asking for the average weekly expenditure for total food consumption and for vegetables. We extrapolated the data collected by multiplying the weekly figures by four in order to obtain monthly data for comparison with the NSO Consumer Survey data presented in chapter 2 (section 2.3.2, table 2.7).

According to our calculations, *food consumption expenditure* of the average survey household is about 3,800 THB (appendix 5). However, comparison with NSO data indicates a noticeable overestimation (Bangkok and Vicinity 2,500 in 2002, see section 2.3.2, table 2.8), even though our average household size is larger than the NSO figure by about one person. The difference in expenditure may be explained by the fact that the official consumer surveys rely on relatively precise household accounting records, whereas our data are probably biased by wrong appraisal. In any case, it is really difficult to give precise ad hoc information. The same seems to be true for *vegetable expenditure*: according to our survey, households should have disbursed about 1,300 THB per month for vegetables, which is about one third of total food expenditure. In contrast, the NSO reported only some 240 THB (10 % of food expenditure). Hence, even if we account for the high proportion of our survey respondents affiliated to special consumer groups emphasising vegetables in their diet (see following paragraph), the customers' expenditure specification in our survey, as well as the calculated expenditure share, seems to be at least questionable.

In order to generate information on consumer attitudes and habits, we asked respondents additional questions. Firstly, we addressed the customer's *nutritional style* (appendix 6). Surprisingly, almost 28% of the respondents practised special diets attaching importance on food from crops: vegetarian (13.3%), Macrobiotics[4] (5.5%)

[4] Macrobiotics is known mainly as a balanced diet. The basic practices include eating more whole grains, beans, fruits and fresh vegetables, using traditional cooking methods, eating regularly and less in quantity, chewing more and maintaining an active and positive life and mental outlook. The term "macrobiotics" comes from Greek. It is a combination of "macro", meaning large or long, and "biotic" meaning related to life or living things, so the word refers to the "big view of life." (TREVENA K. and TREVENA J. 1998)

and Cheewajit[5] (8.9%). Therefore, we could assume that this relatively large share of interviewees was not only informed about health issues but should have been interested in EFPV and hence most likely to have participated seriously in the survey.

This appraisal was reinforced by the fact that 74% of total respondents at the same time *purchased and prepared* the vegetables for the household, suggesting competent knowledge of vegetable quality aspects concerning appearance, preparation and taste (appendix 6). The high percentage matches with the finding of 73% female respondents, playing the important role in choices for a household's food consumption, as is generally known.

However, urbanisation and double income in many families have changed people's lifestyle from exclusively *preparing food at home* to frequently *eating out* due to longer distances between their place of work and home, and lack of time for shopping and preparing food. In the survey, less than 20% of the households prepare every meal at home, with another 20% doing so only one to three times a week.

The *frequency of vegetables purchase* was two to three times a week on the average, but as many as 30% purchased vegetables at least once a day. This stresses once more the findings from the market analysis showing that vegetables are an important food item in Thailand, most often served with every dish, and hence consumers should have a sound knowledge of vegetables (see chapter 2).

In order to identify the preferred *retail outlet for vegetables*, customers were asked to classify the three most important specific sources of supply according to a respondent's frequency of vegetable purchases in: open markets, super- and hypermarkets, and green shops (we additionally asked for "others" to allow for mobile food stalls etc.). Respondents were requested to qualify each category independently using the ratings "almost always", "occasionally" and "never". However, many consumers answered "almost always" for more than one outlet. This is a somewhat strange result, but it might be explained by the unaided – and therefore obviously

[5] Cheewajit was introduced by Dr. SATIS INTARAKAMHANG popularized in Thailand since 1998. Cheewajit is an alternative naturopathy or Thai lifestyle concept linking health and even cancer prevention to the maintenance of one's immune system through healthy eating and living. Dr. SATIS invented a rejuvenating concoction approach and his natural herbal food that was popularized in the context of heightened awareness of cancer in Thai society (SINGTIPPHUN, 2002).

imprecise - question: most likely respondents qualified the different outlets as implicitly referring to different kinds of vegetables – a problem that was not anticipated and was not identified during the pre-test phase. Nevertheless, the results confirm that green shops are by far the least important type of retail outlet for vegetables, and they support the expectation that open markets are still the most important source of supply for vegetables in Thailand (only 8% of the customers declared that they never purchase vegetables at open markets).

4.2.2.2 Consumers' attitudes, habits, and behaviour towards EFPV

The main focus of the research was on EFPV, i.e. on vegetables produced in order to mitigate environmental damages and prevent human health hazards caused by the (over- and mis-) use of chemicals in conventional vegetable production. In order to address these aspects, we continued the questioning by identifying respondents' existing concerns and knowledge about residues, as well as their applied risk-coping strategies (appendix 3, questions 9–12). In a further step, we turned to special aspects of EFPV (questions 13-22).

The results obtained on consumers' *residue concerns* were somewhat puzzling at first sight (table 4.3, questions 9-12): on the one hand, an expected high proportion of respondents (87% out of a total of 1,320) professed to be concerned about residues from agricultural chemicals; and with respect to the four main residue groups specified in question 10, around 99% of the respondents being worried about residues were at least "concerned" about chemical fertiliser residues. Roughly 88% were ill at ease about pesticides, approximately 80% about heavy metals, and nearly 85% about pathogens (multiple answers admitted). Hence, chemical fertilisers and pesticides turned out to be the most critical residues from our respondents' point of view, followed by heavy metals (and pathogens, which, however, are at least not directly addressed by EFPV).

On the other hand, a surprisingly high 84% of the residue-concerned consumers conceded that they really don't know to evaluate nitrate residues. Again, a definitive explanation for this seemingly contradictory result is not at hand. However, consumers were most likely not in a position to associate the application of chemical

(nitrogenous) fertiliser in agricultural production with the transformed residual nitrate in food, presumably due to lack of knowledge.

Table 4.3 Consumers' concerns about residues (question 9-11, appendix 3)

Q9: Are you concerned about residues that remain in vegetables you consume?					
Percentage of respondents' answer					No. of observations
Yes		No			
86.5		13.5			1,320
Q10: Which one of the following residues are you concerned about?					
Are you aware of … ?	Percentage of respondents				No. of observations
	Very concerned	Concerned	Not concerned	Don't know	
Chemical fertiliser residues	72.7	26.4	0.6	0.3	1,143
Pesticide residues	39.6	48.0	7.0	5.3	1,143
Heavy metal residues; e.g. lead, mercury	50.2	30.0	12.4	7.4	1,143
Pathogens	40.6	44.1	12.6	2.7	1,141
Q11: Are you concerned about Nitrate residues?					
Percentage of respondents' answer					No. of observations
Yes		No		Don't know	
13.0		2.7		84.3	1,143

Source: Consumer survey

This interpretation – not understood or misconceived nitrate question due to lack of knowledge - is encouraged by the findings about the *vegetable dressing strategies* for cooking (table 4.4, question 12). Not surprisingly, almost each and every survey respondent declared they wash vegetables before cooking, a commonly known strategy of housewives and cooks all over the world in order to free vegetables from soil residues and pathogens.

Table 4.4 Consumers' vegetable dressing strategies for cooking (question 12, appendix3)

Q12: Usually, how *do you* clean your vegetables before cooking? (multiple answers allowed)			
Method	Percentage of respondents		No. of observations
	Yes	No	
No washing	0.4	99.6	1,320
Soak in water	64.5	35.5	1,320
Wash under running water	39.7	60.3	1,320
Wash with natural liquid	25.8	74.2	1,320
Wash with chemical liquid	32.0	68.0	1,320

Source: Consumer survey

Nevertheless, even having regard multiple answers, at least approximately one third of our respondents apply special dressing methods in order to cope with residues more specifically. Washing with rice rinsing water, saline solution or vinegar ("natural" liquids), and using special preparatory liquids ("chemical" liquids) such as potassium permanganate solutions, baking soda, vegetable washing liquids etc. to clean vegetables before cooking (table 4.4). This result militates in favour of consumers' awareness of residues and indicates that they address this problem by a number of specific strategies in order to reduce at least surface residues on vegetables. Hence we may conclude that EFPV should be highly valued by an important proportion of consumers, for the central characteristic of EFPV is low or no chemical residues.

The next step was to determine consumers' *overall perception of EFPV*, so far not directly addressed by the survey (appendix 7). In order to assist respondents and to standardise the answers, we provided different definitions for EFPV and asked them to select one of the statements or to give a subjective definition. According to the results, some 18% of the respondents equated EFPV with vegetables produced without any chemical input and handled post-harvest with special care to avoid any chemical contamination, i.e. organic. Additionally, almost 36% identified EFPV as vegetables grown without any chemical fertilizer and pesticide use. Another 17% selected the attribute 'produced without using pesticides', and about 13% argued that EFPV are produced with fewer pesticides. Hence, almost 85% of all respondents seem to have a more or less correct idea of the main characteristics of EFPV. These findings match

quite well with the conclusion drawn from the market description in chapter 2, where we emphasized the wide variety of differently advertised EFPV[6].

Referring to the definitions approved by respondents, it is not surprising that health concern is the dominant *driving force to purchase EFPV*: about 85% indicated this incentive to be most important, and more than 90% agreed or strongly agreed to the statement "pesticide use in vegetables increase health hazards" (appendices 9 –11).

Actually, consumers also give consideration to the special *packaging and labelling* activities of producers and vendors (table 4.5). More than 83% of the interviewees look for packaging, and 43% simultaneously pay attention to package, certificate and brand name. The results further indicate that certificates are more important than brand names, and that packaging by itself is by no means sufficient to attract consumers' interests and induce purchases. This, again, militates in favour of our findings in chapter 2 that labelling is an important activity of the supply side, but that the manifold certificates, labels and brand names might cause information overflow and thus consumers' uncertainty at the same time.

Table 4.5 Importance of packaging and labeling for EFPV purchase decision (question 13, appendix 3)

Q18: Concerning the presentation of EFPV, what aspects of appearance do you usually take into account when buying EFPV? (multiple answers allowed.)	
Package	Percentage of respondents
No packaging	16.7
With packaging but no brand name and certificate	4.3
With packaging and certificate	30.1
With packaging and brand name	5.7
With packaging, certificate and brand name	43.2
Does not pay attention	0.4
No. of observations	1,120

Source: Consumer survey

[6] In order to complete the information on consumers' purchasing behaviour with respect to EFPV, we asked *complementary questions* about the frequency of purchasing EFPV per week and about the reasons for the reluctance of consumers never or only rarely buying EFPV. The descriptive results are summarised in appendix 8.

To generate more in-depth information on the *importance of labelling* from the consumers' point of view, we challenged respondents to recall certificates, labels, and/or brand names from memory without any aid. The results reveal that more than half the respondents did know the term "organic" (table 4.6), and more than one third knew Doi Kham – the brand name and certificate ("safe") of the Royal Project Foundation[7]. On the other hand, a total of 56 different brand names, certificates and/or labels were mentioned, and the frequencies were each below 4% (total respondents answering this question: 1,035). Consequently, except for the non-specific "organic" and the specific Royal Project, unaided recall of labelling in general is only marginal.

[7] Please note: the graphical representations of the most frequently given labels have been added to table 4.6 just to assist readers to evaluate the quality of the answers; respondents obviously were also somewhat familiar with the associated logos. Moreover, please keep in mind that the interviewees were asked to name firstly one and then successively more labels. In table 4.6 only the frequencies of the label notified at first are reported. However, the general situation does not change when accumulating the data for the first three positions.

Table 4.6 Consumers' knowledge of different labels (questions 22, appendix 3)

Q22: Which certificates or/and brands of pesticide-safe vegetables you know?[1/]		
Brand name (first name)	Percentage of respondents [2/]	Illustration [3/]
1. *Organic*	54.8	 The respondents named "*Organic*" which is the wording appearing on packages, e.g. on the Lemon Farm's product.
2. *Doi Kham* (Royal Project's brand name)	34.7	 *Doi Kham* is the brand name of the Royal Project that is very popular in Thailand. *Doi Kham* is available in the big supermarkets, hypermarkets, and some green shops
3. *Doctor's Vegetable*	3.8	 *Doctor's Vegetable* was appeared in the market in 1993 as the first brand name of pesticide-safe vegetable in Thailand. Nowadays, they have 1,500 rai of production area. Their products are displayed in 2 big supermarkets (TOPs and Foodland) and 2 hypermarkets (BigC and Tesco Lotus).
4. *Aden*	1.2	*Aden* is used as the brand name of Aden shops. Aden shop is the green shop, which has 8 branches in Thailand (in 2004).
5. *Sarapee*	0.9	*Sarapee* is the local brand name of pesticide-safe vegetables in Chiang Mai.
6. Walter (TOPs's brand name)	0.5	 *Khun Walter* is promoted as the great produce expert of TOPs ("invisible spokesman") who was supposed to ensure the highest quality produce for TOPs'consumers.
No. of observations	1,035	(first place of notified labels)

Note: [1/] Unaided question-There was a total of 56 brand names stated by respondents.
[2/] The listed six labels cover almost 96% of the given first responses.
[3/] The descriptions of labels were not presented to respondents.
Source: Consumer survey

The next step consisted of an assessment of consumers' knowledge, aided by the presentation of different (existing) labels (table 4.7):

Table 4.7 Knowledge of labels and buying decisions for EFPV (questions 23, appendix 3)

Q24: Which certificate or/and brand do you know? (Pictures of certificates and packages were presented)					
Picture of certificate and package	Percentage of respondents			No. of observations	Description [1/]
	Know & buy	Know & never buy	Don't know & never buy		
	24.6	9.6	65.8	1,036	DOAE (pesticide-safe vegetables)
	22.0	8.2	69.8	1,036	DOAE's official seal/logo (pesticide-safe vegetables under IPM-rules)
	39.7	6.3	54.1	1,036	DOA (hygienic vegetables, pesticide-safe vegetables)
	18.6	6.3	75.1	1,036	MOPH (internal quality control system, pesticide-safe vegetables)
	14.0	7.4	78.6	1,034	CP (pesticide-safe vegetables)
	74.4	7.6	18.0	1,035	Royal Project's package (pesticide-safe, organic vegetables,)
	12.4	5.0	82.6	1,032	CP's package (pesticide-safe vegetables)

Note: [1/] see more details of the certificates in section 2.4.3

Source: Consumer survey

In line with the results from the unaided approach, the logo for the Royal Project Foundation (Doi Kham) was the most commonly known label: almost 75% of all consumers indicated they know - and buy - vegetables certified and sold under the band name Doi Kham and consider them to be "safe". Doi Khum's products have been controlled by an internal quality control system, the so-called "Plant Protection Center (PCC)", which is certified by MOPH (logo (f) in chapter 2). PPC has arranged for pesticide residue analysis immediately before harvesting and again at a PPC laboratory before dispatch to the market in order to ensure that the products are safe for consumers.[8] The second place is held by the certificate from DOA qualifying the vegetables of the specified members (suppliers) as "safe", too. Products bearing the two DOAE certificates ("safe", and without specific emphasis on "safe" or "free", but produced under IPM-rules) are known and bought by some 20% of the consumers each. It is interesting to note that the certificate controlled by the MOPH does not gain more importance, although it is placed on the vegetables sold under Doi Kham. The findings show that consumers are relatively well informed about EFPV and the different sources of supply.

The importance of labelling is reinforced by the fact that more than half the respondents emphasised that certificates create faith in the quality of the certified product, and about 40% choose well-known brands (table 4.8). Both these results confirm the general findings in other countries that labelling - and brand recognition – as well as certification in order to create credibility and attain consumers' confidence, are central marketing tools to promote experience or credence goods not being per se search goods.

[8] Crop production specialists and plant protection advisors who regularly visit farmers' planting plots control production process under IPM-rule (With the rise of organic product demand, some planting plots are cultivated under Organic Thailand standard rules). There are two methods have been applied to analyse the pesticide residue by the GT test kit and chromatography. Firstly, a rapid test method by GT test kit is used to check a production area before harvesting and again in the laboratory. If a pesticide residue higher than FAO CODEX maximum is found, the sample is rechecked three times. Secondly, the toxic product will be checked again by using Gas Chromatography and High Performance Liquid Chromatography. If the results are still above the limits, the contaminated products will be rejected and destroyed (official visiting at Royal Project in Chiang Mai on the 22nd July, 2005 and see more details about Royal Project at http://kanchanapisek.or.th/kp12/index_e.html).

Table 4.8 Role of EFPV-labelling in purchase decision

Q24: What are the reasons to choose the certificate or/and brand *s? (*respondents who answered "don't know & never buy" (Q23) excluded). (Multiple answers allowed.)	
Reason	Percentage of respondents
Trust in the certificate	53.9
Well known	40.7
Cheaper than similar product	4.0
Easy to find in the market	39.5
Higher quality than other certificates/brands	20.2
No. of observations	932

Source: Consumer survey

4.3 Evaluation of Consumer Preferences for EFPV: Conjoint Analysis

The first part of the more sophisticated analyses of survey data addresses the *product characteristics stimulating* consumers to enter into a purchase decision for vegetables in general and for EFPV in particular.

4.3.1 Selection of characteristics relevant to vegetable purchase decisions

The theory of consumer purchase decision-making postulates that customers perceive goods - in our case vegetables - as bundles of utility-creating attributes with different levels. Customers are assumed to value the different levels of attributes at the goods available for purchase and to aggregate the corresponding part-worths to give overall values for the products (see section 3.2.1 and figure 3.3). These overall values of the goods supplied enter the decision-making process of consumers, where they are compared with the customers' individual needs, preferences, and other options to result in the optimal choice. In our case of vegetables, for example, consumers in general may pay attention to various combinations of different levels of appearance, freshness, taste, safety levels, trademarks, cachets from private and public organisations, designation of origin, price, and the like.

In order to assess the relative importance of factors relevant to purchasing decisions on EFPV, we followed a two-tiered approach of selection and evaluation. In the first step, we identified factors most likely to be important in the purchase vegetables in general and EFPV in particular. The selection was based on the results of the preparatory and pre-test phase and supported by findings of the market report. Referring to the purchase decision on *vegetables in general*, six factors have been accepted in this first phase for further evaluation in the survey - the second step: freshness, appearance, geographical origin, certificate, price, and family's preference. The first two factors are typical vegetable characteristics, the third and fourth factor are indicators able to create confidence and credibility. The fifth factor (price) is the central economic variable; and the sixth factor reflects a household's overall propensity to consume vegetables, which was expected to be relatively highly ranked due solely to the fact that non-shoppers of vegetables were excluded from the survey by the first question (see appendix 3, question 1, and section 4.1.3).

With respect to the attributes most important for causing consumers to purchase *EFPV in particular*, we pre-selected the following three factors in order to a priori constrain the fractionated design and to facilitate the feasibility of the in-depth conjoint approach: certificate, price, and chemical residues. Hence, we included only two out of the six general factors most likely to significantly affect vegetable purchase decisions in general (certificate and price), and we added the attribute degree of "chemical free" to account for the central characteristic of EFPV, i.e. to be less polluted by chemical residues than conventionally produced vegetables. The exclusion of freshness, appearance, and family's preference was justified by the pre-test results indicating that these attributes are barely capable of differentiation between EFPV and conventionally produced vegetables. And with respect to geographical origin, closer market appraisal and discussions with store managers revealed that until now this attribute actually exists only with carrots, although, even in this case, the geographical origin is favourable only in terms of the non-specific notation "upland carrots". Therefore, pre-test results had to be qualified: the stated preference for geographical origin in the pre-test seems to be primarily based on the special case of carrots[9]. On the other hand, however, we believe that geographical origin might be an additional characteristic for future enhancement of product differentiation. Experience from other countries, for example from the EU, supports this point of view.

The second step in evaluating the pre-selected six general factors relevant to vegetable purchase decisions consisted of asking participants in the main survey to score the selected six general stimuli for vegetable purchase (including the potentially differentiating attribute geographical origin) by a school-grades system (identical scores for different attributes were allowed, appendix 3, first part of question 8)[10] [11]. In

[9] By the way, the minor existing labeling of geographical origin is undoubtedly connected to the lack of package engineering activities with vegetables in general, and the identification marking on the packages of EFPV up to the present concentrates on residue characteristics and certificates, but does not differentiate with respect to geographical origin.

[10] The question was asked before the interview explicitly turned from the residue and health problems, to the special issues of EFPV and certification in detail in order to prevent survey and interviewer bias, e.g. towards certification. Additionally, after having asked the respondents to value the items independently, they were asked to rank the six factors comparatively. According to this second step, not published here, the sequence did not change, although the attribute appearance received the last lowest, falling again markedly behind the fifth rank (geographical origin).

[11] The second step to assess the relative importance of the three factors relevant for purchasing EFPV was subject-matter of the conjoint experiment (section 4.3.2).

order to detect existing distinctions between respondents who always purchase EFPV and those who don't, the whole sample data was split into these two consumer groups. The graphical representation of the average scores for the six attributes in the two groups reveals that freshness is the most important attribute of vegetables, noticed by all consumers, followed by family's preference, and that geographical origin is the least scored attribute, as expected (see figure 4.1).

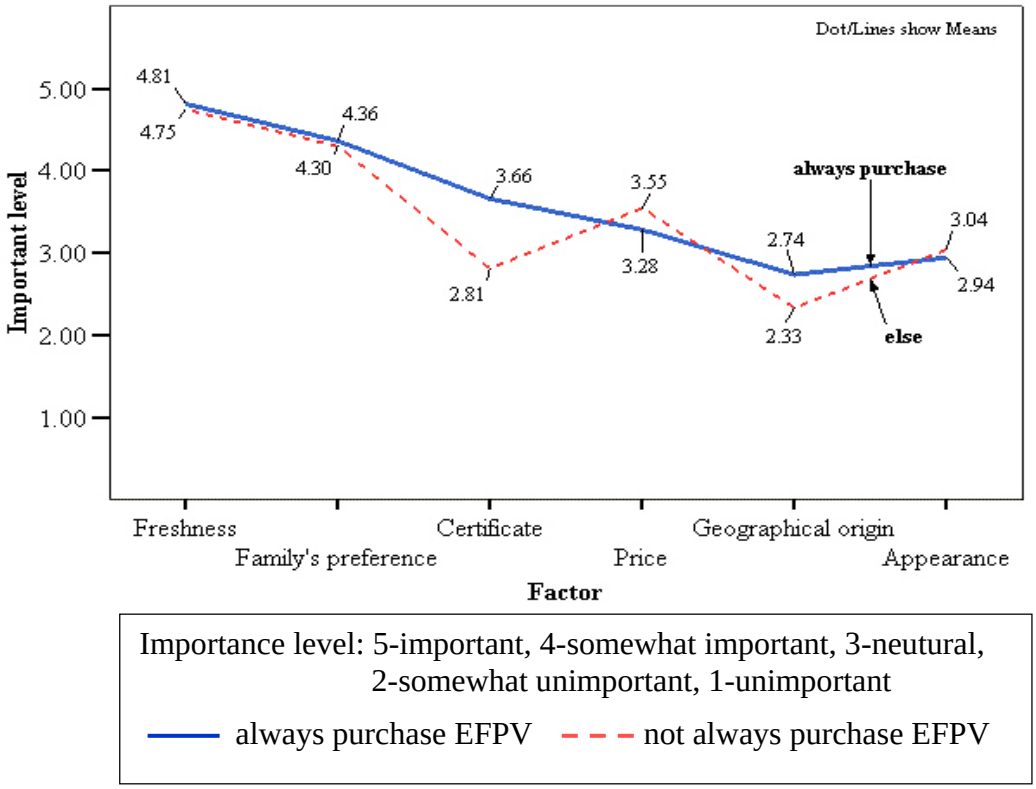


Figure 4.1 Average importance of factors affecting vegetable purchase in general by consumers always buying EFPV and others

Source: Consumer survey

The absolute differences in the scores for the two highest valued characteristics between the two consumer groups are negligible, and therefore these differences seem to be economically of little significance. The same is true for appearance, which, again, is almost identically valued by the respondents in both consumer groups. However, in contrast, the average scores for certificate, price, and geographical origin show distinct differences between the two consumer groups: certificate and geographical origin are noticeably higher, and price is clearly lower valued by consumers always buying EFPV as compared to the other group. Hence, in principle,

these attributes should most likely contribute to the discrimination of EFPV buyers from non-buyers.

In order to re-check the descriptive results, we applied the Wilcoxon-Mann-Whitney test to the two sets of data for each of the six characteristics[12]. The outcome of the test confirms the general visual impression from the diagrammatical depiction (table 4.9):

Table 4.9 Test on equality of mean scores for important factors for vegetable purchase between consumers who always purchase EFPV and others (appendix 3, question 8)

Factor	**Mean rank of importance in the group of consumers who …**		**Comparison of importance mean rank between two groups**	**Mann-Whitney test**
	… always purchase EFPV (group 1)	… not always purchase EFPV (group 2)		
Freshness	4.81	4.75	group1>group2	Sig. at α =0.01 Reject H_0
Family's preference	4.36	4.30	group1>group2	Non-sig. at α =0.01 Accept H_0
Certificate	3.66	2.81	group1>group2	Sig. at α =0.01 Reject H_0
Price	3.28	3.55	group1<group2	Sig. at α =0.01 Reject H_0
Geographical origin	2.74	2.33	group1>group2	Sig. at α =0.01 Reject H_0
Appearance	2.94	3.04	group1<group2	Non-sig. at α =0.01 Accept H_0

Source: Consumer survey, (see details in appendix 12)

[12] The Wilcoxon-Mann-Whitney (or Mann-Whitney) test is a non-parametric test used to inspect whether two samples originate from the same population and presupposes at least ordinal-scaled data. The criterion W_x is based on a rank-transformation of the merged sample data and compares the rank-sums of the samples. In case of large samples (at least one sample size needs to exceed (only!) 10) the distribution of the standardized W_x converges to the standardized normal (http://www.ai.wu-wien.ac.at/usr/ebner/archive/derfl/seminar/node1.html). – Alternatively, we could have used the Kruskal-Wallis test, which is a nonparametric analogue to ANOVA. It can be viewed as ANOVA based on *rank-transformed data*. That is, the two sample t-test is a test of the hypothesis that two population means are equal. The initial data are transformed to their associated ranks before being submitted to ANOVA. (http://www2.sjsu.edu/faculty/gerstman/StatPrimer/anova-b.pdf). The two tests generate the same results for testing on equality of mean between two groups.

The null (no difference between the average scores) is rejected at the defined 1%-significance level for freshness, certificate, price, and geographical origin, but accepted for, family's preference, and appearance. Thus, the findings demonstrate that respondents of the first group (always purchasing EFPV) are more familiar with certificates and geographical indications, and they value freshness (although in absolute terms only slightly) more than consumers of the second group ("other consumers"). Furthermore, EFPV consumers are more likely to accept a price premium for EFPV as compared to the second group of "other consumers". This statement, however, does not include the fact that price is of minor interest for consumers in the first group. The average scores alone indicate that price setting is not as important as certification for members in the first group, and that price for this group is less important than for the second group. In contrast, consumers not or not always buying EFPV score price significantly higher than certificate.

Recapitulating, the results of the consumer survey reveal four crucial aspects in favour of the pre-seleted factors relevant to vegetable purchase decisions in general, and they justify the choice of the three specific factors to compose the conjoint experiment for EFPV. Firstly, referring to the average scores above mean (3 = "neither important nor unimportant", i.e."neutral valuation") in both consumer groups set up, we apparently pre-selected at least four major factors influencing general vegetable purchase decisions: freshness (average scores 4.81 for "always buyers" and 4,75 for "others consumers"), family's preference (4.36 and 4.30 respectively), certificate (3.66 and 2.81), and price (3.28 and 3.55). Secondly, the high and significantly different scores for certificate and price between the two groups confirm the appropriateness of the pre-selection of these two factors to run the conjoint experiment. They not only turned out to be important for vegetable purchase in general, but are most likely to be particularly relevant for the EFPV purchase decision as well. Thirdly, the very small – although significant - difference in the highest scored attribute "freshness" between the consumer groups (4.81 and 4.75) supports our decision to disregard this atrribute as a major discriminating factor in the conjoint experiment: the discriminating power with respect to the demand for EFPV as compared to conventionally produced vegetables should be very limited. Finally, the failure by producers to mark vegetables to emphasise their geographical origin is justifiable - not only because of its virtual

non-existence in the market (s.o.) but in view of the lowest scores among all six factors investigated, showing a tendency to “unimportant” (average scores of 2.74 for EFPV-buyers and 2.33 for other consumers are both below the mean score of 3 = “neither important nor unimportant”). Against this background, the significant difference in scores for “geographical origin” between consumer groups also seems to be not important for the present research, although it could be an interesting starting point for further marketing activities of vegetables in general and for EFPV in particular.

4.3.2 Evaluation of specific attributes of EFPV: Conjoint experiments

4.3.2.1 Selection of attributes and general design of the experiments

In economics, conjoint analysis is used to evaluate the relative importance of different levels of a set of attributes that stimulate consumers’ choices. The data necessary to run a conjoint analysis are generated by experiments. Survey participants are faced with varieties of one differentiated product, the varieties differing with respect to predefined levels of selected attributes (section 3.2.1).

The first step, therefore, is to decide on the *product* to be analysed. For our study of vegetables we selected “Chinese cabbage”, a leafy vegetable well-known by Thai consumers. Hence, consumers would certainly have had some basic knowledge of and experience with the product selected for the experiment.

In a second step, the *attributes* of Chinese cabbage were specified, building on the results so far produced. The in-depth analysis in the previous section uncovered two crucial factors almost surely affecting demand for EFPV in particular: certificate and price (4.3.1). Additionally, pre-test and market description in section 2.4.2 emphasised the wide range of differently produced vegetables on sale, the labels and claims for EFPV particularly focussing on the extent and level of chemical input use (“safe”, “free”, “organic”, and the like). Therefore, and being the most important characteristic of product differentiation for EFPV from producers’ and vendors’ point of view, the use of chemicals in production has been selected a priori to form part of the analysis. Ex post, this approach has been justified by the survey results as respondents emphasised their concerns about health problems and chemical pollution of vegetables

(section 4.2.2). Furthermore, consumers pointed out their special treatment of vegetables and tended to buy pesticide-reduced or even organically produced vegetables as coping strategies to prevent health hazards (section 4.2.2 and appendix 3, questions 9 et sqq.). Theoretically, we could have added one or two other factors, for conjoint analysis in principle is able to handle numerous attributes and their levels simultaneously. In empirical analysis, however, we generally limit the number of attributes and levels, because the number of combinations of these increases disproportionately with their numbers, and the risk of overwhelming respondents also dramatically increases. Therefore, in the present analysis, we decided on three attributes: price, certificate, and chemical input use.

In a third step we opted for *three different levels of each attribute*. The levels were based on pre-survey information, and the selected gradations were approved by experts consulted. The grades chosen to indicate different levels of *chemical residues* were “conventional” (no packaging or qualification at all), “pesticide-safe” (qualified on the package as “safe for consumption” or “no contamination over MRL”), and “organic” - denoted as “organically produced” on the package (table 4.10). The three different levels for the attribute *certificate* are “no certificate”, “government certificate”, and “company certificate” in order to allow for differentiation between the acceptance and credibility of public versus private/non-governmental certifying authorities[13]. Finally, the different *price* levels have been defined as percentage premiums on the basic price of 20 THB, which was about the representative market price at the time of data collection. The different premiums, again, have been checked by pre-test and experts’ opinions.

[13] During the survey period, there was only one private company (CP) certifying, although ACT (a NGO) had already started certification (see chapter 2.4.3). Vegetables with an ACT certificate were actually not available in the domestic market during the sample period.

Table 4.10 Attributes and levels in conjoint experiments

Attribute	Level
Chemical residue	Conventional (D_{11})
	Pesticide-safe (D_{12})
	Organic (D_{13})
Certificate	No certificate (D_{21})
	Government (D_{22})
	Company (D_{23})
Price	25% margin (D_{31})
	50% margin (D_{32})
	100% margin (D_{33})

Source: Own presentation

Even with just three different levels of the three different attributes, there is a remarkable total of $3^3 = 27$ different combinations of attribute-levels (appendix 13). This full set of 27 (full-factorial) combinations is by far too many different product varieties to be clearly ranked by respondents.

In order to avoid overwhelming respondents and hence to prevent generation of doubtful data, and at the same time satisfying the standard criterion of a parsimonious number of parameters in any quantitative analysis, the full profile has been reduced by a so-called "orthogonal design" allowing for a statistically independent selection and estimation of principal effects (UNIVERSITAETS-RECHENZENTRUM TRIER, 1997, p. 4 and section 3.2.1). In our case, the program SPSS was used to randomly generate a particular fraction of the full profile, consisting of nine combinations of attribute levels extracted from the 27 possible combinations. These nine well-defined combinations identified by the orthogonal design have been used to prepare so-called "plan cards" containing a picture of Chinese cabbage and a brief verbal description of the attribute levels. We deliberately decided not to use (potentially emotive) pictorial representations of certificates and labels in order to prevent biased responses.

The *conjoint experiment* consists of asking the respondents to rank the nine plan cards according to their preferences, starting with the most preferred product variety (rank 1) and ending up with the least preferred product variety (rank 9).

In empirical conjoint analysis, price is looked upon as a somewhat critical variable (RAO and MONROE, 1989, TELLIS, 1988, ERICKSON and JOHANSON, 1985). The reason

is the ambivalent role of price in consumers' decision-making processes: on the one hand, price is quite commonly used as a quality signal, i.e. consumers implicitly or explicitly infer a higher quality from a higher price, hence increasing the likelihood of buying the product. On the other hand, price is one crucial monetary constraint in a consumer's choice; hence there exists at the same time a negative relationship between price and purchase probability. Consequently, we are unable to separate the quality aspect from the constraining feature of price. Instead, we tend to measure the net effect of both (GUSTAFSSON et al., 2000. p.47-49). Therefore, and in order to take care of possible excessive price effects on the rankings, we ex ante decided to design two different conjoint experiments. The first approach was to carry out the conjoint experiment including the price attribute, while the alternative excluded the price attribute. In both experiments, respondents had to evaluate the complete set of nine combinations of the three levels of chemical residues and certificate, generated by the orthogonal design routine in SPSS. However, in the first round, these nine product variants had also been combined with different price levels simultaneously assigned by the orthogonal design (product variants generated for both experiments and corresponding plan cards established, see appendices 14-17).

4.3.2.2 Consumer preferences for EFPV: Conjoint analytical results

As pointed out in section 3.2.1, the OLS method of SPSS was applied to estimate the parameters of the conjoint models explaining the overall value W (measured in terms of ranks) of the r=9 different product variants by their specific attribute-level-combinations generated through the orthogonal design:

$$W_r = \beta_0 + \sum_{j=1}^{3} \beta_{1j} D_{1j} + \sum_{k=1}^{3} \beta_{2k} D_{2k} + \sum_{m=1}^{3} \beta_{3m} D_{3m}$$

The variables D denote three indicator variables (dummies) defining the presence (1) or absence (0) of the respective levels (j, k, m) of the attributes considered: chemical residue (index 1), certificate (index 2), and price (index 3). The parameters β_{1j}, β_{2k}, and β_{3m} are the part-worths of the attribute-levels to be numerically estimated by OLS. From a computational point of view, the constant term β_0 is just the mean rank for the product variants (in our case the average of the ranks r = 1,..,9, i.e. 5.0), but one might try to interpret the estimate as the value of some sort of "base-product" serving as a

reference to measure divergences from the base-product attributable to the variation of attribute-levels.

In order to account for possible regional differences we ran four different models using (1) the whole set of survey data as well as the data for the three cities (2) Bangkok, (3) Chiang Mai and (4) Khon Kaen for comparison. The results are summarised in table 4.11.

The *general test statistics* show that the models are able to adequately represent the data generating process of respondents' ranking: Pearson's R as well as Kendall's τ indicates an excellent fit of the four data sets; the values are significantly different from zero even at a level well below 0.1% (table 4.11, and for details see appendices 18-25). Furthermore, most notably, the results for the models including and excluding the price attribute are *economically* convincing in each and every case; they are *meaningful and substantial*. To exemplify the reasonability of the findings, we will explicitly value the estimates for the models for the total sub-set of data *including price* first and discuss the model excluding the price and the different regional models afterwards.

According to the commonly used statistic "*average importance*", measured in terms of the attribute-specific spans of the part-worths for the different levels relative to the sum of total spans of all levels and attributes considered, certificate is most important, accounting for almost 46% of the total value. Chemical residue is the second important covering about 37% of the overall value, followed by price at a remarkable distance (share almost 18%). This importance grading is really plausible: certification is used to guarantee specific characteristics labelled on the package; hence it should get the highest rank, followed by the chemical residue attribute, which represents the special quality warranted - and hopefully controlled by the certification authority. The price undoubtedly is relevant because of its economic importance. However, as already pointed out, the estimates generated for the price influence are compound effects of most likely prevailing simultaneous positive and negative impacts on the overall value (rank) of a product variant, caused by the perception that a higher price implies higher quality (irradiation), and the economic role of price. From this it follows that the price effect should be relatively low compared to the other attributes.

Table 4.11 OLS-results of conjoint analyses including and excluding the price attribute – Whole survey and three sub-samples (appendix 18-25)

Model		Chemical residues [2/]			Certificate [2/]			Price Premium [2/]			Average importance [3/]			Overall fit [4/]
	β_0 [1/]	Conv β_{11}	Safe β_{12}	Organ β_{13}	No β_{21}	Gov β_{22}	Comp β_{23}	25% β_{31}	50% β_{32}	100% β_{33}	Residue	Cert	Price	Pearson's R *Kendalls τ*
Total survey (n=1293)														
Incl. Price	4.996	-1.458	0.832	0.626	-1.615	1.231	0.385	0.395	0.320	-0.715	36.66	45.56	17.78	1.000***
Utility span		*2.290*			*2.846*			*1.111*						*1.000****
Excl. Price	4.999	-1.797	1.075	0.722	-1.932	1.482	0.449				45.68	54.32		0.998***
Utility span		*2.871*			*3.414*									*1.000****
BKK (n=629)														
Incl. Price	4.996	-1.505	0.836	0.669	-1.628	1.240	0.387	0.350	0.306	-0.656	37.67	46.14	16.18	1.000***
Utility span		*2.341*			*2.868*			*1.006*						*1.000****
Excl. Price	4.998	-1.777	1.063	0.714	-1.934	1.458	0.476				45.57	54.43		0.999***
Utility span		*2.840*			*3.392*									*1.000****
CM (n=290)														
Incl. Price	5.000	-1.409	0.776	0.633	-1.670	1.370	0.300	0.185	0.367	-0.552	35.57	49.49	14.95	1.000***
Utility span		*2.185*			*3.040*			*0.918*						*1.000****
Excl. Price	4.998	-1.780	1.022	0.758	-1.941	1.536	0.405				44.63	55.37		0.997***
Utility span		*2.803*			*3.478*									*1.000****
KK (n=374)														
Incl. Price	4.994	-1.417	0.868	0.549	-1.553	1.107	0.446	0.635	0.307	-0.942	35.04	40.78	24.18	1.000***
Utility span		*2.285*			*2.660*			*1.577*						*1.000****
Excl. Price	5.001	-1.843	1.134	0.709	-1.921	1.482	0.439				46.66	53.34		0.996***
Utility span		*2.977*			*3.403*									*1.000****

Note: [1/] average rank, constant basic utility of some base-product; [2/] part-worths of the attribute-levels; [3/] utility span of the attribute levels divided by the sum of spans for all three attributes. Total subset including price, for chemical residues e.g., [(0.832-(-1.458))/ (0.832-(-1.458))+ (1.231-(-1.615))+(0.395-(-0.715))]*100 = 36.66; [4/] 1st row:=Pearson's R, 2nd row=*Kendall's τ.* - ***Significance level $\alpha<0.0001$.

Source: Consumer survey

Looking more closely into the *marginal values of the different levels of the attributes* again reveals a reasonable gradation in principle (see table 4.11 and figures 4.2 and 4.3): with respect to the major attribute *certificate* the estimates confirm that "*no certificate"* has a relatively high negative impact. In contrast, "public" certification by governmental authorities greatly increases the overall value of Chinese cabbage. On the other hand, company (i.e. "private") certification is far less convincing. These findings are consistent with results frequently reported for industrialised countries (e.g. WIRTHGEN, 2003; BECKER, 2000). Referring to *chemical residues*, conventional production noticeably decreases the overall value of Chinese cabbage, whereas a pesticide-safe attribute causes the highest increase. At first glance, this result might seem strange, for (real) organic food is produced without any chemical inputs. However, at least at the time of the survey, organic food was not well known in Thailand, except by vendees in green shops: a good 85% of the respondents in our total survey were accustomed to buying pesticide-safe vegetables, but only about 18% knew the definition of organic vegetables and consumed higher standard products (question 14, appendix 3, see later table 4.14). On the other hand, the attribute "safe" combined with the precisely known hazardous residue "pesticide" was most likely to attract consumers effectively. Therefore, we accepted the higher value of "pesticide-safe" relative to "organic" and we tend to interpret this result as a good starting point for further powerful marketing activities for EFPV in between conventionally and organically produced vegetables. The results concerning the price levels seem equally plausible, although they are most likely biased due to the ambivalent characteristic discussed above. The estimates show that a lower price premium somewhat increases the total value of the product variant, but a higher premium causes a much more pronounced decrease in the overall value (table 4.11). Accordingly, a lower price increment for pesticide-safe or organic vegetables will stimulate the sales of EFPV and organic vegetables – as is often reported for industrialised countries. The price estimates underline the hypothesis developed in section 4.2.1 that price is an important variable influencing the purchase of EFPV.

Turning to the *regional* conjoint experiments including price, we observed almost identical results for Bangkok and the total subset with respect to all three attributes and their levels. Obviously, this follows solely from the relatively high proportion of data

from Bangkok in the subset. Including the other two cities into the comparison, however, we perceive diverging part-values worth mentioning for the price variable only, whereas the estimates for the part-worths of certificate and chemical residue vary only slightly and are most likely non-significant (table 4.11), The *price influence* in Chiang Mai tends to be lower compared to Bangkok (and to the total subset) - especially for the lower and the higher premium. On the other hand, the price influence in Khon Kaen tends to be somewhat higher than for Bangkok (and the total subset, and – quite understandably - more pronounced compared to Chiang Mai). This result may be due to special regional characteristics: Chiang Mai is the capital of the administrative region North, where vegetable production takes place and people are used to vegetable consumption that is well above country's average, i.e. vegetable prices are inclined to be below the national average and consumers tend to be less (vegetable-) price-sensitive due to higher preferences at the same time (appendix 5). With this background, the lower (positive) part-worths of the lower price premium and the lower (negative) impact of the higher price premium are reasonable. On the other hand, Khon Kaen is the capital of the administrative region North East, the region with significantly lower per capita income compared to Bangkok and Chiang Mai (appendix 5). Hence, consumers are assumed be more price-sensitive. In this context, the higher (positive) part-worth for the lower price premium and the higher (negative) impact of the higher premium again make absolute sense.

Comparing the results of the conjoint experiments including price with the results obtained for the design neglecting price, we found again quite reasonable and substantial results (figure 4.2 and 4.3): firstly, it goes without saying that dropping one variable would increase the relative importance of the remaining variables according to the criterion of average importance. Secondly, however, it is worth emphasising the unchanged ordering of importance; certificate now accounts for more than 50% of the overall values of the product variants whereas chemical residues account for some 45%. Thirdly, and importantly, the regional differences with respect to the levels of certificates and chemical residues tend to converge.

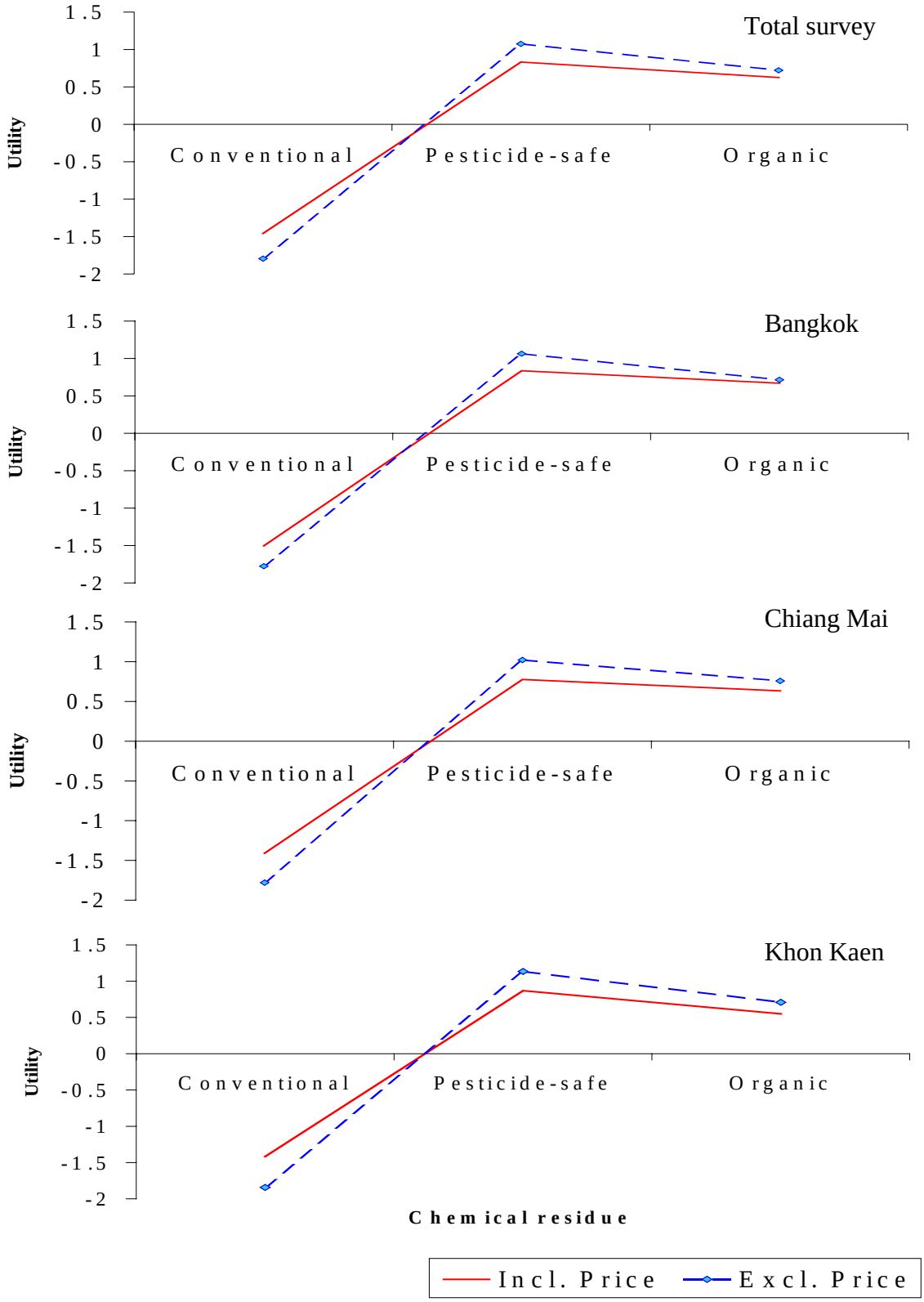


Figure 4.2 Part-worths of the levels of chemical residue-attribute in the conjoint analyses including and excluding price (OLS)

Source: Consumer survey

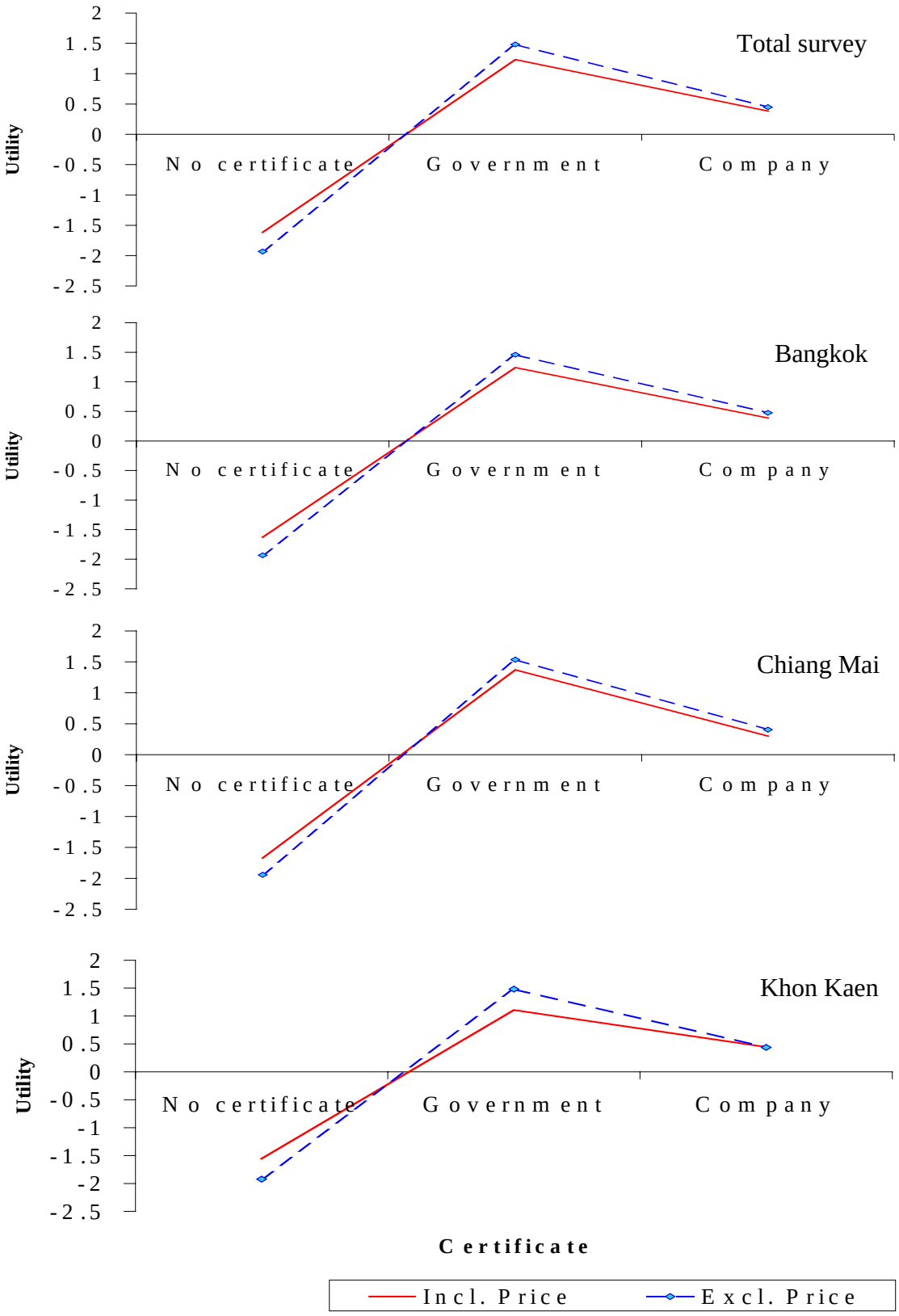


Figure 4.3 Part-worths of the levels of certificate attribute in the conjoint analyses including and excluding price (OLS)

Source: Consumer survey

Hence, we may conclude that the attributes certification and chemical residue are of almost identical importance throughout the regions included in our survey. Fourthly, quite interestingly, the part-worths of the levels of the attribute changed their importance (figure 4.2 and 4.3). The comparison reveals a value loss for conventionally produced vegetables with respect to both attributes when price is excluded, i.e. the negative impact on preferences is higher without price compared to the estimates including the price attribute. This result indicates that a lower price for conventionally produced vegetables might at least partly compensate for missing certification and lacking the characteristic of reduced residues. On the contrary, the noticeable increase in the part-worths for the levels of pesticide-safe and government certification confirm that price is actually important in the marketing of EFPV as well. At the same time, the only slight changes for private certification and organic vegetables reveal that the important attribute of certification is to be recommended and that organically produced food should be subject to labelling and certification in Thailand. Both these recommendations are comparable to the EU uniform labelling provisions established for organically produced food in the past.

Although we initially decided to follow common practice and set up the conjoint experiment a with view to applying OLS method (section 3.2.1), we finally re-organised the survey data in order to re-estimate the conjoint experiments. As pointed out in section 3.2.1, OLS presupposes metrically scaled endogenous variables in principle. Our endogenous variable, however, is ordinally scaled, for we used rankings to indicate the overall values of the product variants. Hence, from a methodological point of view, one should not use OLS but apply a method suited to estimate ordinally scaled variables. We followed this line of reasoning, and re-estimated the experiments using MONANOVA. As expected from the experience reported in the literature, the results generated for the models without price actually do not show conspicuous differences as compared to the OLS estimates – they are almost identical, (table 4.12; figures 4.4-4.6; appendix 26 and 27 for the model including and excluding price and the total subset of data).[14]

[14] The “city- models” show quite comparable similarities, hence we did not reproduce the detailed results in the appendix.

Table 4.12 MONANOVA-results of conjoint analyses including and excluding the price attribute – Whole survey and three sub-samples

Model		Chemical residues [2/]			Certificate [2/]			Price Premium [2/]			Average importance [3/]			Overall fit [4/]
	β_0 [1/]	Conv β_{11}	Safe β_{12}	Organ β_{13}	No β_{21}	Gov β_{22}	Comp β_{23}	25% β_{31}	50% β_{32}	100% β_{33}	Residue	Cert	Price	R-Square *F-Value*
Total survey (n=1293)														
Incl. Price	4.995	-1.516	0.917	0.598	-1.714	1.260	0.454	0.555	0.235	-0.791	36.02	44.05	19.93	0.461
Utility span			*2.433*			*2.974*			*1.346*					*1692.3****
Excl. Price	4.994	-1.818	1.085	0.733	-1.953	1.499	0.454				45.68	54.32		0.565
Utility span			*2.903*			*3.452*								*3853.5****
BKK (n=629)														
Incl. Price	4.993	-1.547	0.907	0.640	-1.721	1.258	0.463	0.493	0.247	-0.740	36.81	44.69	18.50	0.462
Utility span			*2.454*			*2.979*								*814.6****
Excl. Price	4.990	-1.788	1.066	0.722	-1.944	1.466	0.478				45.57	54.43		0.551
Utility span			*2.854*			*3.410*								*1749.2****
CM (n=290)														
Incl. Price	5.000	-1.481	0.848	0.633	-1.789	1.398	0.390	0.346	0.257	-0.603	36.03	49.30	14.67	0.458
Utility span			*2.329*			*3.187*								*381.1****
Excl. Price	5.001	-1.816	1.043	0.773	-1.980	1.567	0.413				44.63	55.37		0.576
Utility span			*2.859*			*3.547*								*919.4****
KK (n=374)														
Incl. Price	4.995	-1.489	0.985	0.504	-1.649	1.177	0.472	0.795	0.222	-1.017	34.79	39.73	25.48	0.475
Utility span			*2.474*			*2.826*								*521.3****
Excl. Price	4.993	-1.869	1.149	0.720	-1.948	1.503	0.445				46.65	53.35		0.579
Utility span			*3.018*			*3.451*								*1191.8****

Note: [1/] average rank, constant basic utility of some base-product; [2/] part-worths of the attribute-levels; [3/] utility span of the attribute levels divided by the sum of spans for all three attributes. Total subsets including price, for chemical residues e.g., [(0.917-(-1.516))/ (0.917-(-1.516))+ (1.260-(-1.714))+ (0.555-(-0.791))]*100 = 36.02; [4/] 1st row:= R-Square, 2nd row= *F-Value* - ***Significance level α<0.0001.

Source: Consumer survey

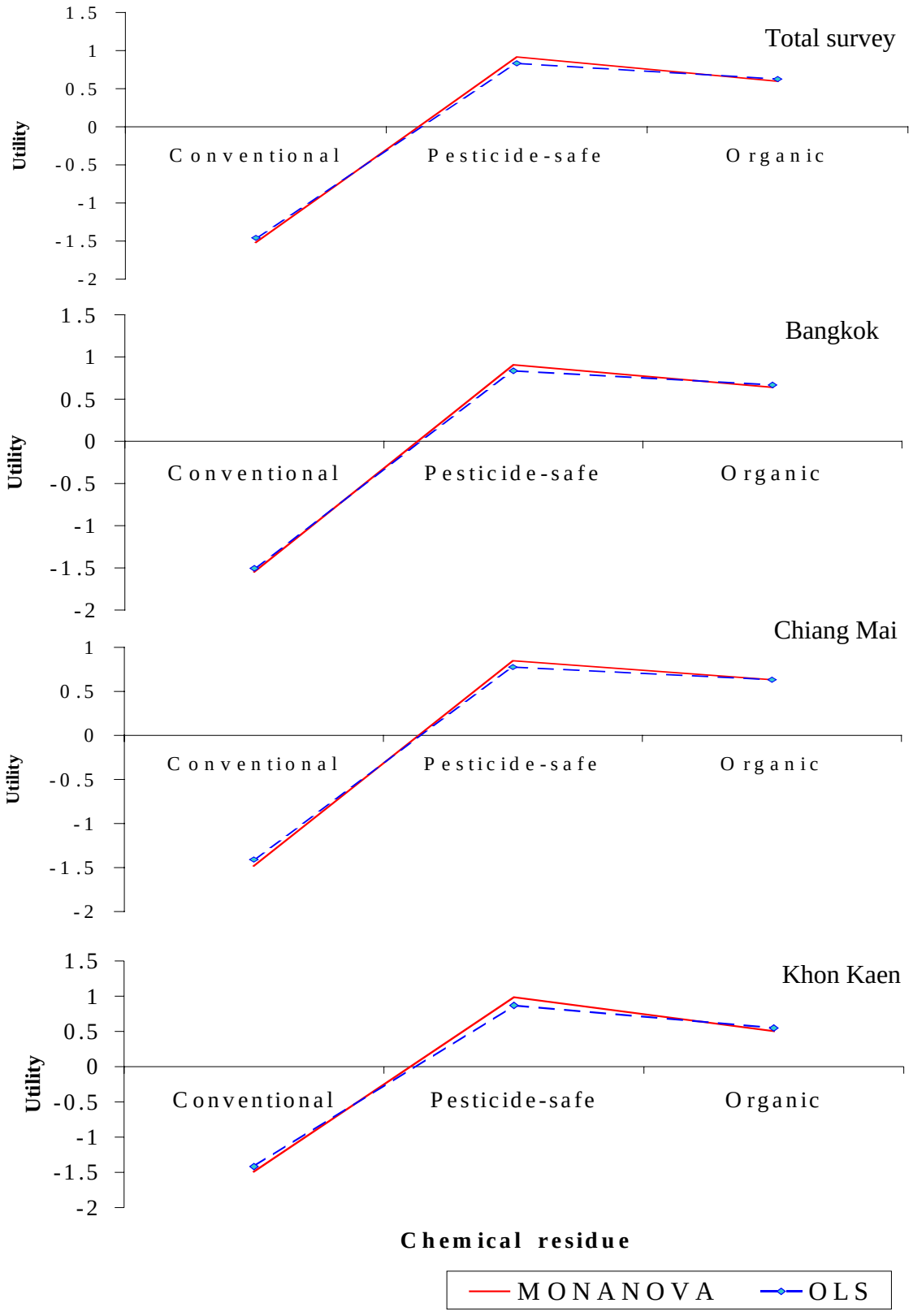


Figure 4.4 Part-worths of the levels of chemical residue-attribute in the conjoint analyses including and excluding price (MONANOVA)

Source: Consumer survey

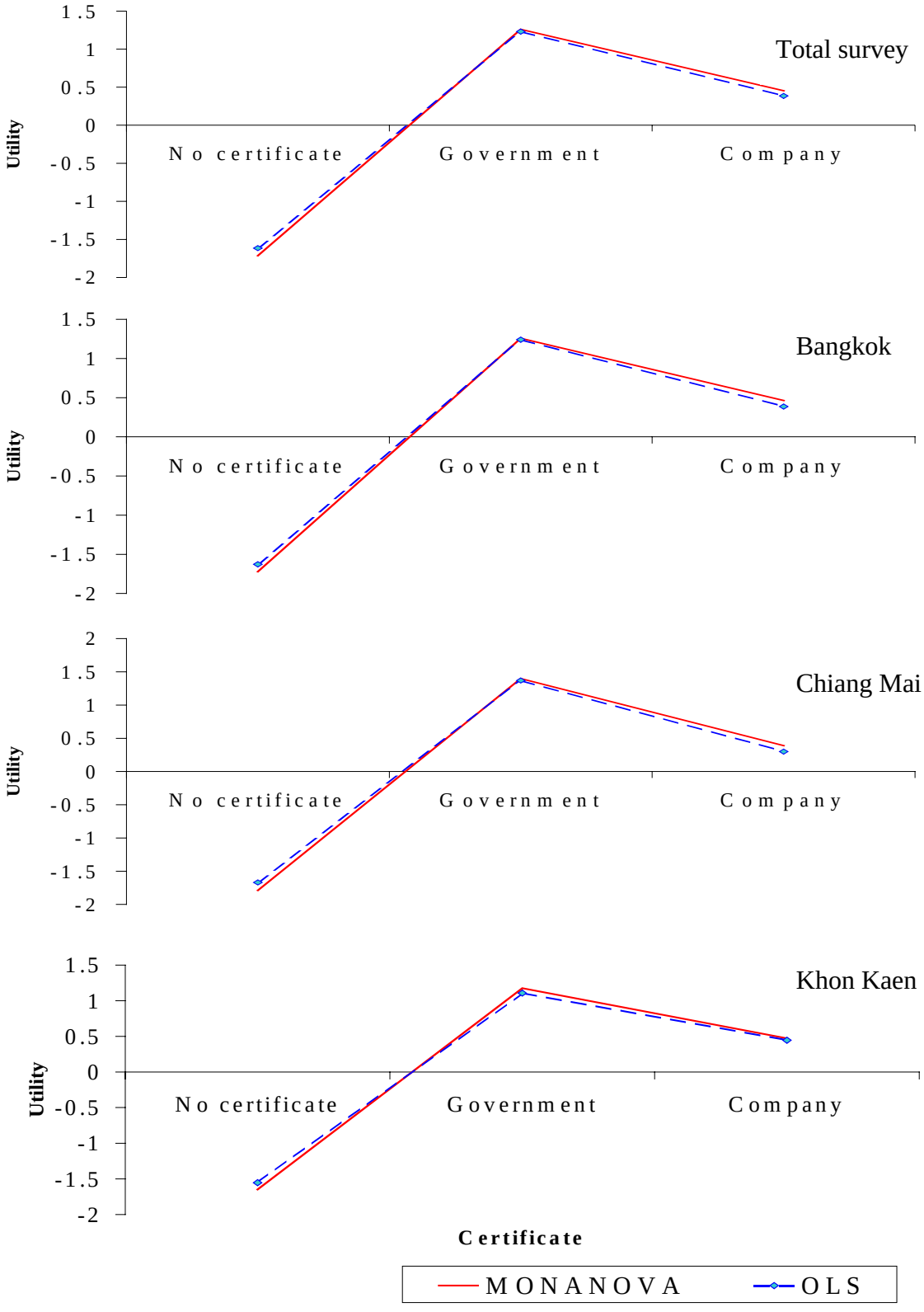


Figure 4.5 Part-worths of the levels of certificate attribute in the conjoint analyses including and excluding price (MONANOVA)

Source: Consumer survey

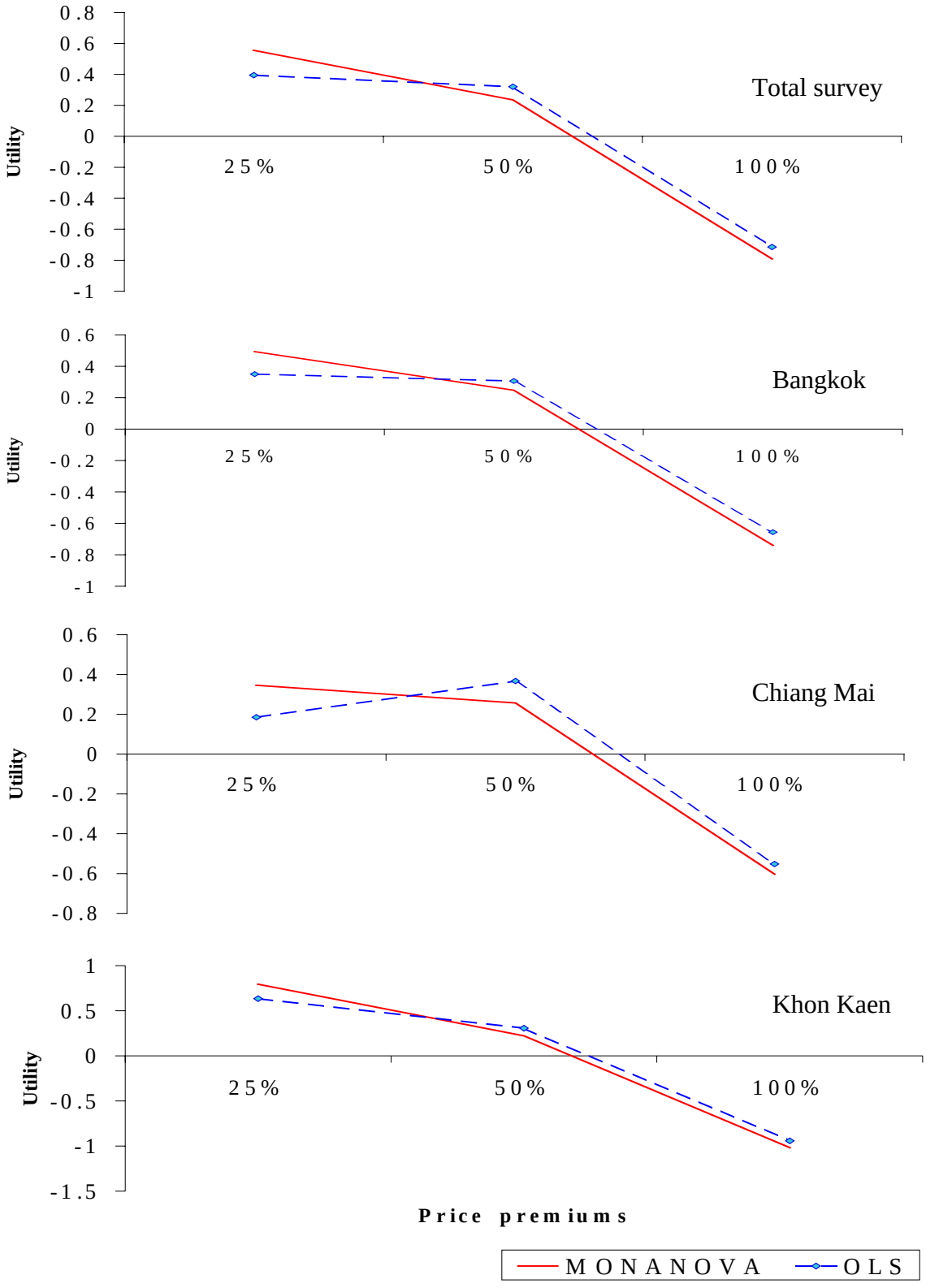


Figure 4.6 Comparison of the part-worths utility of price premiums-attribute in the conjoint analyses between MONANOVA and OLS

Source: Consumer survey

However, the estimates for the models including the price attribute-levels show at least one detail worth mentioning. Although the gradation between the part-worths of all attribute-levels, and even the numerical values of the part-worths for chemical residues and certificate remain almost unchanged (figure 4.4 and 4.5), the MONANOVA estimates tend to result in somewhat higher absolute values for the price levels compared to OLS results (figure 4.6). A straightforward explanation is not obvious, and it is beyond the scope of the present research to look for the reasons behind this. However, it seems noteworthy that the important result – the rankings of the attributes and their levels according to their part-worths - is not affected by the methods used, and the differences in the numerical values are not of economic importance, for the individual part-worths are hard to interpret[15].

[15] However, the MONANOVA results generated by SAS include some additional and helpful test statistics, e.g. the estimated standard errors of the part-worths, showing numerical values well below the coefficients, hence indicating significant representation of the data sets in all models not only in general, but even in detail.

4.4 Evaluation of Consumers' Purchase Decision-Making Process for EFPV: Logistic Regression Approach

It is important for producers and vendors to have a knowledge of how product attributes and their levels attract consumers' interest so that they can adequately customize products to match consumers' preferences. Product characteristics are definitely also important for customers. However, as pointed out in chapter 3, product characteristics on their own will not guarantee purchase, because every consumer individually evaluates the information collected about the products offered against the background of the combined effect of *basic and surrounding determinants* before making a definite a decision.

Therefore, the second part of the more sophisticated analyses presented here is designed to identify and quantify the role of factors affecting consumers' purchase decisions, i.e. to explain the outcome of the binary choice to buy or refrain from buying EFPV. In order to solve this problem analytically by a logistic regression approach, we initially had to generate information on consumers' actions in deciding to buy or not to buy EFPV and on their individual backgrounds and surrounding factors most likely relevant to EFPV purchase decisions. This, again, was done in the consumer survey.

The binary variable to be explained, i.e. whether the respondent buys or refrains from buying, has been defined in a two step procedure in order to reduce the bias of apple polisher: in a first step we asked whether respondents have ever bought EFPV and listed the yes-no-answers (table 4.13 and appendix 3, question 14). However, experience reported in the literature casts this grouping into doubt. Researchers repeatedly emphasised that interviewees tend to answer in the affirmative. Therefore, we immediately asked respondents answering "yes" a second question about the frequency of actually buying EFPV. Only those who answered "always" to this additional question have been treated as actual "buyers" in the logistic models specified (in fact a remarkable 544 individuals). On the other hand, both occasional buyers and non-buyers of EFPV have been treated as non-buyers in the models (773 individuals). Hence, the number of observations in the two consumer groups indicates that there existed a distinguishable class of consumers actually consuming EFPV.

Table 4.13 Definition of dependent variables used in the logistic regression models.

Questionnaire wording and number of answers		**Dependent variable**
(Q.14) Have you ever bought any pesticide-safe vegetables?		
- No	194 (14.7%)	$Y_i = 0$
- Yes (1126 (85.3%))		
(Q.19) How often do you buy pesticide-safe vegetables?		
- Occasionally	491 (37.2%)	
- Rarely	88 (6.7%)	
- Always	544 (41.2%)	$Y_i = 1$
Total no. of observations	1,217 (100%)	-

Source: Consumer survey

To explain the binary choice between purchasing and refraining from purchase, we analysed survey data specifically collected on four basic and five surrounding determinants, summarised in table 4.14. As is always done in this type of research when theoretical concepts have been translated into consumer questions, the questions and statements were checked by taking expert advice and additionally by pre-testing before the survey was conducted. Accounting for the so-called *basic determinants*, we generated information on *needs* (household's frequency of food preparation at home, appendix 3, question Q3; frequency of buying vegetables, Q5), *motives* (respondent's involvement in food preparation at home, Q2), *personality* (strong affiliation to a special nutritional style attaching importance on food from crops, Q4; age, Q31), and *awareness* (serious concerns about residues in terms of chemicals, Q10, and heavy metals, Q11; application of special methods of dressing vegetables before consumption in the form of chemical liquids, Q12; assignment of organically produced vegetables to the attribute "pesticide-safe" indicating particular involvement in EFPV, Q13). On the other hand, in order to incorporate so-called *surrounding factors*, we used survey results on *family influences* (prevailing chronic diseases, Q28; number of children up to 5 years, Q30), *social factors* (source of incentive to purchase EFPV, Q17; level of education, Q 33), *business influences* (occupation, measured in terms of "white collar"; Q35), *income influences* (total monthly income per capita in 1,000 THB, Q35), and *cultural influences* (allowing for possible different levels of

propensity to purchase EFPV among the three locations Bangkok, Chiang Mai, and Khon Kaen).

Table 4.14 Definition of independent variables used in the logistic regression models

Determinants	Variable name	Definition (question no.)
Basic determinants		
Needs	-*Eatout*	Dummy =1, if eating out more than 2 meals a day; equal 0 otherwise. (Q3, transformed from answer-categories 1-3)
	- *Buy*	Frequency of vegetable buying per week (daily= 7, 4-6 times a week= 5, 2-3 times a week= 2.5, 1 time a week= 1, not weekly=0, Q5)
Motives	- *Prepare*	Dummy = 1, if respondent prepare food for his/ her household; otherwise 0. (Q2, answer-category 1,)
Personality	- *Vegeta*	Dummy =1, if applied vegetarian; otherwise 0. (Q4)
	- *Macro_chee*	Dummy =1, if applied Macrobiotic or/and Cheewajit; otherwise 0. (Q4)
	- *Age*	Age in years (Q31)
Awareness	- *Pest_con*	Dummy =1, if very concerned about pesticide residues; otherwise 0. (Q10, answer category 1)
	- *Chem_con*	Dummy =1, if very concerned about chemical residues (fertilisers); otherwise 0. (Q10, answer category 1)
	- *Heavy_con*	Dummy =1, if very concerned about heavy metal residues; otherwise 0. (Q10, answer category 1)
	- *Nitrate*	Dummy =1, if concerned about Nitrate residues; otherwise 0. (Q11, answer category 1)
	- *Washing*	Dummy =1, if special care washing by some chemical liquid; otherwise 0. (Q12, answer category 5)
	- *Defi_or*	Dummy =1, if organic definition known; otherwise 0. (Q13, answer category 5)
	- *Attitude*	Consumers' attitude scores (Q27, sum of scores for all 6 statements,)

Table 4.14 continued

Determinants	Variable name	Definition (question no.)
Surrounding determinants		
- Family influences	- *Sick*	Dummy =1, if any household member has been sick with a chronic disease; otherwise 0. (Q28, answer category 1)
	- *Child*	Dummy =1, if there is/ are child/ children (up to 5 years) in household; otherwise 0. (Q29)
- Social influences	- *Reason*	Dummy = 1, if the incentive to buy EFPV came from someone's recommendation or advice; otherwise 0. (Q17, answer category 2)
	- *Uni*	Dummy =1, if Bachelor's degree or higher; otherwise 0. (Q32, answer categories 7 and 8)
- Business influences	- *Occupa*	Dummy = 1, if respondent's occupation is white-collar[1/]; otherwise 0. (Q33)
- Income influences	- *Income*	Average income per person in 1000-THB. (Q35)
- Cultural influences	- *BKK*	Dummy = 1, if location in Bangkok; otherwise 0. (first page of questionnaire)
	- *KK*	Dummy = 1, if location in Khon Kaen; otherwise 0. (first page of questionnaire)

Note: [1/] Answer to open-ended question Q33: Respondents state a total of 26 different occupations, which have been subsumed under 6 categories. The white-collar workers perform jobs that are less labour-intensive, and receive middle to high salaries, such as government officer, professional, technical, and administrative employee or independent contractor.

Source: Own presentation

Any quantitative analysis consists of a stepwise procedure, starting with a model specification based on the preferred comprehensive theoretical concept and taking account of available data. A second step follows the selection and application of an adequate estimation method. The numerical results are then – in a third step – inspected by means of test statistics to check for the *statistical significance* of the explanation of the observations by the data generating process defined by the model specification, and – most notably - by means of an economic evaluation of the estimates obtained, i.e. check the findings for *economic reasonability* and *importance*. This stepwise procedure is reapplied to gradually varied model specifications based on varying the basic theoretical concept including testing competing theoretical

approaches. The interplay among theoretical considerations, statistical significance and economic valuation of the results finally leads to the "best" model in terms of an optimal combination of theory and economic and statistical performance. In our case, however, we are faced with special additional theoretical and computational problems. We can neither theoretically nor empirically exclude any of the 21 variables listed in table 4.14 at the outset, for every variable will, or at least might, exert influence on the likelihood of buying EFPV. On the other hand, the method applied is barely able to separate the different effects of the variables due to prevailing multicollinearity. In our case, this phenomenon results from the inherent but substantial similarities among the various questions and statements designed to approximate the unknown true underlying motives, attitudes and other behavioural aspects of consumers. To cope with these conditions, empirical econometricians recommend starting the process of model selection by estimating a comprehensive model first, including all or most of the variables coming into question, and to vary and reduce the complexity successively, taking account of unsatisfactory results in terms of statistical significance and economic plausibility[16]. We followed this line of reasoning and estimated numerous different specifications of the logit model for comparison. However, the presentation and discussion in the following will focus on only three models in order to illuminate the proceedings: (1) a comprehensive model, including the full set of 21 explanatory variables plus the constant term ("full model"); (2) a specification similar to the final model but using a reduced set of 10 genuine explaining variables ("reduced model"), and (3) the finally selected specification ("final model") incorporating only 8 out of the total of 21 variables to measure the influences of basic and surrounding conditions on the EFPV purchase decisions.

Following the concept developed in section 3.2.2, the assessment of *statistical significance* and the statistical comparison of different models was carried out by use of summary significance measures of goodness of fit (likelihood ratio L- and Wald W-test-statistic), accuracy of prediction (Hosmer-Lemeshow C-test statistic) and by tests

[16] Alternatively, one may extract communalities among the different variables surveyed by factor analysis and use the factors to explain the logits. However, this method causes problems, too, especially in terms of commonly emerging unreasonably variable groupings. This was actually the case with our research. Therefore, we decided in favour of the use of directly generated information. This approach has the advantage of straightforward interpretable results of the causal factors affecting the purchase decisions, indicating direct starting points for marketing activities.

on the significance of individual parameters (W-test). Additionally, we calculated descriptive statistics ($R^2_{Logistic}$, ROC-curve, and ROC-coefficient). The *economic reasoning* was assessed by means of the signs of the parameters alone; due to lack of a priori theoretical indication and empirical knowledge we can neither evaluate on the magnitude of the individual influences nor even on the orders of magnitude of the different influences. The *economic importance*, however, has been valued based on both the signs and magnitudes of the parameter estimates.

Referring to the numerical values of the L- and W-test statistic on the overall goodness of fit, the *full model* containing the total set of 21 possibly explaining variables reveals significant representation of the dichotomous choice. Comparison of the empirical values L = 244.38 and W = 170.73 with the percentiles of the chi square-distribution and 21 degrees of freedom (df) confirms explanation at less than 0.1% marginal significance (appendix 28). Furthermore, the descriptive $R^2_{Logistic}$ = 0.834 shows good overall statistical fit, and the descriptive ROC statistic (ROC = 0.764) stands for an acceptable discrimination between buyers and non-buyers (table 4.15, and section 3.2.2).

Table 4.15 Comparison of Goodness-of-fit ($R^2_{Logistic}$) and accuracy of prediction (ROC-statistic) between the "full", "reduced", and "final" model

Model	**-2ln L**		$R^2_{Logistic}$	**ROC-statistic**
	Intercept only ($-2\ln \hat{L}_U$)	**Intercept and covariates** ($-2\ln \hat{L}_R$)		
Full model	1473.106	1228.724	0.8341	0.764
Reduced model	1722.881	1487.276	0.8632	0.738
Final model	1722.881	1501.135	0.8713	0.730

Note: $R^2_{Logistic} = 1 - \frac{(-2\ln\hat{L}_U) - (-2\ln\hat{L}_R)}{-2\ln\hat{L}_U}$

Source: Consumer survey (appendix 28-30)

Looking into more details, however, statistical and economic shortcomings are apparent. Firstly, the Hosmer-Lemeshow test-statistic C on the accuracy of prediction for the 10 groups ("decile risks") generated by SAS is only C = 9.97 with df = 8, linked to a reported marginal significance level of an unsatisfactory 27%, well above the ubiquitously used level of 5%. Secondly, according to the W-test statistic for individual parameters, about eight estimates are non-significant even at a marginal significance level of 10%. Thirdly, and moreover, the direction of some of the influences estimated is by no means plausible from an economic point of view: being concerned about nitrate, having at least one person in the household suffering from a chronic disease, having at least one child aged below five years, and having a white collar occupation appeared to be negative. Hence, this initial model has to be rejected from both a statistical and economic point of view although various details are convincing, such as the significant positive influence of income, age, attitude, practicing of special diets, attaching importance on food from crops as well as the negative influence of the frequency of eating out,[17].

The unsatisfactory results of the full model gave rise to a re-estimation of the model with different numbers and combinations of the initially used full set of variables. This procedure resulted temporarily in the *reduced model*, explaining the purchase decisions by means of 10 variables, including the two local dummies allowing for different purchase probability levels among the three cities (appendix 29). The overall statistical significance is again striking: the empirical L- and W-statistics report significance at less than 0.1%, well below the generally accepted level of 5%, and the coefficient of determination for logistic regressions, derived from the log-likelihood of the unrestricted and restricted models is $R^2_{\text{Logistic}} = 0.863$. These results shown are even somewhat higher than the full model-statistic (table 4.15).

[17] By the way, we initially separated consumers practicing special diets into vegetarian, macrobiotic and cheewajit in the logit analyses as we did in the survey. However, the parameters for macrobiotic and cheewajit in the corresponding full model differed only very slightly (highly significant at 0.545 and at 0.524, respectively, quite different from the insignificant coefficient for vegetarian of 0.266). Moreover, this result remains rather stable when changing the specification. Therefore, we decided to merge the two consumer groups affiliated with macrobiotic and cheewajit. Actually, adherents of cheewajit in the survey tend to affirm to being macrobiotics, too. The reason behind this is that cheewajit basically relies on macrobiotics, adjusted to the Thai diet and habits, including adoption of Buddhistic elements (e.g. meditation and positive thinking). Hence, both groups are most likely attracted by EFPV equivalently and consequently there is no rationale for differential treatment of the groups in marketing activities.

Furthermore, in the reduced model every individual parameter is highly significant: only two parameters are associated with marginal significance levels slightly exceeding 1% (university degree 1.2%, eating out 1.1%). However, although the descriptive ROC statistic remains in the range of "acceptable discrimination" (ROC = 0.738, i.e. only slightly below the value of the full model), the Hosmer-Lemeshow test-statistic C is non-significant: the marginal significance level of C = 7.70 with df = 8 is at 46%, far from the commonly accepted 5%, indicating an unacceptably low capacity to rightly project the endogenous variable. This result is even less satisfactory than for the full model (C = 9.97 and reported marginal level of significance 0.27) [18]. Yet, the signs of the explanatory variables included in the reduced model are economically reasonable. All variables selected tend to increase the purchase probability in terms of the logit, except for eating out (see below for details). Actually, this last finding is plausible too because people frequently eating out may have little reason to buy EFPV.

In view of the economic and statistical quality of the estimates in general, we tried to slightly adjust the model in order to improve the predictive power without changing the basic economic structure. The adjustment produced our *final model*, including the variables of the reduced model except for the two city dummies (appendix 30). The estimates of the final model are statistically significant with respect to every criterion defined: The overall statistical performance based on the likelihood ratio- and Wald test-statistics (L=221.75 and W=167.29, both at df=8) are significant at a marginal significance level of less than 0.1; and the descriptive $R^2_{\text{Logistic}} = 0.871$ indicates a slightly better overall representation of the data than the reduced model – even though two explanatory variables are omitted (table 4.15). Also, the estimates of the individual parameters are highly significant at less than 1% with only one exception– the marginal significance level of the parameter of the variable eating out rose slightly to 1.75%, yet even this is well below the level of 5%. The most important improvement, however, is not the increased significance of the individual parameters

[18] This might at least partly be due to the fact that we could not use the larger number of n = 1,268 observations to estimate the full model but only n = 1,074. Different samples will actually alter results and tend to make comparison difficult. However, in the present case this problem seems to be of relatively little importance, for the parameter estimates for the variables included in the final model in general differ only moderately from the coefficients calculated in the full model (see table 4.16):

but the striking increase in the predictive power: the C-statistic is boosted to C=16.99, indicating a marginal level of significance of only 3%. In contrast, the descriptive ROC statistic was not improved (ROC = 0.730), but the numerical value calculated from the (2x2)-table of correctly and incorrectly projected decisions shows that the model rightly differentiates between buyers and non-buyers in a noteworthy majority of 73% out of a total of 1,268 cases, i.e. still remaining in the range of acceptable discrimination (section 3.2.2).

In order to evaluate the results of the final model more precisely, we compared the individual regression coefficients and their statistical significance among the full, reduced, and final models. In general, parameter values and their computed significance levels will change with changing model specifications and number of observations included. In empirical research, the extent of the parameter changes is looked upon as valuable additional information about the appropriateness of the analysis, as they indicate the degree of sensitivity - or stability - of the estimates. Parameters highly sensitive to model changes – in spite of their eventually high statistical significance – indicate unsecured relationships, thereby reducing the credibility of the results obtained. On the other hand, parameters changing only moderately reflect stability of the influences and of the whole underlying model structure. Therefore, in addition to the other statistical and economic considerations, stability is used to evaluate the adequacy of the data generating process adopted the analysis.

As a start, we may positively realise no swap in signs of every regression coefficient among the models in our case. Yet, the parameter values tend to slightly decline from the full over the reduced to the final model, except for special treatment of vegetables before consumption (*washing*) and high concerns about pesticides (*pest_con*) where the coefficients of the final model tend to show somewhat higher values (table 4.16).

Table 4.16 Comparison of parameter estimates for the full, reduced, and final logit-model

Variable	Regression coefficients [2/]			Exp (regression coefficient)[3/]		
	Full model	Reduced model	Final model	Full model	Reduced model	Final model
Income	**0.0278**	**0.0225**	**0.0227**	**1.028**	**1.023**	**1.023**
	33.3491	31.2585	32.0537	1.019-1.038	1.015-1.031	1.015-1.031
Age	**0.0283**	**0.0272**	**0.0270**	**1.029**	**1.028**	**1.027**
	17.6106	21.0040	21.3347	1.015-1.042	1.016-1.040	1.0161.039
Attitude	**0.1186**	**0.0972**	**0.0961**	**1.126**	**1.102**	**1.101**
	19.8720	17.3826	17.1910	1.069-1.186	1.053-1.154	1.052-1.152
Macro_chee	**0.7173**	**0.6193**	**0.5993**	**2.049**	**1.858**	**1.821**
	6.9687	16.7543	15.8519	1.203-3.490	1.381-2.499	1.356-2.446
Washing	**0.4933**	**0.4935**	**0.4979**	**1.638**	**1.638**	**1.645**
	10.6547	13.3789	13.7865	1.218-2.202	1.257-2.134	1.265-2.140
Pest_con	**0.2833**	**0.3874**	**0.3932**	**1.328**	**1.473**	**1.482**
	3.4091	8.5150	8.8666	0.983-1.793	1.136-1.911	1.144-1.919
Uni	**0.4195**	**0.3379**	**0.3568**	**1.521**	**1.402**	**1.429**
	7.3999	6.3324	7.1459	1.124-2.058	1.078-1.824	1.100-1.856
Eatout	**-0.4310**	**-0.3236**	**-0.2999**	**0.650**	**0.724**	**0.741**
	8.3683	6.4872	5.6499	0.485-0.870	0.564-0.928	0.579-0.949
BKK	**0.5170**	**0.5304**		**1.677**	**1.700**	
	9.1968	11.9972		1.201-2.342	1.259-2.294	
KK	**0.5592**	**0.4244**		**1.749**	**1.529**	
	10.9054	7.7348		1.255-2.438	1.134-2.062	

Note: [1/] results reported concentrate on the variables in the final model only. - For further details see appendices 28-30.
[2/] first row (bold face): estimate, second row (roman): W-statistic.
[3/] first row (bold face) exponent of the logistic model, taking antilog of the regression coefficient, second row (roman): 95% Wald confidence intervals

Source: Consumer survey

However, the variability of the numerical values can be considered to be moderate in general, although we may identify three different classes of stability. The first group of really striking stability includes the coefficients of washing and age, showing deviations of only 1% and 4.6% respectively. The second group, of moderate variability, consists of consumer attitudes towards the general use of chemicals in vegetable production (*attitudes*, 9%), education (*uni*, 15%), and affiliation to special diets (*macro_chee*, 16.5%). The third group, of more distinct parameter changes, contains income (20%), high concerns about pesticide residues (*pest-con*, 28%), and

out of home consumption (*eatout*, 30%). Although the parameter changes in the first and even in the second group can be classified as acceptable in the sense of sufficient stability, the more pronounced parameter variability in the third group cannot. The reason behind this is hard to clarify. However, although we cannot exclude lack of adequacy of the model specification, the instability in this group should be partly due to the (cross-sectional) character of the data and the relatively high number of observations – both routinely causing instability and low statistical significance due to high variances. On the other hand, the variable *eatout*, for example, is not directly surveyed but derived from other data (table 4.14), and thus may not contain much information on what we actually wanted to measure.

Additionally to the analysis of parameter stability, we evaluated the stability of the statistical significance of the estimated coefficients among the three models. Passing from the full to the final model, the results show a tendency to lower standard errors of the individual parameters, i.e. higher statistical significance. These findings indicate that the quality of the approach is good, and emphasise the superiority of the final model. At the same time higher statistical significance and acceptable parameter stability in general provide an additional justification for the exclusion of the exogenous variables from the final and reduced model: in the final analysis, the omitted variables most likely do not contribute to an explanation of the decision making process for EFPV.

The validation of the *economic implications* of the results obtained needs some further computation. As derived in section 3.2.2, the starting point in deriving the model to be estimated by the ML method is the logistic model (section 3.2.2, equations (3.13a) and (3.13b)):

$$\pi(\mathrm{Y}) = \frac{1}{\left[1+\exp(-\beta_0 - \beta_i \mathrm{x}_i)\right]} \quad = \quad \frac{[\exp(\beta_0 + \beta_i x_i)]}{[1+\exp(\beta_0 + \beta_i x_i)]}$$

The equation is linearised by taking logarithms on both sides. This procedure results in the so-called logit-transformation, or alternatively logistic probability unit or even simply logit model (section 3.2.2, equation (3.14)):

$$\text{logit } \pi(Y) \equiv \log\left(\frac{\pi(\text{Y})}{1-\pi(\text{Y})}\right) = \beta_0 + \beta_i x_i$$

The fraction in the brackets of the second expression is the odds, which is the relationship of the probability of buying EFPV and the complementary probability of refraining from buying EFPV. Equivalently, log[π(*Y*)/ (1-π(*Y*))] is the log-odds, in turn being identical to the logarithm of the probability to buy log(π(Y)). The right-hand side of the equation is the right-hand side of the classical regression model containing the constant term (β_0), and the influences of the exogenous variables ($\beta_i x_i$). Hence the logit is shown to be a linear function of the explanatory variables on the right-hand side. This is the appealing characteristic of the transformation relating the log-odds ratio directly to changes in the explaining variables.

The final logit model written down at length reads as follows (appendix 30):

$$\begin{aligned} \textit{Logit } \pi(Y) = \; & -2.6455 \; + 0.0227 x_1 \; + 0.0270 x_2 \; + 0.0961 x_3 \; + 0.5993 x_4 \\ & \qquad\quad \textit{Income} \qquad\quad \textit{Age} \qquad\quad \textit{Attitude} \qquad\quad \textit{Macro\_chee} \\ & + 0.4979 x_5 + 0.3932 x_6 \; + 0.3568 x_7 \; - 0.2999 x_8 \\ & \quad \textit{Washing} \qquad \textit{Pest\_con} \qquad \textit{Uni} \qquad\quad \textit{Eatout} \end{aligned}$$

The numerical values of the parameter estimates measure the influence of a change of the independent variables on the logit or log-odds ratio (left-hand side). An income increase by one unit of measurement (1,000 THB), for example, increases the log-odds ratio by 0.0227, and an increase in the frequency of eating out by one (measured in terms of reducing time eating at home by once per week) will decrease the log-odds ratio by 0.2999.

Similarly, taking anti-logs will result in an explanation of the odds ratio, i.e. the relationship of the probability of buying and the complementary probability of refraining from purchase in terms of variable changes, and the associated logistic function is in case of a singe variable approach (section 3.2.2, equations (3.13b) and (3.13a) respectively):

$$\pi(x) = \frac{1}{\left[1 + \exp(-\beta_0 - \beta_i x_i)\right]}$$

The final model explicitly written down gives:

$$\pi(Y) = \frac{1}{1+\exp(2.6455 - 0.0227\,x_1 - 0.0270x_2 - 0.0961x_3 - 0.5993x_4 - 0.4979x_5 - 0.3932x_6 - 0.3568x_7 + 0.2999x_8)}$$

The exponent of *income* (x_1) is exp(0.0227) = + 1.023, and in case of eating out exp(-0.2999) = + 0.741 (see appendix 30). The associated substantial interpretation will change accordingly to: an increase in income by one unit of measured income (1,000 THB) will increase the odds ratio in favour of buying and the value of the logistic function by (1.023-1) = 0.023, i.e. 2.3%. However, an increase in the frequency of eating out by one unit will reduce the odds ratio and the value of the logistic function by (0.741-1) = 0.259 i.e. by a pronounced 25.9%.

As before in the case of the parameter estimates, we compared the derived odds ratios among the three models (table 4.16). The comparison again confirms the superiority of the final model. On the one hand, the *stability of point estimates* throughout the models is acceptable in general, although again different among different coefficients. On the other hand, the computed 95%-Wald confidence intervals for the point estimates of the odds ratio exp(β_i) were reduced in the final model compared to the full and reduced models. In this context it is important to note that the confidence interval of the odds ratio for *pest_con* in the final model no longer includes zero as in the full model. This is actually a substantial improvement, for concerns about pesticide use should have an important positive influence from both a theoretical and empirical point of view. Hence, the final model seems to reproduce the observations better than the other models.

The preceding economic interpretation of the numerical results in terms of the log-odds and odds ratios, however, is really not meaningful. To give an example: an income increase by one unit (i.e. by 1,000 THB) will increase the odds ratio by only 2.3%, but an increase in the frequency of eating out instead of at home by once a week decreases the odds ratio by remarkable 25.9% - hence *eatout* is more important than income? A reasonable judgement is not possible, at least as long as the variables are measured in different units (table 4.17).

In order to calculate coefficients having an identical scaling factor, we standardise the variables by subtracting their mean and dividing the difference by their standard deviation, generating variables having identical zero mean and unit variance. This transformation eliminates intrinsic measurement biases from the coefficients and thereby allows approximation of the *relative importance of the influences* (appendix 30). According to these calculated standardised coefficients, the most important factor in the final model is *income* (0.287), followed by *age* (0.170), awareness of pesticide contaminations (*attitudes*, 0.149), affiliation to special diets (*macro_chee*, 0.136), reducing pesticide contamination on vegetables by special dressing methods (*washing*, 0.128), concerns about pesticide residues in general (*pest_con*, 0.103), and higher education (*uni*, 0.098). The least important, (although negative) effect on the purchase decisions according to our final model is eating out (*eatout*, -0.083).

Table 4.17 Definition, mean and standard deviation of the explaining variables of the final model

Variable	Definition	Mean (Standard deviations)
Income	Average income per person (1000-THB) (Q35)	20.94 (22.82)
Age	Age in years (Q31)	35.97 (11.43)
Attitude	Consumers' attitude scores (sum of score for all 6 statements, Q27)	3.85 (2.80)
Macro_chee	Dummy = 1, if applied Macrobiotic or Cheewajit	0.21 (0.41)
Washing	Dummy =1, if special care washing by some chemical liquid; otherwise 0. (answer category 5, Q12)	0.32 (0.46)
Pest_con	Dummy =1, if very concerned about pesticide residues; otherwise 0. (answer category 1, Q10)	0.34 (0.47)
Uni	Dummy =1, if study Bachelor's degree or higher; otherwise 0. (answer categories 7 and 8, Q32)	0.54 (0.49)
Eatout	Dummy =1, if eating out more than 2 meals a day; equal 0 otherwise. (transformed from answer categories 1-3, Q3)	0.48 (0.49)

Source: Consumer survey

Finally, evaluating the *marketing implications* of the findings from the logit analysis we may confirm the existence of both EFPV-promoting and EFPV-hampering effects. Turning to the disadvantageous external factor first: in the course of still-increasing economic growth and the concomitant phenomena of income increase and urbanisation, consumers will continue to reduce food preparation at home and increase the frequency of eating out. Hence, consumer purchases of EFPV will decline a.e.e. However, future selling to commercial restaurants and canteens might compensate for this development – provided that marketing activities are directly addressed towards these customers. Additionally, taking account of the positive and most important income effect, the expected overall income increase will help to compensate or even exceed the negative but only moderate effect of eating out. The positive income effect is further enhanced by the fact that vegetables (and fruits) are food items benefiting from income increases and habit changes more than proportionally (chapter 2). On the other hand, changing age structures may exert either negative or positive impacts depending on the development of the population in Thailand. In the case that Thailand experiences the typical increase in the ageing population of industrial countries, age structure will change in favour of EFPV, for the older population prefers EFPV. Yet, addressing differentiated marketing activities may stimulate sales to the elder as well to the younger population group. The likely development of the other variables identified to influence purchase decisions tend to enhance EFPV consumption. Rising awareness of environmental and health problems, and induced changes in consumer preferences towards food produced with less or without chemicals most likely will strengthen EFPV consumption. Actors in the supply chain should take advantage of this trend by designing appropriate marketing strategies and by stressing the significant contribution of EFPV in reducing environmental damage and health risks by means of public relations activities. In this respect, promising starting points for promoting sales of EFPV in general can be recommended: general advertising for EFPV and organically produced food, public campaigns against environmentally harmful developments in the society, strengthening education in order to increase knowledge of chemical residues and the characteristics of EFPV are likely to change the market situation in favour of EFPV. In this process, certification receives a crucial role as it allows for educational advertisement, at the same time matching the high preference by consumers as identified in section 4.3.

4.5 Evaluation of Consumers' Willingness to Pay for EFPV: Contingent Valuation Approach

In the preceding two sections of empirical analysis we identified and evaluated *product characteristics* relevant to consumers' purchase decisions of EFPV by conjoint analysis, and we assessed the importance of relevant *basic and surrounding factors* affecting the likelihood of buying EFPV by logit analysis. The essential missing link is the role of the *price* for EFPV in explaining consumers' purchase decisions. Prices and income restrict consumers' capacity to consume, and hence they are also relevant economic determinants of the purchase decisions. At the same time, pricing policy is one of the four traditional vital marketing areas that marketers use to to open up opportunities and increase profits. In the following section the price aspect of EFPV is analysed by applying the double bounded contingent valuation method (CVM) outlined in section 3.2.3. Hence we focus on consumers and aim at evaluating their WTP.

4.5.1 Design of the experiment and selection of the appropriate distribution function

The data necessary to run the CVM have again been generated by the survey, in particular by the double bounded bidding approach translated into question 26 (appendix 3). The questioning of consumers to determine WTP started consistently throughout the whole census by giving an initial price of 20 THB/kg for Chinese cabbage specified as conventionally produced with unknown chemical residues[19]. This is in line with the representative market price for conventionally produced Chinese cabbage at the time of sampling in the different locations. Before starting the actual bidding process, we introduced EFPV by stressing the two crucial attributes "produced without any chemical input" and "certified by a trustworthy agency". The subsequent first and second bids for EFPV were defined according to the maximum WTP specified by consumers in the pre-survey (open-ended direct WTP questioning). An evaluation of this pre-test revealed three price modes at 25 THB, 30 THB, and 40 THB. In order to broaden the information basis for the CVM, we therefore decided to split the interviews in every city and each store into three different sub-samples of

[19] In the following, the quantity unit kg will be omitted for convenience.

approximately equal size, and started the bidding procedure in the sub-samples by naming first bids for EFPV at 25 THB, 30 THB and 40 THB respectively. Correspondingly, we put the second bid offered higher at 30 THB, 40 THB, and 60 THB in the respective sub-samples for respondents accepting the first bid, and somewhat lower at 23 THB, 25 THB, and 30 THB for those rejecting the first bid. After having received answers to either of the alternative second bids, we finally asked respondents who refused the first and the lower second bid ("no-no-answers") as well as respondents having accepted the first and the higher second bid ("yes-yes-answers") to specify the maximum amount of money they would be willing to pay for EFPV (i.e. we put an open-ended question). By doing so, we tried to generate additional information about the lower and upper limit of the whole range of monetary amounts consumers were generally willing to pay for EFPV against the background of the initially given anchor-price for conventionally produced Chinese cabbage. The designs of the three different sub-samples are summarised in Table 4.18.

Table 4.18 Summary of the three bidding designs for the double-bounded CVM

Bid 1 THB/kg	**No.**	**Initial bid**		**Bid 2 THB/kg**	**Follow-up bid**		
		Response	No.		Response	No.	*%*
25	407	No	14	**23**	No[1/]	7	0.5
					Yes	7	0.5
		Yes	393	**30**	No	176	13.3
					Yes[2/]	217	16.4
30	510	No	58	**25**	No[1/]	22	1.7
					Yes	36	2.7
		Yes	452	**40**	No	320	24.2
					Yes[2/]	132	10.0
40	403	No	150	**30**	No[1/]	44	3.3
					Yes	106	8.0
		Yes	253	**60**	No	192	14.5
					Yes[2/]	61	4.6

Note: Total observations = 1,320

[1/] After answering "No" for the second bid, the respondents were asked to state their maximum WTP.

[2/] After answering "Yes" for the second bid, the respondents were asked to state their maximum WTP.

Source: Consumer survey, appendix 3, question 26.

As developed in section 3.2.3, CVM is widely used in economics to establish the WTP of individuals for some well-defined hypothetical good by a set of socio-economic characteristics, similarly to the logit approach. However, the endogenous variable in the contingent valuation model is not dichotomous as with the logit analysis, but censored, that is, values of the dependent variable that fall within a certain range are all transformed to a single value. In our case of double bounded CVM the outcomes of the bidding process are assigned to four different WTP ranges bordered by the defined bids in the bidding game. From a probability point of view the WTP of different individuals will follow some probability distribution. Accordingly, the empirical WTP ranges correspond to a division of the underlying theoretical probability density function into four sections, each related to a certain probability, and with probabilities for the four sections adding up to 1 (section 3.2.3, figure 3.6 and equations (3.23)-(3.26)). Hence, the application of any probability function to the surveyed data requires data editing according to the interval-censoring rules defined by the researcher. In this respect, the lower bound of the first interval (lowest WTP) and the upper bound of the last interval (highest WTP) are of special interest because they give scope for discretion. In the economic literature, the first interval is generally closed by the "natural" lower bound of zero WTP, and the upper bound for the last interval is put at the highest amount of the second bid (Model 2 (lower, upper)). Yet, the special design of our experiment allows for an alternative definition of the lower bound of the first and of the upper bound of the last WTP interval: Immediately after they decided on the second bid, we asked consumers in the first (no-no) and in the fourth (yes-yes) group to quote the maximum amount of money they were willing to pay for EFPV (open ended question). Hence, as an alternative to the approach generally described in the literature, we could use the lowest maximum amount of money given in the open ended question in the first group as the lower limit in this group (minimum, actually 15 THB) and the highest maximum amount of money given by consumers in the highest WTP class (maximum, actually 100 THB) to close the whole WTP range. This results in Model type 1 (min, max). In terms of probability density functions, the two approaches change the modelling of the left and right tail of the functions, thereby modifying their general shapes and also their capacity to represent the empirical frequency distribution.

Having prepared the data accordingly, the underlying probability distribution has to be specified to estimate the CV-models. Yet, as pointed out in section 3.2.2 and again in 4.4, it is very difficult to justify the choice of one distribution or the other on theoretical grounds. Therefore, we tried to isolate the general shape of the distribution in a first step by depicting the empirical relative frequencies calculated from the survey. In this regard, the design of our experiment allows for computing frequencies for six different WTP-ranges: the first covers zero (or lower in case of Model type 1) to 23 THB, the second 23 to 25 THB, the third 25 to 30 THB, the fourth 30 to 40 THB, the fifth 40 to 60 THB, and finally, the sixth ranges from 60 to 100 THB (or max in case of Model type 1). The diagrammatical representation clearly points out a negatively skewed distribution (for Model type 2 see figure 4.7). Hence, symmetric distributions are out of the question, and we pre-selected the three left skewed Weibull, log-logistic and lognormal distribution for further investigation of the two model types.

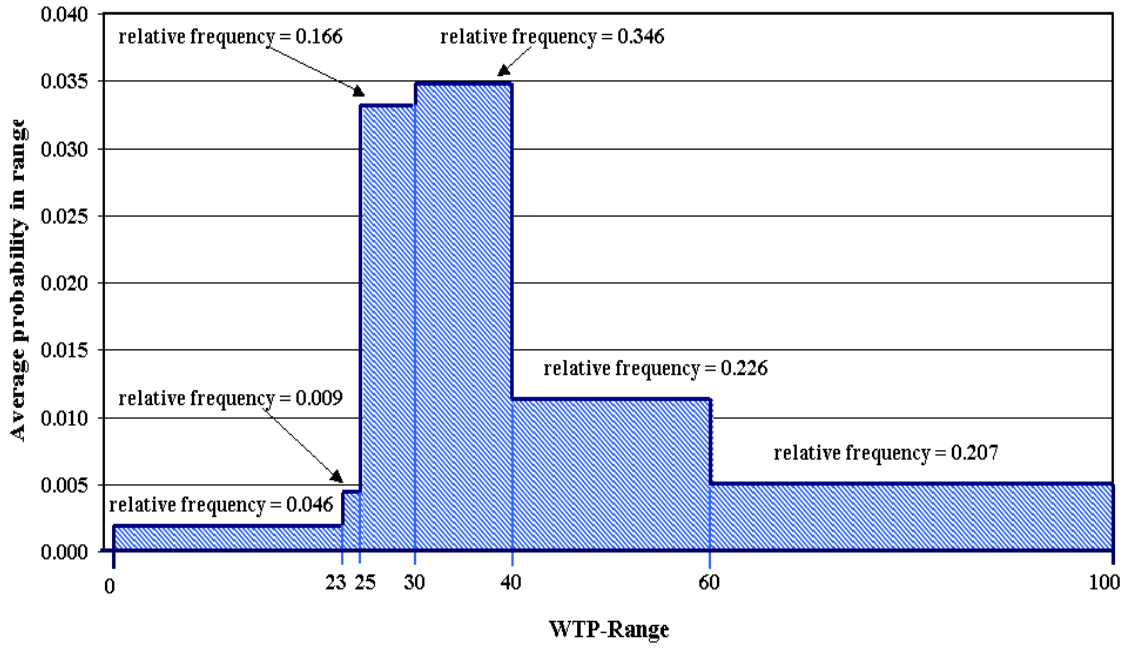


Figure 4.7 Frequency distribution of WTP for EFPV

Source: Consumer survey

In a second step, we applied these distributions (plus the exponential function to demonstrate inappropriateness) to the data prepared following the alternative rules of Model 1 and Model 2. The results are compared by means of the logarithm of the ML-residual variance estimate (the value of the log likelihood function L) in order to determine the probability distribution best suited to represent the empirical data and at the same time to select the superior model type (table 4.19 and appendices 31-38).

Table 4.19 Comparison of different probability functions to represent the empirical distribution of WTP using alternative lower and upper limits for the WTP

Distribution Function	**Log likelihood of unrestricted models (-log L)**	
	Model 1[1/]	**Model 2**[2/]
Exponential	2,870.5249	2,226.1591
Weibull	1,777.7839	1,556.3083
Log-logistic	1,620.3295	1,456.8396
Lognormal	1,619.9825	1,454.8924

Note: number of observations = 1247. - For details see appendices 31-38

[1/] lower and upper limit of the whole range of WTP set to specified (minimal) maximum WTP quoted by a respondent in the first group (no-no) and the (maximal) maximum WTP quoted by a respondent in the fourth group (yes-yes) respectively ("min, max")

[2/] lower limit of the whole range of WTP set to zero, upper limit of the price range set to the 2nd bid in the corresponding subset ("lower, upper")

Source: Consumer survey

The statistical selection criterion reveals a distinct superiority of Model 2 over Model 1, irrespective of the assumed probability distribution function. Therefore, we decided to use the specification of Model 2 with WTP overall range (lower; upper). On the other hand, evaluating the appropriateness of the four probability distributions, the criterion strength of L militates clearly against the Weibull distribution, and as expected from the depicted frequency distribution also against the exponential distribution. By contrast, the lognormal and the log-logistic distribution seem to be more or less equivalently suited to represent the empirical WTP distribution. Nonetheless, we finally selected the lognormal distribution for further investigations although the value of the log likelihood of the lognormal is only slightly lower than for

the log-logistic distribution (table 4.19 and appendices 31-38)[20]. However, the probability plot for the lognormal representation reveals less extreme residuals outside the 95%-confidence interval as compared to the log likelihood function (appendix 39).

4.5.2 Results of the contingent valuation approach

In the first instance, we used the results generated by applying the lognormal distribution to the pure WTP data, excluding any explanatory variable ("unrestricted", i.e. under H_0: $\beta_i = 0$) in order to compute general characteristics of the estimated WTP distribution. In a second step we then specified models to explain the WTP by introducing exogenous variables as arguments in the lognormal ("restricted", i.e. allowing for free parameter variation). The findings of both steps are presented and discussed in the following paragraphs.

According to the "unrestricted" lognormal the *mean WTP* of respondents in our survey is $\overline{WTP} = 38.83$ THB, which corresponds to a substantial premium on the prevailing price for conventionally produced vegetables (20 THB) of almost 100% (table 4.20). The *standard error of the WTP* is low at only S = 0.3604 THB, leading to a *coefficient of variation* of $V = S*100/\overline{WTP} = 0.3604*100/38.83 = 0.93\%$. This value of V is far below the usually reported upper limit of 10% in denoting low dispersion, hence V indicates high homogeneity of the WTP distribution and a concentration around the mean. Therefore, the *median of the WTP* is also close to the mean at just under 37.5

[20] A straightforward explanation for the inferiority of model 1, using additional information on the lower and upper limit of the WTP generated by the open ended question, again, is not obvious. From a data quality point of view, one might argue that the WTP quoted in the open-ended question contains unreliable information solely because respondents possibly named just some amount below or above the second bid without attributing any relevance, due to decreasing interest. From a statistical point of view the different capacity to approximate the empirical observations by the four distributions tested tends to be linked to the steep empirical distribution heavily concentrated around the mean and having very thin tails (see following chapter 4.5.2). Given this special situation in our survey data, different definitions of the lower (left) and upper (right) tails may exhibit strong effects on the whole shape of the curve and hence on the statistical results, even given only few data for the tail areas. In any case, Model 2 has the advantage being able to better represent the data generated for the numerically precisely given bids in the experiment, the bidding process being executed for three different sets of bids, and especially to approximate the WTP around the mean – in our case the most interesting region of our steep distribution.

THB, and the calculated *95%-conficence interval* for the average WTP is narrow and ranges only from 38.9 THB to 40.4 THB[21].

Table 4.20 Mean, Median, and 95%-Confidence Interval for the surveyed WTP (unrestricted lognormal model 2), appendix 38)

Characteristic of WTP- distribution	Statistic
Log likelihood of unrestricted model ($-\mathrm{Ln}\hat{L}_U$)	1,454.8924
Intercept (μ)	3.6231
Scale (σ)	0.2685
Mean WTP (THB/ kg) [1/] [Percent of premiums] [2/]	38.83 [94.15]
Median WTP (THB/ kg) [3/] [Percent of premiums] [2/]	37.45 [87.25]
95% CI of mean WTP (THB/ kg) [4/] [Percent of premiums] [2/]	38.87 – 40.43 [94.35 – 102.15]

Note: [1/] Mean WTP $= e^{\mu+\sigma^2/2}$ $\quad e^{3.6231+0.2685^2/2} = 38.83$

[2/] relative to conventionally produced Chinese cabbage = 100x((WTP-20)/20)

[3/] Median (WTP) = e^{μ} $= e^{3.6231} = 37.45$

[4/] using parameter estimates of 95% CI of mean, see appendix 38

Source: Consumer survey

At a first glance these results indicate a relatively high level of WTP that should be adjusted downwards when looking for a realistic, acceptable price - as is done in most empirical research using CVM. The reason quoted in the literature for doing so is the hypothetical situation – no real purchase situation but only an appraisal for an artificial product – which tends to overestimate the true WTP. In our case, however, this potential bias is at the most of only moderate importance: the average price premium for Chinese cabbage being advertised as “less-pesticide” reported in the sales data of one hypermarket for the period January 1999 until May 2001 was in fact 78%. Accounting for the quality difference between the actual “less-pesticide” Chinese cabbage offered on the market and our product, specified as produced without any

[21] We calculated the confidence interval using the lognormal, although we might have used the normal as well because according to the law of large numbers means are distributed asymptotically to normal regardless of the underlying distribution.

chemical inputs and certified by a trustworthy agency, the "true" WTP for high-quality EFPV should be close to our estimate[22].

However, in empirical economic analysis we are not only interested in the average WTP and in the general dispersion between customers, but also in the identify and quantification of factors most likely affecting the WTP. Therefore, we tried to assign the varying WTP values to causal factors influencing consumers' WTP, although the descriptive statistics of the WTP indicate a steep and homogenous distribution with possibly limited scope for broader in-depth analysis due to the low variance. As pointed out in chapter 3 and section 4.4, economic theory suggests that consumers evaluate information collected about the products at choice against the background of basic and surrounding determinants before definitely making their decisions. In this context, the WTP is a crucial aspect of any purchase decision. In consumer research we generally postulate that the WTP is determined by virtually the same factors as the final decision to buy or to refrain from buying. Following this line of reasoning, we commenced our more sophisticated analysis of the WTP by entering the comprehensive variable set used to estimate the initial logit model ("full model", section 4.3 and appendix 28) into the lognormal, subsequently adjusting the model specification according to statistical significance and economic reasoning. However, the logit regression was used to explain the breakdown of consumers into buyers and non-buyers, hence the observed buying/non buying decision was treated as an endogenous variable in the estimation. By contrast, the CVM tries to explain consumers' WTP, which is most likely to be crucially determined by their buying habits. Hence we have to include an additional exogenous variable to separate buyers from non-buyers. We used the apportioning of consumers derived for the logit analysis in CV-models (i.e. "always" buyers and "others", see table 4.13).

Referring to the numerical value of the likelihood ratio test statistic selected to assess the overall goodness of fit, the *comprehensive CV-model ("full model")* reveals a significant reduction in the residual variance of the unrestricted model, attributable to

[22] However, the result may also be affected by the observed high level of knowledge of pesticide-safe vegetables and concerns about residues, and the relatively distinguished proportion of consumers always buying EFPV. Under these conditions, the knowledge of the actual price premium might have influenced the prices quoted.

the covariates and hence indicating improved representation of the WTP-frequency-distribution: the asymptotically chi-square distributed empirical L = 111.91 with 22 degrees of freedom confirms explanation at less than 0.1% marginal significance (table 4.21, appendix 40). Furthermore, the numerical value of the descriptive statistic R^2_{CV} = 0.9137, which is comparable to the coefficient of determination in classical regression analyses and which has been computed from the likelihood functions of the unrestricted and restricted lognormal (22 genuine parameters), is also high.

Table 4.21 Comparison of Goodness-of-fit (R^2_{CV}) between the "full", "reduced", "final", and "ultimate" CV-model

Model	**-Log Likelihood (-ln $\hat{L}$)**		**Likelihood-ratio-test-statistic (df)** $-2\ln L = -2(\ln\hat{L}_R - \ln\hat{L}_U)$	R^2_{CV}
	Intercept only $(-\ln\hat{L}_U)$	**Intercept and covariates** $(-\ln\hat{L}_R)$		
Full [1/]	1,297.0983	1241.1438	111.91 (df = 22)	0.9137
Reduced [2/]	1,297.0983	1245.7490	102.70 (df = 11)	0.9208
Final [3/]	1,297.0983	1257.1197	79.96 (df = 9)	0.9384
Ultimate-CV [4/]	1,297.0983	1248.6333	96.93 (df = 6)	0.9626

Note: Number of observations used = 1,176. - parameter estimates and significance levels see table 4.22. - $R^2_{CV} = 1 - \frac{(-2\ln\hat{L}_U) - (-2\ln\hat{L}_R)}{-2\ln\hat{L}_U}$.

[1/] Model specification corresponding to logit full model
[2/] Model specification corresponding to logit reduced model
[3/] Model specification corresponding to logit final model
[4/] Finally chosen CV-Model, different from logit

Source: Consumer survey (see details in appendix 40-43)

A more detailed examination, however, shows that the statistical significance is not acceptable, and economic reasoning is not matched – as in the case of the corresponding logit model: only six of the 22 parameters are significant at the 5% level, and several parameters show unreasonable signs, e.g. food preparation at home, concerns about heavy metal, and income are estimated to exhibit negative, although insignificant, influences on the WTP (table 4.22). Hence, the full model was rejected.

Table 4.22 Comparison of parameter estimates for the "full", "reduced", "final", "CV01", "CV02", "CV03", "CV04", and "ultimate" of CV-model

Variable	Parameter estimates of CV-Model (P-value)							
	Full	Reduced	Final	CV01	CV02	CV03	CV04	Ultimate
Intercept	3.4863	3.5575	3.5230	3.5477	3.5625	3.5326	3.5339	3.5484
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Always_buy	0.1214	0.1031	0.1026	0.1077	0.0965	0.1042	0.0987	0.0928
	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Eatout	0.0103	0.0107	0.0234					
	(0.5265)	(0.5058)	(0.1437)					
Buy	0.0155							
	(0.4801)							
Prepare	-0.0071							
	(0.6976)							
Vegeta	0.0155							
	(0.5179)							
Mac_Chee	0.0515	0.0503	0.0559	0.0573	0.0578	0.0637	0.0572	0.0572
	(0.0513)	(0.0469)	(0.0280)	(0.0251)	(0.0243)	(0.0134)	(0.0247)	(0.0255)
Age	0.0002	0.0001	0.0008					
	(0.8227)	(0.8919)	(0.2764)					
Pest_con	0.0310	0.0341	0.0246				0.0349	0.0329
	(0.1056)	(0.0435)	(0.1451)				(0.0373)	(0.0498)
Chem_con	0.0207							
	(0.3083)							
Heavy_con	-0.0188							
	(0.3287)							
Nitrate	0.0127							
	(0.6205)							
Washing	0.0155	0.0142	0.0174					
	(0.4120)	(0.4507)	(0.3465)					
Defi_or	0.0194							
	(0.3457)							
Attitude	0.0085	0.0084	0.0099	0.0096	0.0094	0.0109	0.0085	0.0083
	(0.0049)	(0.0049)	(0.0009)	(0.0011)	(0.0014)	(0.0002)	(0.0044)	(0.0052)
Sick	0.0395			0.0410	0.0382	0.0345	0.0380	0.0377
	(0.0275)			(0.0221)	(0.0331)	(0.0550)	(0.0339)	(0.0352)
Child	0.0089							
	(0.6283)							
Reason	0.0126							
	(0.6699)							
Uni	-0.0316	-0.0280	-0.0263					
	(0.0791)	(0.0928)	(0.1144)					
Occupa	0.0107							
	(0.5428)							
Income	-0.0060	-0.0060	-0.0003	-0.0008				
	(0.0989)	(0.1000)	(0.3933)	(0.0348)				
BKK	0.0445	0.0428		0.0378			0.0387	
	(0.0354)	(0.0414)		(0.0654)			(0.0583)	
KK	-0.0574	-0.0514		-0.0593	-0.0791		-0.0553	-0.0818
	(0.0142)	(0.0248)		(0.0075)	(0.0001)		(0.0128)	(0.0001)
Scale	0.2337	0.2346	0.2368	0.2354	0.2363	0.2382	0.2349	0.2357
$-\text{LnL}_R$	1241.14	1245.75	1257.12	1247.23	1250.55	1260.65	1245.48	1248.63

Note: Number of observation = 1,176, $-\text{Ln}\hat{\text{L}}_U$ = 1,297.0983. For the details of the 3 models comparable to logit (full, reduced, final) as well as the "ultimate" CV-model see appendix 40-43.

Source: Consumer survey

In a second step, we adjusted the specification according to the reduced logit model in order to check whether we could find results comparable to the generally acceptable logit approach. The overall statistical significance of the *reduced model* again is high - the empirical value L = 102.70 indicates significance below 0.1% - and has even somewhat improved. The same is true for the coefficient of determination, calculated by using the error variances of the unrestricted and restricted model, which has equally slightly increased to R^2_{CV} = 0.9208. However, *age*, *washing*, *uni* (higher education) and *eatout* are non significant even at a marginal significance level of 10%.

Therefore, we changed the model specification to the final logit model, although we did not expect to get more convincing results by dropping the city-dummies for Bangkok and Khon Kaen. The results are also reported in table 4.21 and details can be found in table 4.22 and appendix 42. *Income*, *age*, *pest_con* (concerns about pesticide residues), *washing*, and *uni* remain non-significant at more than 10% marginal significance level.

Hence, we started to specify various models independently from the logit approach in order to explain the varying consumers' WTP, some of which are presented in table 4.22. We finally selected the "*ultimate CV-model*" on the basis of statistical significance and economic reasoning[23]. The overall goodness of fit is superior to the other models discussed so far: the likelihood ratio test shows somewhat higher significance and the descriptive R^2_{CV} = 0.9626 also increased. According to this ultimate model, the WTP is significantly explained by six variables: buyers or non-buyers of EFPV (*always_buy*), affiliation to special diets (*macro_chee*), concerns about pesticide use (*pest_con*) attitudes towards general use of chemicals in vegetable production (*attitude*), household member suffering from chronic disease (s*ick*), and one of the two regional dummies (for Khon Kaen-*KK*; table 4.22). Each parameter is significant at less than 5% marginal significance. Referring to the standardized regression coefficients, adjusted for different scaling, we note that all variables tend to increase the WTP for EFPV with the exception of the parameter indicating the city of Khon Kaen, which is negative. The signs are reasonable in any case: variables that

[23] The term ultimate is simply used to differentiate between the "final" logit and the finally selected CV-model.

tend to increase the WTP represent concerns about health hazards and environmental damages, and the negative dummy variable for Khon Kaen may be attributable to significantly different regional habits[24].

Although the "ultimate" model has been selected by trial and error, the results seem to match the empirical situation: the parameters of the explaining variables in the ultimate model proved to be relatively stable with changing model specification (see table 4.22), contrary to the other variables finally excluded. The coefficients of the other variables varied heavily, sometimes even changing the sign, and the statistical quality ranged from significant to non-significant. Hence there is good reason to accept the selected ultimate model as superior.

With respect to the relative importance of the different factors, we realize that habitually (i.e. always) buying EFPV exhibits the strongest (positive) influence (besides dwelling place). This is quite reasonable because the habitual purchase of EFPV reflects evidence for high preference for EFPV and market knowledge. Similarly, our expectations are also matched by the higher WTP calculated for consumers practicing special diets, being concerned about chemical use and residues as well as increased WTP for households having members suffering from chronic diseases. On the other hand, the findings show particular low but significant regional differences in the WTP for Khon Kaen (table 4.22).

Contrary to both our expectations and previous studies (FU et al., 1999; BOCCALETTI and NARDELLA, 2000), the WTP for EFPV in our research exhibits no significant dependency on income and education. However, experience from industrialised countries often shows comparable findings (WIRTHGEN, 2002). Yet, the failure to identify income influence might be due to statistical effects: the empirical frequency distribution of WTP is extraordinarily concentrated around the mean and identification of the income effect might have been prevented by the multicollinearity. Nonetheless,

[24] The lower WTP level in Khon Kaen might also be due to the lower incomes there, since we failed to include the income variable separately – the income effect was very small and negative, and in most cases non significant at more than 20% significance level. If this was caused by multicollinearity, the possibly important income effect was not identifiable, and the influence is implicitly captured by other variables.

the CV model finally selected implies statistically highly significant and economically reasonable findings.

The high importance of the regional dummy deserves closer attention. In order to generate more precise information on the regional WTP we stratified the empirical distribution with respect to the different locations (Bangkok, Chiang Mai, and Khon Kaen), types of stores (Carrefour, Tops, BigC, and Aden), types of consumers (always buyers and others), and differentiated among the three bidding sets defined. The computations show a remarkable WTP variation: Bangkok (average WTP = 42 THB), Chiang Mai (about 41 THB), and Khon Kaen (WTP=36) and a significant difference between Bangkok and Khon Kaen. Both findings are perfectly compatible with our results from the ultimate model and again confirm that its specification is reasonable. As already mentioned, this may be partly due to the different income levels, which are 13,488 THB per person a month in Bangkok, 9,464 THB in Chiang Mai, and only 7,671 in Khon Kaen (section 4.2, table 4.2). Moreover, as pointed out in chapter 2, regional habits differ significantly among regions in Thailand, and the population in Khon Kaen still relies on vegetables grown in home gardens and bought directly from farmers. Hence, from a marketing point of view, the markets in Bangkok and Chiang Mai are of greater interest than those of Khon Kaen.

We also looked into the different WTP of habitually, occasionally, and rarely or never buying consumers and revealed the expected ranking from 44 THB for always over almost 38 THB for occasionally to about 37 THB for rarely or never buyers (see table 4.23). This again shows that marketers should address their advertising activities to the habitually buying consumers and then aim at attracting the occasionally buying customers

Table 4.23 Comparison of mean WTP among difference groups of respondents

Group of respondents		No. of observation	Mean	95% Confidence Interval for mean	
All		1,247	38.83	38.87	40.43
Province	BKK	606	41.99	40.81	43.17
	CM	290	41.11	39.47	42.75
	KK	351	36.10	35.27	36.93
Frequency of purchase	Always	530	44.14	42.69	45.58
	Occasionally	473	37.53	36.64	38.42
	Rarely and never	244	36.85	35.69	38.01
Starting point bid	Bid1=25 THB	400	30.41	30.04	30.77
	Bid2=30 THB	488	37.10	36.56	37.63
	Bid3=40 THB	359	48.28	46.94	49.62
Store	Carrefour	404	40.73	39.41	42.06
	TOPs	407	41.78	40.37	43.20
	BigC	296	36.14	35.19	37.10
	Aden	129	41.93	39.67	44.18

Source: Consumer survey

Finally, we segmented the WTP data according to the starting bids and the different stores. Quite reasonably, the average WTP increases with the increasing level of bids quoted by the interviewer. However, the findings might after all indicate some leeway for pricing. The WTP differs noticeably among different types of shops, which might be due to different company strategies used to attract consumers.

Again drawing conclusions with respect to marketing policies addressed at enhancing sales of EFPV, our results indicate that even relatively high prices for EFPV are not the limiting factor when transforming potential into effective demand. However, contingent valuation analysis at the same time revealed significantly different regional WTP and price elasticities, most likely due to region-specific consumption habits rather than to income or other socio-economic determinants. In principle, this finding

allows for regional price differentiation as an instrument to create higher profits for marketers. The contingent valuation results indicate that increasing awareness of consumers about health hazards caused by chemical residues, and growing concerns about environmental problems in general, will change the marketing situation in favour of EFPV. The results again confirm our findings from conjoint and logit analyses, and they strengthen our recommendation to intensify private and public educational advertising on environmental pollution and health hazards from over- and misuse of chemical inputs in agriculture.

CHAPTER 5

SUMMARY AND CONCLUSION

5.1 Summary

For many years, consumers in industrial countries have shown a growing interest in food production-marketing systems other than the conventional kind. This interest was initially driven by environmental concerns, recently reinforced by an increasing demand for food safety and health, taste, origin and traceability. About two decades after appearing in older industrialized countries, environmental and health concerns resulting from conventional agricultural production systems have also received attention in the NICs. This is especially true for Taiwan, and more recently for Thailand.

In the light of these changes, and taking account of the enforced challenge to produce and market safe and healthy food in Thailand, DFG has financially supported a joint research project aimed at improving the production-marketing system for vegetables so that it results in the least possible health hazard and no environmental damage. Vegetables were selected for an in-depth study because conventional vegetable production systems use intensive chemical inputs, giving rise to a potentially serious health danger from hazardous residues. At the same time, vegetables are often consumed fresh (uncooked), which increases the hazard compare to cooked food. This is of special importance for Thailand, where fresh (especially leafy) vegetable consumption is common practice every day.

The thesis presented here concentrates on consumer demand. The overall objective, as stated in **chapter 1** of the thesis, is to identify possibilities and constraints in marketing EFPV, thereby filling the existing information gap in order to improve consumer-oriented marketing activities for EFPV in Thailand. To reach the overall objective we defined five main sub-goals to be achieved in sequence: provision of an overview of vegetable, especially EFPV-consumption; evaluation of the product attributes desired by consumers; explanation of the purchase decision, assessment of consumers' WTP, and, finally, conclusions for improving the marketing of EFPV in Thailand. The paper is organized according to this sequence of goals.

Following the introductory chapter, **chapter 2** presents the existing situation and development of EFPV marketing in Thailand in terms of production, marketing and consumption. This chapter was based on information obtained from the official statistical data and other sources available, including interviews with experts. The main findings of chapter 2 with respect to marketing and consumption are briefly as follows. The main increase in vegetable production in Thailand came from expansion of the growing area and intensive use of agro-chemicals. which may cause an increase in environmental contamination and health hazards. The increasing number of EFPV labels and certificates and the greater proportion of EFPV to conventional vegetable sales, indicates a rapid growth in EFPV production-consumption. This rapid growth created many varieties of labels and certificates with which consumers are confronted. Those labels should help consumers with purchase decisions, but instead created confusion and uncertainty. Despite the rapid growth, the discovery of excess pesticide residues in supposedly pesticide-reduced vegetables demonstrated the problem of dishonest or incompetent producers and non-approved quality control processes. Another of the main findings discussed in chapter 2 is related to “price”. Although the price premium for EFPV is tending to decline, the price of EFPV is still generally higher than that of conventional vegetables partly because of higher production and marketing costs.

Chapter 3 reviews the theoretical concepts of consumer behaviour and the multivariate methods to be used. The first part of the chapter describes the theory of consumer behaviour, which in general is the study of the psychology behind consumers’ purchase decisions. Based on that theory, when the crucial factors that influence consumers’ purchase decisions for EFPV are elucidated, the theoretical economic models of consumer behaviour can be formulated.

Deriving from theoretical models, the statistical models were estimated using three analytical approaches. Firstly, conjoint analysis was used to determine the importance of product attributes. The results can be applied to design new products and marketing strategies according to consumer requirements, while improving cost efficiency. Secondly, logistic regression was applied to identify and quantify factors that affect consumers’ purchase decision, including those of non-buyers. This information will

assist in defining specific market segments and contribute to extending the EFPV market. Thirdly, the contingent valuation method was used to assess consumers' WTP.

The second part of chapter 3 presents the analytical tools used to achieve the sub-goals (ii)-(iv) defined in chapter 1: conjoint experiment to evaluate the attributes of EFPV that attract consumers, logistic regression in order to explain the actual consumer decision to buy or to refrain from buying, and a double-bounded contingent valuation approach to assess the WTP for EFPV. In each of the respective three sub-sections the economic model is derived and transformed into the estimation model. The estimation techniques are briefly reviewed and the descriptive and test statistics used to evaluate the estimates are introduced. However, the quantitative analyses needed survey data collection because adequate information from secondary sources was not available.

Chapter 4 presents the empirical analysis and discusses the results obtained. This chapter discusses the design of a questionnaire based on the theory of consumer behavior. The pre-survey was conducted via 30 face-to-face interviews to identify improper questions or those capable of being misunderstood. Additionally, the pre-test was used to define the attributes to be included in the conjoint experiment and assess the initial bidding points and the upper and lower bounds in the second round of the contingent valuation experiment.

The main survey was conducted by face-to-face interviews in the real market place. A total of 1,320 face-to-face interviews were conducted in Bangkok, Chiang Mai and Khon Kaen. The questionnaire was designed to ask only consumers who are accustomed to buying vegetables. Comprising three different aspects (product characteristics, basic and surrounding determinants of consumer purchase decisions, and consumers' WTP for EFPV), the first section of the questionnaire was related to behavioural aspects of vegetable consumption and purchase. The second section was designed to collect socio-demographic and socio-economic characteristics. To understand interviewees' behaviour, the descriptive findings present background information on consumers' attitudes, habits and behaviour towards both conventional vegetables and EFPV. The majority of respondents in the survey were female. Because of the special selected cities and survey points, interviewees most likely belong to the middle and higher income classes of Thai society.

After an evaluation of the design of the questionnaire and descriptive results of the main survey, the selection of attributes relevant to EFPV purchase decisions was discussed. After the pre-selected six general stimuli were scored during the survey, we analyzed the data and found that the average scores for certificate, price, and geographical origin showed significant differences between the two consumer groups: buyers and non-buyers. However, the attribute geographical origin was dropped, because producers do not mark or emphasise geographical origin on their products and this attribute had the lowest score among six factors. Instead of geographical origin, the level of chemical input usage was considered to be the most important characteristic of EFPV and was selected a priori to be one of the important attributes. Thus three main important EFPV attributes for the conjoint analysis are: chemical residue, certificate, and price.

The conjoint experiment was used to simulate consumer choice and to discover which product attributes attract consumers. In the experiment respondents were asked to rank the different products in order from the most preferred product to the least preferred. Using orthogonal design, nine “plancards” (products) were randomly generated by the SPSS program for the conjoint experiment. To investigate the possible excessive effect of price on the ranking, two conjoint experiments, including price and excluding price, were conducted and the respective models estimated using the OLS method. However, OLS in principle requires metrically scaled endogenous variables, hence from a methodological point of view OLS is not suitable for estimating the ordinal scaled rankings of our experiment. In order to take account of this caveat, the models were re-estimated using the MONANOVA, a non-metric regression technique. However, the results from the two approaches did not differ remarkably, confirming the common practice of treating ordinally scaled endogenous variables as if they were metrically scaled and applying the OLS method.

Among the three attributes, respondents indicated that certificate is the most important to them. The respondents prefer that a certifying body guarantees the product and also prefer government certification to that from private companies. The reverse is also true, and lack of a certificate has a relatively high negative impact on consumers’ utility. Among the different levels of chemical residue, the most preferred attribute is pesticide-safe even though the organic vegetables. The attribute “safe” combined with

the precisely known hazardous residue “pesticide” was most likely to effectively attract consumers. The least important attribute for respondents was price. These results also support the hypothesis that price is not the first priority factor when the respondents purchase EFPV. Among three levels of the price attribute, those of 25% and 50% premium have a positive influence on consumers, while the 100% premium is the least preferred. Thus lower prices for pesticide-safe or organic vegetables will definitely stimulate the sales of EFPV.

Although product attributes are important to customers, they do not guarantee a purchase. Basic and surrounding determinants, as discussed in chapter 3, also influence the purchase decision. Based on the theory of consumer behaviour, a theoretical economic model of purchase decision called a binary choice model was formulated. Twenty-one of the basic and surrounding determinants were initially identified and translated into a questionnaire. Each determinant and its questions were revised and discussed with the experts and pre-tested before the main survey was conducted. After the data for individual backgrounds and surroundings was collected, we translated the theoretical economic model into a statistical binary choice model and analyzed the data by a logistic regression.

To select the model best suited to represent the empirical data in terms of statistical performance and significance, together with economic reasoning and importance, we applied a stepwise procedure. We started by estimating models that included all variables collected that might have importance, and successively varied and reduced the specification of the logistic model in the light of the statistical and economic findings. To illuminate the procedure, three models have been selected for discussion in the thesis: the “full model”, including all 21 explanatory variables and the constant term; (2) a “reduced model” using a set of 10 explanatory variables, and (3) the “final model” incorporating only 8 variables that significantly and economically have a reasonable influence on EFPV purchase decisions.

The results from the logistic approach reveal that the most important factor is income. This is followed by age, awareness of pesticide contaminations (attitudes), affiliation to special diets (Macrobiotic and Cheewajit), reducing pesticide contamination on vegetables by special dressing methods (by chemical liquid), concerns about pesticide

residues in general (very concerned about pesticide residues), and higher education, respectively. The least important, having a negative effect on purchase decisions, is eating out.

Every one thousand THB increase in income is associated with a 2.3% increase in the likelihood of buying pesticide-safe vegetables. This result supports the theoretical expectation that higher income consumers are able to afford higher-quality products. However, urbanization and income increases may change consumer preference towards eating out rather than preparing food at home.

Age is the second most important factor that affects the likelihood of purchasing EFPV. An increase of a year in age increases the chances of purchasing EFPV by 2.7%. The positive or negative effects of age depend on the population structure. Thailand is moving towards an increase in the proportion of aged people that is typical of industrial countries. The change in age distribution will favour EFPV consumption because the older population prefers EFPV.

The third most important factor, awareness of environmental and health problems, has pushed consumers towards foods with less chemicals, thus enhancing EFPV consumption. Educational advertisements, certificate and labelling play crucial roles in strengthening consumers' awareness, favouring the market situation for EFPV. All the remaining influential variables identified tend to enhance EFPV demand.

Apart from product characteristics and the basic and surrounding factors affecting consumers' purchase decisions, *price* is also important, not only to consumers but also to producers and traders. For the purpose of an in-depth analysis of market development and policy, it is necessary to know the value of WTP and the factors that affect it.

After the data was collected from the main survey, we estimated the WTP model using the Life Regression procedure in the SAS program. Because the answer of respondent's WTP is the interval-censoring data, there are two possible sets of lower-upper bounds used to estimate the WTP model. We could choose the lowest and highest WTP from what the respondents answered in the open-ended question (model 1). Alternatively the "lowest WTP" could be zero and the "highest WTP" could be the

highest amount of the second bid (model 2). Then we estimated the unrestricted versions of models 1 and 2, excluding all explanatory variables, using four different distribution functions in order to determine which probability distribution and model was best suited to represent the empirical data. Based on the test statistics: log likelihood values, the lognormal distribution and model 2 were selected to represent the superior model type and to calculate mean WTP of respondents in our survey.

When estimating the WTP model including explanatory variables, at first we postulated that the variables in the WTP model would be the same as in the logit model. Then the full, reduced and final models of the WTP were estimated in order to compare the factors that influence consumers' purchase decision and consumers' WTP. However, on the basis of statistical significance and economic reasoning, we were not satisfied with the empirical results. Thus we continued to successively vary and reduce the specification of the WTP model. Finally we selected the "ultimate CV-model" as being superior to the other models in terms of both statistical significance and economic reasoning.

During the main survey the respondents were asked to state their WTP for the EFPV on the well-known vegetable "Chinese cabbage" with a base price of 20 THB/kg. The average WTP for EFPV (Chinese cabbage) is 38.83 THB/kg or 94.15% premium on the conventional vegetable price. This WTP might be high because the respondents answered on the grounds of a hypothetical situation. However, when considering the value of WTP, consumers were willing to pay a price premium of almost 95% while the average observed premium was 78%. The high WTP indicates that the consumers have a high demand for EFPV. This result also shows the importance consumers place on preventing potential risks of exposure to pesticide residues in their vegetables.

Regarding the factors that affect its magnitude, the WTP is highly and positively influenced by the frequency of purchasing EFPV, affiliation to special diets, awareness of health and chemical residue problems, and household members suffering from chronic illnesses. The WTP is, however, negatively correlated to the city of Khon Kaen. This seems to be reasonable and in line with expectations because interviewees in Khon Kaen have lower incomes than the average. The negative influence may be due to both lower income and different regional habits. Hence, from a marketing point

of view, the markets in Bangkok and Chiang Mai are of greater interest than those in Khon Kaen.

Among all factors, the frequency of purchasing EFPV is the most influential. This is reasonable because respondents who always purchase the EFPV are more likely to have higher preferences and more likely to be familiar with the market price premium. The finding suggests that marketers should enhance their advertising activities to persuade consumers to become habitual purchasers.

Additionally, consumers' awareness of health hazards caused by chemical residues, and growing concerns about environmental problems generally, has a positive influence on WTP. Furthermore, the respondents who adopt Macrobiotic and/or Cheewajit diets tend to purchase EFPV more frequently and be willing to pay more for EFPV. Similarly, the households that have members suffering from chronic diseases also have high WTP.

With a better understanding of consumer behaviour, marketers are likely to launch a campaign that positively affects consumers' purchasing decisions. In terms of product development, this justifies the promotion and development of new products to fulfill the consumers' needs. Because consumers require some sort of "guarantee" of genuinely safe vegetables from the producers, traders or even politicians, it is crucial to have more effective and better communication policies. Knowing the factors that influence the purchasing decision, a trader could evaluate the EFPV market according to consumer characteristics and uncover niche markets.

After assessing the market potential based on consumers' WTP, this study infers that the high prices for EFPV are unlikely to be the obstacle in effecting the transformation from potential to effective demand. It is more likely that the tendency to purchase EFPV increases when the awareness of consumers about potential health hazards and environmental problems is more pronounced. This WTP is vital for policy makers in order to improve their marketing strategies and develop the marketing of EFPV in Thailand. The study also provides a good example for research in another country.

5.2 Conclusion

The major contribution of this thesis is the econometric result that provides an insight into how to improve the market potential for EFPV. The results of the study can be applied based on the four marketing strategies (4P's) -product, price, placement (or distribution) and promotion (proposed by MCCARTHY, 1978). These are the common elements used in formulating appropriate marketing plans in order to elaborate on starting points for private and public strategies to promote the marketing of EFPV.

Product strategy: the study shows that freshness is the common attribute that consumers are highly concerned about when purchasing vegetables. Staleness of EFPV may adversely affect consumers' purchase decisions. Normally, vegetables can deteriorate rapidly after removal from the farm. EFPV should be carefully handled, packed, and delivered to the market in prime condition in order to increase the shelf life. Hence, producers and marketers need to manage and be aware of all steps along the handling and distribution chain.

According to our conjoint analysis, government certificate and pesticide-safety level are the attributes that consumers pay more attention to than price. Consumers who require specific characteristics of EFPV have to rely on the truthfulness (safe for consumption) of the claims by the seller. Consistent with our research results in chapter 4, more than half of consumers emphasise that certificates create faith in the quality of a certified product. Hence, certification is vital for any producer who wishes to produce and sell EFPV. Producers have to control their products' quality consistently and transparently. However, it is doubtful whether many producers have indeed produced good quality vegetables and complied with the requirement of certified standards.

Price strategy: the result of the estimation of consumers' WTP for EFPV indicates that even relatively high prices for EFPV are not the limiting factor in transforming potential demand into effective demand. It is confirmed by conjoint analysis that price is an important factor influencing the purchase decision, but the price effect is relatively low when compared to the other attributes (certificate and chemical residue). According to results from CVM, consumers are willing to pay more for EFPV than the existing prices in the retail market. Furthermore, the price premium for EFPV tends to

decline, partly because more new producers and marketers have entered into EFPV market. It is very likely that the average consumer's WTP is high enough to cover the production and marketing costs of EFPV. From our observations, the high price of EFPV does not seem to be an obstacle to marketing. In fact, the high value of WTP indicates a considerable demand by consumers and the possibility of market expansion for EFPV in the future.

However, the estimated WTP of different regions illustrates different consumer demand due to region-specific consumption. On average, consumers in Bangkok and Chiang Mai have a higher WTP than those in Khon Kaen. This finding is consistent with the result from the conjoint analysis that consumers in Khon Kaen pay more attention to price than consumers in other regions. As mentioned previously, the markets in Bangkok and Chiang Mai are of greater interest than those of Khon Kaen. The marketers could run reduced price strategies in Khon Kaen in order to stimulate the sales of EFPV. Nevertheless, price has to be high enough to cover production and marketing cost, but lower than consumers' WTP. However, lower price strategies for EFPV do not ensure producers and marketers of higher revenue. A low price strategy will increase revenue when the price elasticity of demand is highly elastic (more than one). Thus, the marketers need to understand how their consumers react to the low price strategy.

Place strategy: Chapter 2 explained that EFPV market channels have been developed outside the existing distribution paths for conventional vegetables, and mainly comprise special retail markets. Hence, the distribution of EFPV plays a central role in the success of its marketing. Every day supermarkets and hypermarkets require large quantities of EFPV with homogeneous qualities and punctual delivery. This demand is difficult for small farmers to fulfil. Because the marketers need to maintain the balance between the demand and supply for EFPV in the massive supermarkets and hypermarkets, marketers should act as middlemen supporting the business between farmers and stores. An increase in EFPV supplies in general would help to free up all channels of the marketing chain (MICHELSEN et al., 1999, p.115).

One of the results of logistic regression shows that increases in income and urbanization will increase the frequency of eating out and decrease the chances of

buying EFPV. To overcome this negative trend, a potential marketing strategy is to sell EFPV directly to restaurants and canteens. This will create new market channels, which seem to be small enough to allow small groups of farmers to manage themselves in cooperatives. As with supermarket channels, the producers and marketers in this new area will have to maintain the balance between the quantity and quality of the products; otherwise there would be lack of product varieties and a failure to meet the demand.

Furthermore, the results of CVM confirm that health concerns influence WTP. Households having members suffering from chronic diseases have higher WTP. This study result points to a new market channel reaching that special group of consumers. Thus it would be possible to sell EFPV directly to hospitals or establish specialised shops nearby.

Promotion strategy: the study concludes that the various certificates and labels of EFPV in the market cause consumer confusion by information overload. Consumers should need some knowledge of only a few standards. Government authorities should be able to more effectively communicate to consumers so that they have a better understanding about the meaning of standards. To avoid consumer confusion, most European governments use a “single label and unified certificate” policy to promote organic products in their domestic markets. Most recently, in December 2005, the European Commission made compulsory the use of either the EU logo or the words “EU-organic” on products with at least 95 percent organic ingredients (DIMITRI and OBERHOLTZER, 2005). This policy aims to offer transparency for consumers and creates uniformity and clarity. Similarly to European and other developed countries, the Thai government has created the “Q sign” to indicate the national standard for food-safety products in a single logo. By means of good public relations, consumers’ understanding of certificate standards will help marketers and growers in promoting the market and reducing the marketing costs. Therefore, national standards need to be widely adopted.

As long as there are several certificate labels competing in the same market, the brand name or commercial label may be another appropriate tool in marketing promotion because consumers have no idea which certificates indicate superiority over others. We

found in our study that the commercial "Doi Kham" label was more well known and recognised than the certificate logo. Hence the success of any commercial label depends on the degree to which it is well known by consumers, and this presupposes some kind of promotion (MICHELSEN et al., 1999, p.41).

The market development for EFPV is highly dependent on consumer confidence, so quality control of the product is very important. Reports on finding significant pesticide residues in supposedly pesticide-reduced vegetables gradually erode consumer confidence in EFPV. The government authorities should enforce regulations and punish producers or marketers who are dishonest and use non-approved quality control processes. Moreover, the government should carry out regular inspections in order to assure consumers of the quality and safety of the product. To avoid a conflict of interest, it is also important to ensure that the government agency responsible for inspection is separate from the one that promotes the marketing of EFPV.

In order to reduce marketing costs, producers and marketers should understand their target before launching any promotion strategies. Certificates and labels are the complementary means of communicating with consumers about the products. This study shows that consumers prefer the certificate labels issued by government agencies rather than those issued by private organizations. Therefore, producers and marketers who run their business in the domestic market should be certified by government agencies. On the other hand, Thai government certification is unknown in international trade. Hence, producers and marketers who export their products need to be certified by a well-known certification body within the importing country or to international standards. Fortunately, there is a local certification body –ACT (Thai certification body that is accredited by IFOAM)- that has been recognised internationally. This organization offers a cheap and efficient service for exporters.

Because increasing awareness of environmental and health problems is leading to an increase in the likelihood of purchasing EFPV and a higher WTP for EFPV, marketers and government agencies should plan appropriate marketing strategies with an emphasis on the significant contribution by EFPV in reducing environmental damage and health risks. Intensive private and public advertising for EFPV and organically produced foods is recommended. The public campaigns need to focus on environment

pollution and health hazards from over- and misuse of chemicals in order to increase knowledge about chemical residue. They should also address education on the characteristics of EFPV and certification, which are likely to change the market situation in favour of EFPV. These activities will not only create more sales for EFPV but will also increase consumers' WTP.

The experiences and results of this study have contributed in-depth information to help improve strategies for market development of EFPV in Thailand. However, some limitations and problems are recommended for future study.

- The first limitation of this study concerns the income variable. Most respondents were reluctant to reveal their actual income. Due to this difficulty, the close-ended answers were expressed as ranges of income. When the econometric models use average income per person, there may be some problems because the ranges are too wide. This might lead to a non-significant income coefficient in the model. The income ranges should be narrower in further study.

- The second limitation of this study is that detaching of yea-saying bias and starting point bias in CVM. The yea-saying biases, however, might be small in our study because our experiment studied the real product (food safety product) differing from environmental evaluation. But starting point bias may occur. We attempted to reduce starting point bias by using three starting points. Our result confirmed that the estimated WTP was narrow and highly significant. The analyses of these two biases are methodology and tool problems considered not to be in our scope of study. Further research is needed to verify our results even the bias might be small for a food safety product.

- The next concern is whether a lower price for EFPV induces higher revenue or not. To answer this question requires "price elasticity of demand" for EFPV but unfortunately the value of this elasticity in unknown. Calculation of price elasticity requires detailed data, price and selling quantities from supermarkets and hypermarkets. However this data is considered to be business confidential and it is very difficult for researchers to acquire.

- The final recommendation for future research is for ongoing updating of the study of consumer behaviour in EFPV market because its development and consumer taste might be continuously changing. For instance, if consumers understand what organic vegetables are, they might change their preferences to higher quality product. The demand for pesticide-safe vegetables might decrease or finally disappear in the market. Thus, it would be interesting to compare later results with the previous research in order to adjust market strategies in future.

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APPENDICES

Appendix 1: Map of Thailand

Source: http://www.lib.utexas.edu/maps/cia05/thailand_sm05.gif

Appendix 2: Land Area Under Organic Management (SOEL-Survey, February 2004)

Order	Country	Organic Hectares	Order	Country	Organic Hectares
1.	Australia	10,000,000	41.	Colombia	33,000
2.	Argentina	2,960,000	42.	Norway	32,546
3.	Italy	1,168,212	43.	Estonia	30,552
4.	USA	950,000	44.	Ireland	29,850
5.	Brazil	841,769	45.	Greece	28,944
6.	Uruguay	760,000	46.	Belgium	20.241
7.	UK	724,523	47.	Zambia	20,000
8.	Germany	696,978	48.	Ghana	19,460
9.	Spain	665,055	49.	Tunisia	18,255
10.	France	509,000	50.	Egypt	17,000
11.	Canada	478,700	51.	Latvia	16,934
12.	Bolivia	364,100	52.	Sri Lanka	15,215
13.	China	301,295	53.	Yugoslavia	15,200
14.	Austria	297,000	54.	Slovenia	15,000
15.	Chile	285,268	55.	Dominican Rep.	14,963
16.	Ukraine	239,542	56.	Guatemala	14,746
17.	Czech Rep.	235,136	57.	Costa Rica	13,967
18.	Mexico	215,843	58.	Morocco	12,500
19.	Sweden	187,000	59.	Nicaragua	10,750
20.	Denmark	178,360	60.	Cuba	10,445
21.	Bangladesh	177,700	61.	Lithuania	8,780
22.	Finland	156,692	62.	Cameroon	7,000
23.	Peru	130,246	63.	Vietnam	6,475
24.	Uganda	122,000	64.	Iceland	6,000
25.	Switzerland	107,000	65.	Russia	5,276
26.	Hungary	103,672	66.	Panama	5,111
27.	Paraguay	91,414	67.	Japan	5,083
28.	Portugal	85,912	68.	Israel	5,030
29.	Ecuador	60,000	69.	El Salvador	4,900
30.	Turkey	57,001	70.	Papua New Guinea	4,265
31.	Tanzania	55,867	71.	Thailand	3,993
32.	Polen	53,515	72.	Azerbaijan	2,540
33.	Slovakia	49,999	73.	Senegal	2,500
34.	New Zealand	46,000	74.	Pakistan	2,009
35.	South Africa	45,000	75.	Luxembourg	2,004
36.	Netherlands	42,610	76.	Philippines	2,000
37.	Indonesia	40,000	77.	Belize	1,810
38.	Romania	40,000	78.	Honduras	1,769
39.	India	37,050	79.	Jamaica	1,332
40.	Kazakhstan	36,882	80.	Bosnia Herzegovina	1,113

Appendix 2: continued

Order	Country	Organic Hectares	Order	Country	Organic Hectares
81.	Liechtenstein	984	90.	Cyprus	166
82.	Bulgaria	500	91.	Laos	150
83.	Kenya	494	92.	Madagascar	130
84.	Malawi	325	93.	Croatia	120
85.	Lebanon	250	94.	Guyana	109
86.	Suriname	250	95.	Syria	74
87.	Fiji	200	96.	Nepal	45
88.	Benin	197	97.	Zimbabwe	40
89.	Mauritius	175	**SUM**		**24,070,010**

Source: WILLER AND YUSSEFI, 2004, p.15

Appendix 3: Questionnaire (translation of Thai version)

Possibilities and Constraints of Marketing
Environmentally Friendly Produced Vegetables in Thailand.

Name of the interviewer: _____

Place: _____ Date: _____/_____/_____

Verified by: _____

Location :	City	Place	
	❑ 1 Bangkok	❑ 1 Supermarket	L1_____
	❑ 2 Chiang Mai	❑ 2 Open Market	
	❑ 3 Khonkaen	❑ 3 Green shop	L2_____

Introduction: The objective of this questionnaire is to collect the data in order to study "Possibilities and constraints of marketing environmentally friendly produced vegetables in Thailand. The data will be used in Mrs Chuthaporn's Ph.D. Dissertation in Agricultural Economics. This study will reveal the consumers' preference and behaviour, which is useful to understand the growth and constraint of the pesticide reduced vegetable marketing in Thailand.

1. Do you usually buy vegetables for your household?
   (Interviewer: If no, please break up the interview)
   ❑ Yes ❑ No

2. Do you prepare food for your household?
   ❑1 Yes ❑0 No If "No", who? _____ E1 ____

3. As a rule, how often do you/your household prepare food at home per week?
   (Interviewer: If "never", break up the interview)
   ❑1 Never ❑2 1-7 times a week ❑3 8-14 times a week
   ❑4 More than 14 times a week ❑5 Other (Please define) ..... E2 ____

4. Do you belong to a special type of consumer, like...

- Vegetarian	❑1 Yes	❑0 No	S1 ____
- Macrobiotic	❑1 Yes	❑0 No	S2 ____
- Cheewajit	❑1 Yes	❑0 No	S3 ____
- Other (Please define)			S4 ____

5. How often do you buy vegetables per week?
   ❑1 Daily ❑2 4-6 times a week ❑3 2-3 times a week B1 ____
   ❑4 1 time per week ❑5 Not weekly (Please define) .....

6. Think of difference markets, where do you buy vegetables?

	Almost always 1	Occasionally 2	Never 3	
Open Market	……..	……	……	B2 ___
Supermarket	……...	……	……	B3 ___
Green shop (Lemon Farm, Aden, Golden Place)	……...	……	……	B4 ___
Other (Please underline or define) (grocery, mobile market, weekly market, direct from the farm, etc...) ……..…….……..	……...	……	……	B5 ___

7. Please estimate your weekly expenditure for food prepared at your home. (excluded rice)
_____ Baht EX1 _____

And could you also tell me the expenditures spent for vegetables for your household?
_____ Baht EX2 _____

8. How important are the following factors to you when you purchase vegetables? Please score, 1 is very important, 2 is somewhat important, 3 is neither important nor unimportant, 4 is somewhat unimportant, and 5 is very unimportant.
(Interviewer: Please give the scale)

Factor	1	2	3	4	5	No answer (99)	
Freshness							F1 ___
Family's preference							F2 ___
Appearance (no perforations, or other damage)							F3 ___
Price							F4 ___
Geographical origin (from the Northern, imported)							F5 ___
Having certificate							F6 ___

Considering the above factors, which factors have the strangest influence (respectively) on your decision when purchasing vegetables?

Please rank the factors according to their importance for your decision, which factor is the most important = 1, the second most important = 2, …, the least important = 6.
(Interviewer: Please give the card)

F7.1	F7.2	F7.3	F7.4	F7.5	F7.6
Family's preference	Freshness	Appearance	Price	Geographical origin	Having certificate

In Thailand, there is a discussion whether residues from chemicals used during the cultivation of vegetables is a problem.

9. Are you concerned about residues that remain in vegetables you consume?

❑$_1$ Yes ❑$_0$ No

(If yes, please continue with question 10. If no, please go to question 11) B6 ____

10. I have listed some residues that could be found in vegetables below. Which one of the following residues are you concerned about? Please have a look and tell me the level of your concern. (Interviewer: Please give the scale and ask the level of concern)
1 = very concerned, 2 = concerned, and 3 = not concerned.

Are you aware of … ?	1 very concerned	2 concerned	3 not concerned	9 Don't know	99 No answer	
Chemical fertiliser residues	……	……	……	……..	……	B7 _____
Pesticide residues	……	……	……	……..…	……	B8 _____
Heavy metal residues; e.g. lead, mercury	……	……	……	……..	…….	B9 _____
Pathogens			……..…	……..	…….	B10 _____
Other (Please define) .....….....	……	……	…….	……..	……	B11 _____

11. In the same context, are you aware of Nitrate residues?

❑$_1$ Yes, I have concerned (Please explain, where is the Nitrate come from?….) ❑$_0$ No B12____

12. Usually, how do you/your household members clean your vegetables before cooking? (Interviewer: several answers are possible, please underline/define solution) W1 _____

❑$_1$ No washing ❑$_2$ Soak in water ____ time(s) W2 _____

❑$_3$ Wash under running water for ____ min. W3 _____

❑$_4$ Wash with natural product: rice rinsing water, saline solution, vinegar _____ W4 _____

❑$_5$ Wash with chemical: potassium permanganate solution, hydrogenperoxide solution, baking soda solution, vegetable washing liquid _____ W5 _____

❑$_6$ Wash with ozonated water. ❑$_7$ Other (Please define) ……. W6 _____

W7 _____

13. In your opinion, what is a pesticide-safe vegetable? I give you some possible explanations and ask you to state your opinion or give your own definition.

❑$_1$ Vegetables which were grown in the net-house.

❑$_2$ Vegetables which were grown using less pesticides or only when necessary and compiled for harvesting period. W8_____

❑$_3$ Vegetables which were grown without any pesticide use.

❑$_4$ Vegetables which were grown without chemical fertilizer and pesticide usage.

❑$_5$ Vegetables which were grown without the use of any chemical input. Farmers pay more attention to all processes of production and post-harvest in their farm without any chemical contamination.

❑$_6$ Other (Please define)..... ❑$_9$ Don't know

Definition of pesticide-safe vegetable is the vegetable that some farmers decrease their use of chemicals in cultivation or do not use them at all. In their product there will be no chemical residue or less residue than the standard limit. This product that is safe for consumption.

14. Have you ever bought any pesticide-safe vegetables?

❑$_1$ Yes ❑$_0$ No B13 _____

(Interviewer: If yes, please go to question 16. If no, please continue with question 15.)

15. If no, please give me some reasons.
(Interviewer: Please cross or complete the lists, several answers are possible) B14

❑$_1$ Hard to find in the market ❑$_2$ No difference with the other vegetables _____1 _____2

❑$_3$ Too limited assortment ❑$_4$ Too expensive _____3 _____4

❑$_5$ Low quality ❑$_6$ Don't know _____5 _____6

❑$_7$ Other (Please define).....

(Interviewer: Please go to question 25.)

16. Please estimate your quantity share of pesticide-safe vegetables to conventional vegetables that you buy per week. (Please give the scale)

❑$_1$ 0% ❑$_2$ 1-25% ❑$_3$ 26-50% ❑$_4$ 51-75% ❑$_5$ 76-100% EX3_____

17. What was your incentive reason(s) to purchase pesticide-safe vegetables? B15

❑$_1$ Health conditions ❑$_2$ Advised/recommendation from someone (doctor, friend,…) _____1_____2

❑$_3$ Easy to find in the market ❑$_4$ To support environmentally friendly production _____3_____4

❑$_5$ Popular ❑$_6$ To contribute to a better environment _____5_____6

❑$_7$ Other (Please define).....

18. Concerning the presentation, what source of appearance do you usually buy?

❑$_1$ No packaging ❑$_2$ With packaging but no brand name and certificate B16 _____

❑$_3$ With packaging and certificate ❑$_4$ With packaging and brand name

❑$_5$ With packaging, certificate and brand name ❑$_6$ Other (Please define).....

19. How often do you buy pesticide-safe vegetables?

❑$_1$ Always ❑$_2$ Occasionally ❑$_3$ Rarely

(Interviewer: If always or occasionally, please go to question 21.
If rarely, please continue with question 20.) B17 _____

20. If rarely, why not more often? B18
(Interviewer: Please cross or complete the lists, several answers are possible)

❑$_1$ Hard to find in the market ❑$_2$ No difference to the other produced ____1 ____2

❑$_3$ Too limited assortment ❑$_4$ Too expensive ____3 ____4

❑$_5$ Low quality ❑$_6$ Other (Please define)..... ___5 ___6

(Interviewer: Please go to question 25.)

21. If always and occasionally, where do you buy the pesticide-safe vegetables?
(Interviewer: Several answers are possible)

❑$_1$ Fresh Market ❑$_2$ Supermarket ❑$_3$ Green shop B19 _____

❑$_4$ Other (Please define): grocery, weekly market, direct from the farm, ……..…

22. Please tell me, which certificates or/and brands of pesticide-safe vegetables you know. B20 _____

1.) .....……..... 2.) ....…..... B21 _____

3.) .....…..... B22 _____

23. I have brought some pictures of various certificate or/and brands. Please have a look these certificates/brands and tell me, which of them do you know?
And, which of these do you usually buy?
(Interviewer: Show the pictures. Please ask and cross each question.)

	Do you know these certificates/brands?		Do you usually buy these certificates/brands?		
	Know	Don't know	Yes	No	
(picture of certificate no1)	❑$_1$	❑$_2$	❑$_3$	❑$_4$	C1 __ __
(picture of certificate no2)	❑$_1$	❑$_2$	❑$_3$	❑$_4$	C2 __ __
(picture of certificate no3)	❑$_1$	❑$_2$	❑$_3$	❑$_4$	C3 __ __
(picture of certificate no4)	❑$_1$	❑$_2$	❑$_3$	❑$_4$	C4 __ __
(picture of certificate and brand no5)	❑$_1$	❑$_2$	❑$_3$	❑$_4$	C5 __ __
(picture of certificate and brand no6)	❑$_1$	❑$_2$	❑$_3$	❑$_4$	C6 __ __
(picture of certificate and brand no7)	❑$_1$	❑$_2$	❑$_3$	❑$_4$	C7 __ __

(Interviewer: If 'Don't know' or/and 'No' in every item go to question 25.)

24. What are your reasons for choosing the certificate(s) or/and brand(s) in question 23?
(Interviewer: Please cross or complete the lists, several answers are possible)

C9

❑$_1$ Trust in this certificate ❑$_2$ Well known ___1 ___2

❑$_3$ Cheaper than similar product ❑$_4$ Easy to find in the market ___3 ___4

❑$_5$ Higher quality than other certificates/brands ❑$_6$ Other (Please define)..... ___5 ___6

25. Suppose you would like to buy vegetables. You found 9 packages of vegetable, which have different characteristics: the level of chemical residue, certificate issued and price. Please rank the packages according to your preference, from 1 (first) to 9 (last)

(Interviewer: Please give cards "set E" and explain the cards)

E ♎	E ❀	E ❖	E ✸	E ♐	E ♈	E ♉	E ♾	E ♓

(Interviewer: Please give cards "set F" and explain the cards)

F ♎	F ❀	F ❖	F ✸	F ♐	F ♈	F ♉	F ♾	F ♓

26. Suppose you usually pay ____ baht/kg for a kind of conventional vegetable of which the chemical residue is unknown. There is the same kind of vegetable but it is pesticide-safe vegetable, which was grown without any chemical fertilizer and pesticide usage. Moreover, it has certificate issued by an agency that you can trust.
Would you like to purchase this pesticide-free vegetable if it costs _____ baht/kg?

❑$_1$ Yes		❑$_2$ No		WTP1 ____
If the price of this pesticide-safe vegetable increases to _____ baht/kg, would you still purchase it?		If the price of this pesticide-safe vegetable decreases to _____ baht/kg, would you still purchase it?		
❑$_{11}$ Yes	❑$_{12}$ No	❑$_{21}$ Yes	❑$_{22}$ No	WTP2 ____
How much is your maximum willingness to pay for this pesticide-safe vegetable? _____ baht/kg			How much is your maximum willingness to pay for this pesticide-safe vegetable? _____ baht/kg	

27. I would like to read some statements. Please tell me the degree of your agreement.
1 = Strongly agree, 2 = Agree, 3 = Partly agree/disagree, 4 = Disagree, and 5 = Strongly disagree
(Interviewer: Please give the scale)

	1 Strongly Agree	2 Agree	3 Partly agree/ disagree	4 Disagree	5 Strongly disagree	9 Don't know	99 No answer	
Chemical fertiliser use in vegetable production is harmless.								A1 _____
Pesticide-safe vegetables should be more expensive than conventional vegetables, to increase pesticide-free production.								A2 _____
Pesticide residues in vegetables increase health hazards: e.g. cancer.								A3 _____
Using pesticides in vegetable production should be banned because of environmental damage.								A4 _____
Even if the farmer uses chemical inputs, there will be no health problems because I wash the vegetable.								A5 _____
I buy pesticide-safe vegetable because I want to improve the environment.								A6 _____

Social-demographic Characteristics

I would like to ask you a few questions about your household situation.

28. In your household, has anybody been sick with a chronic disease such as cancer, diabetes, allergies or nervous system diseases?

❑$_1$ Yes (please explain) .....……..... ❑$_0$ No ❑$_{99}$ No answer D1 _____

29. How many persons including you live in your household? _____persons D2 _____

And, how many children (up to 5 years) are there in your household? _____persons D3 _____

30. Please tell me. How old are you? _____ years old D4 _____

31. Would you please tell me your marital status?

❑$_0$ Single ❑$_1$ Married ❑$_2$ Other ..... ❑$_{99}$ No answer D5 _____

32. Could you please tell me, what is your level of education?

❑$_1$ No schooling ❑$_2$ Primary school (P4) D6 _____

❑$_3$ Primary school (P6) ❑$_4$ Secondary school (M3)

❑$_5$ Secondary school (M6) ❑$_6$ College

❑$_7$ Bachelor's degree ❑$_8$ Master's degree or higher

❑$_9$ Other (Please define)..... ❑$_{99}$ No answer

33. Would you please tell me your occupation? _____ D7 _____

34. How many members including you contribute to the household income? ____persons D8 _____

35. Please assess your total household income per month. Which of the following income group does it belong to?

D9 _____

❑$_1$ 8,000 baht and less ❑$_2$ 8,001-20,000 baht

❑$_3$ 20,001-40,000 baht ❑$_4$ 40,001-70,000 baht

❑$_5$ 70,001-100,000 baht ❑$_6$ 100,001-200,000 baht

❑$_7$ More than 200,000 baht ❑$_8$ Other (Please define)..……..... ❑$_{99}$ No answer

36. Why do you think the market of pesticide-free vegetables is slowly growing?

.....

.....

(Interview: Please write in the next page, if respondent has long comment.)

Name: .....

Address: .....

..... Tel: .....

Thank you very much for completing this survey.
Your help in this study is greatly appreciated.

Gender: ❑$_1$ Female ❑$_2$ Male D10 _____

Additional remarks by the interviewer.

Appendix 4: Socio-demographic characteristics of the survey (question 30-31, appendix 3)

Socio-demographic characteristic	All		Bangkok		Chiang Mai		Khon Kaen	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Gender- Female	1,140	86.4	549	86.6	266	88.4	325	84.4
- Male	180	13.6	85	13.4	35	11.6	60	15.6
No. of observations	1,320	100.0	634	100.0	301	100.0	385	100.0
Q30: Age (average)	(35.97)		(38.25)		(36.09)		(32.15)	
- Less than 20	98	7.4	26	4.1	13	4.3	59	15.3
- 21-30	376	28.5	168	26.6	72	24.0	136	35.3
- 31-40	402	30.5	181	28.6	127	42.4	94	24.4
- 41-50	307	23.3	171	27.0	66	22.0	70	18.2
-51-60	96	7.3	59	9.3	16	5.3	21	5.5
- More than 60	39	3.0	28	4.4	6	2.0	5	1.3
No. of observations	1,318	100.0	633	100.0	300	100.0	385	100.0
Q31: Marital status								
- Single	473	35.8	218	34.4	71	23.6	184	47.8
- Married	835	63.3	414	65.3	224	74.4	197	51.2
- Other	12	0.9	2	0.3	6	2.0	4	1.0
No. of observations	1,320	100.0	634	100.0	301	100.0	385	100.0

Source: Consumer survey

Appendix 5: Average household income, food and vegetable expenditure by province (THB per month)

Province	**No. of observations**	**Total income**	**Food expenditure**	**Vegetable expenditure**
Bangkok	634	60,126	4,355	1,516
Chiang Mai	301	39,033	3,557	1,261
Khon Kaen	385	30,660	3,141	1,008
Total	1,320	46,780	3,821	1,311

Source: Consumer survey

Appendix 6: Characteristics of consumer habits and behaviour (question 2-6, appendix 3)

Behavioural Characteristic		**Frequency**	**Percent**
Q2: Purchase vegetables and prepare food for household.		977	74.0
Q3: Frequency of preparing food at home			
- 1-3 times a week		233	17.7
- 4-7 times a week		403	30.5
- 8-14 times a week		332	25.2
- 15-18 times a week		83	6.3
- Every meal		256	19.4
Q4: Affiliation to a special type of consumer			
- Vegetarian		175	13.3
- Macrobiotic		73	5.5
- Cheewajit		117	8.9
Q5: Frequency of purchasing vegetables			
- Daily		395	29.9
- 4-6 times a week		202	15.3
- 2-3 times a week		522	39.5
- 1 time a week		185	14.0
- Not weekly		16	1.2
Q6: Place to purchase vegetables (multiple answers allowed)			
Open market	- almost always	978	74.1
	- occasionally	236	17.9
	- never	106	8.0
Supermarket	- almost always	411	31.1
	- occasionally	641	48.6
	- never	268	20.3
Green shop	- almost always	272	20.6
	- occasionally	247	18.7
	- never	801	60.7

Note: Total observations = 1,320

Source: Consumer survey

Appendix 7: Consumers' perceptions of EFPV

Q13: What is the definition of EFPV vegetable? (multiple answers allowed)		
Definition	Frequency	Percentage of respondents
Vegetables were grown in the net-house.	199	15.4
Vegetables were grown using less pesticides or only when necessary and compiled for harvesting period	167	12.9
Vegetables were grown without any pesticide use.	218	16.9
Vegetables were grown without chemical fertilizer and pesticide usage.	461	35.7
Vegetables were grown without the use of any chemical input. Farmers pay more attention to all processes of production and post-harvest in their farm without any chemical contamination. (Organic)	234	18.1
Don't know	13	1.0
No. of observations	1,292	100

Source: Consumer survey

Appendix 8: Complementary information on consumer behaviour (question 15, 20 and 16, appendix 3)

Q15/Q20: Reason of respondents who never/ rarely buy EFPV (multiple answers allowed.)		
Reason	Percentage of respondents	
	Never buy	Rarely buy
Hard to find in the market	63.4	58.0
Too expensive	18.0	19.3
Don't know	18.0	-
Does not trust in its quality	16.5	6.8
Too limited assortment	10.3	5.7
Own growing	2.1	2.3
Low quality (disappearance)	1.6	-
Market is far-off (know where to buy)	-	20.5
No. of observations	194	88

Q16: Estimate the quantity share of pesticide-safe vegetables to conventional vegetables that consumer buy per week. (give the scale)				
Quantity share	Frequency (percentage of respondents)			
	Always	Occasionally	Rarely	Total with in row
0 %	0 (0)	9 (0.8)	3 (3)	12 (1.1)
1-25%	59 (5.3)	324 (28.9)	71 (6.3)	454 (40.4)
26-50%	129 (11.5)	142 (12.6)	11 (1.0)	282 (25.1)
51-75%	156 (13.9)	13 (1.2)	0 (0.0)	169 (15.0)
76-100%	200 (17.8)	3 (0.3)	3 (0.3)	206 (18.3)
Total within column	544 (48.4)	491 (43.7)	88 (7.8)	1,123 (100.0)

Source: Consumer survey

Appendix 9: Reasons and outlets to buy EFPV (questions 17, and 21, appendix 3)

Q17: What was your incentive reason(s) to purchase pesticide-safe vegetables? (multiple answers allowed.)	
Reason	Percentage of respondents
Health concerned	85.0
Easy to find in the market	14.5
Popular	10.9
Advised/recommendation from someone (doctor, friend, …)	8.6
To support environmentally friendly production	7.8
To contribute to a better environment	7.2
Confidence in quality	3.1
Advertising	3.0
Testing	1.0
Exotic assortment	0.5
No. of observations	1,126
Q21: Only the respondents who always/ occasionally buy EFPV. Where do you buy the pesticide-safe vegetables? (multiple answers allowed.)	
Market	Percentage of respondents
Fresh market	17.6
Supermarket	55.2
Green shop	10.5
Other (weekly market, monthly market, direct from farm, etc.)	11.9
No. of observations	1,037

Source: Consumer survey

Appendix 10: Respondents' attitudes towards the use of chemicals in vegetable production (questions 27, appendix 3)

Statement	Strongly Agree	Agree	Partly agree/ disagree	Disagree	Strongly disagree	No. of observations
Chemical fertiliser use in vegetable production is harmless. (*A1*)	116	363	117	600	94	1,290
(Percentage)	(9.0)	(28.1)	(9.1)	(46.5)	(7.3)	(100.0)
Pesticide-safe vegetables should be more expensive than conventional vegetables, to increase pesticide-free production. (*A2*)	188	803	97	206	16	1,310
(Percentage)	(14.4)	(61.3)	(7.4)	(15.7)	(1.2)	(100.0)
Pesticide residues in vegetables increase health hazards: e.g. cancer. (*A3*)	563	619	40	66	14	1,302
(Percentage)	(43.2)	(47.5)	(3.1)	(5.1)	(1.1)	(100.0)
Using pesticides in vegetable production should be banned because of environmental damage. (*A4*)	295	612	154	233	16	1,310
(Percentage)	(22.5)	(46.7)	(11.8)	(17.8)	(1.2)	(100.0)
Even if the farmer uses chemical inputs, there will be no health problems because I wash the vegetable. (*A5*)	54	418	138	606	93	1,309
(Percentage)	(4.1)	(31.9)	(10.5)	(46.3)	(7.1)	(100.0)
I buy pesticide-safe vegetable because I want to improve the environment. (*A6*)	208	779	224	69	17	1,297
(Percentage)	(16.0)	(60.1)	(17.3)	(5.3)	(1.3)	(100.0)

Source: Consumer survey

Appendix 11: Comparison of consumers' attitude scores toward 6 statements on health and environmental concerns between two consumer groups (question 27, appendix 3)

Statement[1/]		No.	Mean Rank[2/]	Mann-Whitney U	Z score	P-Value
A1	Always purchase	534	681.99	182365.5	-3.161	0.002
	Others	756	619.72			
	Total	1,290				
A2	Always purchase	541	673.87	198075.5	-1.688	0.091
	Others	769	642.58			
	Total	1,310				
A3	Always purchase	541	698.63	180352.5	-4.233	0.000
	Others	761	617.99			
	Total	1,302				
A4	Always purchase	541	676.64	196576.0	-1.809	0.070
	Others	769	640.63			
	Total	1,310				
A5	Always purchase	540	721.22	171871.5	-5.705	0.000
	Others	769	608.50			
	Total	1,309				
A6	Always purchase	539	683.89	185475.5	-3.216	0.001
	Others	758	624.19			
	Total	1,297				

Note: [1/] *A1*- Chemical fertiliser use in vegetable production is harmless.

A2- Pesticide-safe vegetables should be more expensive than conventional vegetables, to increase pesticide-free production.

A3- Pesticide residues in vegetables increase health hazards: e.g. cancer.

A4- Using pesticides in vegetable production should be banned because of environmental damage.

A5- Even if the farmer uses chemical inputs, there will be no health problems because I wash the vegetable.

A6- I buy pesticide-safe vegetable because I want to improve the environment.

[2/] Mean of rank transformed data: statements *A1* and *A5*: strongly agree= -2, agree= -1, neutral= 0, disagree= 1, strongly disagree = 2. – Statements *A2*, *A3*, *A4*, and *A6*: strongly agree= 2, agree= 1, neutral= 0, disagree= -1, strongly disagree = -2

Source: Consumer survey

Appendix 12: Mann-Whitney-tests on equality of mean scores between consumers who always purchase EFPV and others – details -

Factor		No.	Mean Rank[1/]	Mann-Whitney U	Z score	P-Value
Freshness	Always purchase	544	684.43	198051.5	-2.759	0.006
	Others	776	643.72			
	Total	1,320				
Family's preference	Always purchase	544	679.41	200243.0	-1.714	0.087
	Others	775	646.38			
	Total	1,319				
Appearance	Always purchase	542	643.17	201443.0	-1.257	0.209
	Others	774	669.24			
	Total	1,316				
Price	Always purchase	542	609.28	183078.0	-4.119	0.000
	Others	772	691.35			
	Total	1,314				
Geographical origin	Always purchase	542	719.03	175862.5	-5.124	0.000
	Others	772	614.30			
	Total	1,314				
Certificate	Always purchase	542	793.31	136686.5	-11.122	0.000
	Others	774	564.10			
	Total	1,316				

Note: [1/] Mean of rank transformed data

Source: Consumer survey

Appendix 13: Full factorial design of the conjoint experiment (3 attributes, 3 levels)

Product No.	Chemical residue (β_{1j})	Certificate (β_{1k})	Price (β_{1m})	Utility
1	Conventional	No certificate	25% margin	$U_1 = \beta_{11}+\beta_{21}+\beta_{31}$
2	Conventional	No certificate	50% margin	$U_2 = \beta_{11}+\beta_{21}+\beta_{32}$
3	Conventional	No certificate	100% margin	$U_3 = \beta_{11}+\beta_{22}+\beta_{33}$
4	Conventional	Government	25% margin	$U_4 = \beta_{11}+\beta_{22}+\beta_{31}$
5	Conventional	Government	50% margin	$U_5 = \beta_{11}+\beta_{22}+\beta_{32}$
6	Conventional	Government	100% margin	$U_6 = \beta_{11}+\beta_{22}+\beta_{33}$
7	Conventional	Company	25% margin	$U_7 = \beta_{11}+\beta_{23}+\beta_{31}$
8	Conventional	Company	50% margin	$U_8 = \beta_{11}+\beta_{23}+\beta_{32}$
9	Conventional	Company	100% margin	$U_9 = \beta_{11}+\beta_{23}+\beta_{33}$
10	Pesticide-safe	No certificate	25% margin	$U_{10} = \beta_{21}+\beta_{21}+\beta_{31}$
11	Pesticide-safe	No certificate	50% margin	$U_{11} = \beta_{12}+\beta_{21}+\beta_{32}$
12	Pesticide-safe	No certificate	100% margin	$U_{12} = \beta_{12}+\beta_{21}+\beta_{33}$
13	Pesticide-safe	Government	25% margin	$U_{13} = \beta_{12}+\beta_{22}+\beta_{31}$
14	Pesticide-safe	Government	50% margin	$U_{14} = \beta_{12}+\beta_{22}+\beta_{32}$
15	Pesticide-safe	Government	100% margin	$U_{15} = \beta_{12}+\beta_{22}+\beta_{33}$
16	Pesticide-safe	Company	25% margin	$U_{16} = \beta_{12}+\beta_{23}+\beta_{31}$
17	Pesticide-safe	Company	50% margin	$U_{17} = \beta_{12}+\beta_{23}+\beta_{32}$
18	Pesticide-safe	Company	100% margin	$U_{18} = \beta_{12}+\beta_{23}+\beta_{33}$
19	Organic	No certificate	25% margin	$U_{19} = \beta_{13}+\beta_{21}+\beta_{31}$
20	Organic	No certificate	50% margin	$U_{20} = \beta_{13}+\beta_{21}+\beta_{32}$
21	Organic	No certificate	100% margin	$U_{21} = \beta_{13}+\beta_{21}+\beta_{33}$
22	Organic	Government	25% margin	$U_{22} = \beta_{31}+\beta_{22}+\beta_{31}$
23	Organic	Government	50% margin	$U_{23} = \beta_{13}+\beta_{22}+\beta_{32}$
24	Organic	Government	100% margin	$U_{24} = \beta_{13}+\beta_{22}+\beta_{33}$
25	Organic	Company	25% margin	$U_{25} = \beta_{13}+\beta_{23}+\beta_{31}$
26	Organic	Company	50% margin	$U_{26} = \beta_{13}+\beta_{23}+\beta_{32}$
27	Organic	Company	100% margin	$U_{27} = \beta_{13}+\beta_{23}+\beta_{33}$

Source: Own presentation

Appendix 14: Stimuli of conjoint experiment including price (plandcards set E, appendix 15)

Stimulus symbol	Chemical residue (β_{1j})	Certificate (β_{1k})	Price (β_{1m})	Utility of the combination stimuli
E♆	Conventional	No certificate	50% margin	$U_2 = \beta_{11}+\beta_{21}+\beta_{32}$
E♉	Conventional	Government	25% margin	$U_4 = \beta_{11}+\beta_{22}+\beta_{31}$
E❖	Conventional	Company	100% margin	$U_9 = \beta_{11}+\beta_{23}+\beta_{33}$
E✸	Pesticide-safe	No certificate	25% margin	$U_{10} = \beta_{12}+\beta_{21}+\beta_{31}$
E❁	Pesticide-safe	Government	100% margin	$U_{15} = \beta_{12}+\beta_{22}+\beta_{33}$
E♒	Pesticide-safe	Company	50% margin	$U_{17} = \beta_{12}+\beta_{23}+\beta_{32}$
E♌	Organic	No certificate	100% margin	$U_{21} = \beta_{13}+\beta_{21}+\beta_{33}$
E♟	Organic	Government	50% margin	$U_{23} = \beta_{13}+\beta_{22}+\beta_{32}$
E♓	Organic	Company	25% margin	$U_{25} = \beta_{13}+\beta_{23}+\beta_{31}$

Source: Own representation

Appendix 15: Plancards of conjoint analysis including price attribute (set E)

E⌖  Price 30 bath/ kg Conventional vegetable No certificate	E❁  Price 40 bath/ kg Pesticide-safe vegetable Certified by government	E❖  Price 40 bath/ kg Conventional vegetable Certified by company
E✸  Price 25 bath/ kg Pesticide-safe vegetable No certificate	E♌  Price 40 bath/ kg Organic vegetable No certificate	E♟  Price 30 bath/ kg Organic vegetable Certified by government
E♉  Price 25 bath/ kg Conventional vegetable Certified by government	E♒  Price 30 bath/ kg Pesticide-safe vegetable Certified by company	E♓  Price 25 bath/ kg Organic vegetable Certified by company

Source: Own presentation

Appendix 16: Stimuli of conjoint experiment excluding price attribute (plandcards set F, appendix 16)

Stimulus symbol	Chemical residue	Certificate	Utility
F✟	Conventional	No certificate	$U_1 = \beta_{11}+\beta_{21}$
F✍	Conventional	Government	$U_2 = \beta_{11}+\beta_{22}$
F✸	Conventional	Company	$U_3 = \beta_{11}+\beta_{23}$
F✡	Pesticide-safe	No certificate	$U_4 = \beta_{12}+\beta_{21}$
F❖	Pesticide-safe	Government	$U_5 = \beta_{12}+\beta_{22}$
F❁	Pesticide-safe	Company	$U_6 = \beta_{12}+\beta_{23}$
F♉	Organic	No certificate	$U_7 = \beta_{13}+\beta_{21}$
F❧	Organic	Government	$U_8 = \beta_{13}+\beta_{22}$
F⍋	Organic	Company	$U_9 = \beta_{13}+\beta_{23}$

Source: Own representation

Appendix 17: Plancards of conjoint analysis excluding price attribute (set F)

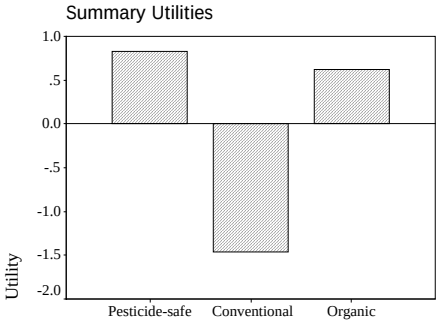
F⌖  Conventional vegetable No certificate	F❁  Pesticide-safe vegetable Certified by company	F❖  Pesticide-safe vegetable Certified by government
F✸  Conventional vegetable Certified by company	F♌  Organic vegetable Certified by government	F♟  Organic vegetable Certified by company
F♉  Organic vegetable No certificate	F♒  Conventional vegetable Certified by government	F♓  Pesticide-safe vegetable No certificate

Source: Own presentation

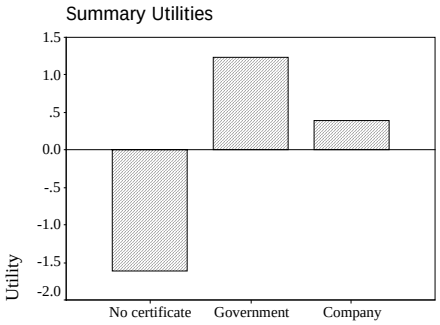
Appendix 18: Results of the conjoint analysis including price attribute by using OLS (total subsets)

Averaged Importance		Utility	Factor
		RES	Chemical residues
36.66	0.8319	--|	Pesticide-safe
	-1.4581	----|	Conventional
	0.6262	--|	Organic
		CER	Certificate
45.56	-1.6154	----|	No certificate
	1.2307	---|	Government
	0.3846	-|	Company
		PRICE	Price
17.78	0.3952	-|	Inexpensive (+25%)
	-0.7154	--|	Expensive (+100%)
	0.3202	-|	Average (+50%)
	4.9961	CONSTANT	

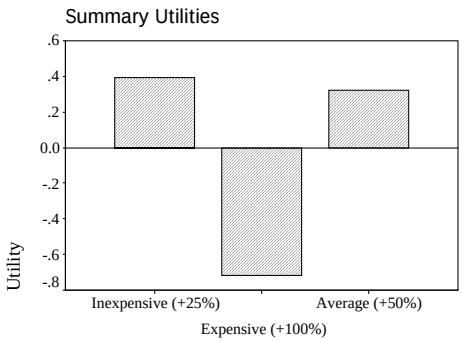
Pearson's R = 1.000 Significance = .0000
Kendall's tau = 1.000 Significance = .0001



Chemical residues



Certificate



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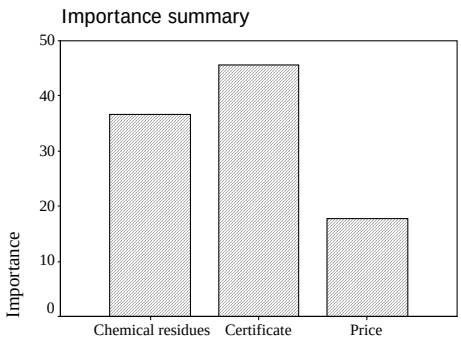
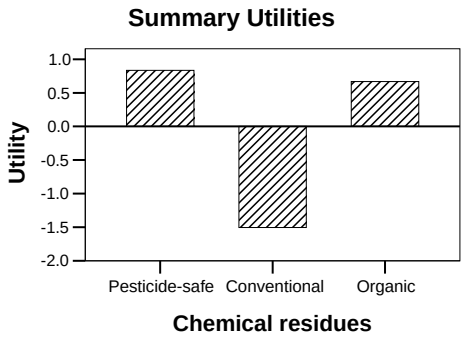
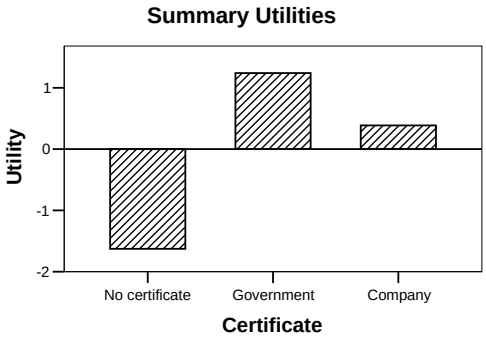


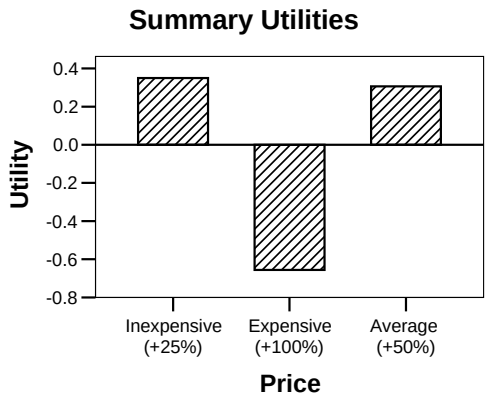
Factor

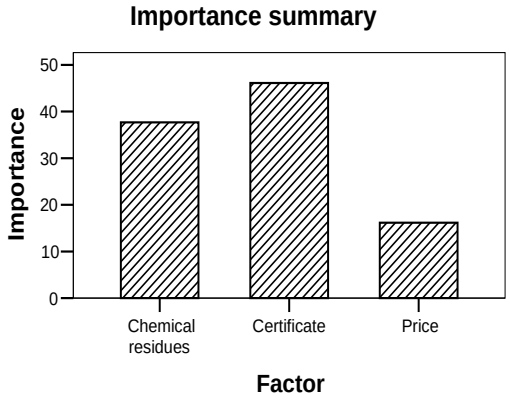
Appendix 19: Results of the conjoint analysis including price attributes by using OLS (Bangkok)

```
 Averaged
Importance   Utility        Factor
                            res          Chemical residues
   37.67       .8362             --       Pesticide-safe
              -1.5050        ----          Conventional
               .6688             --       Organic
                  |
                            cer          Certificate
   46.14     -1.6275        ----          No certificate
              1.2401             ---      Government
               .3874             -        Company
                  |
                            price        Price
16.18             |
               .3498             -        Inexpensive (+25%)
              -.6561           --          Expensive (+100%)
               .3063             -        Average (+50%)
                  |
              4.9958        CONSTANT
Pearson's R   = 1.000                      Significance =  .0000
Kendall's tau = 1.000                      Significance =  .0001
```







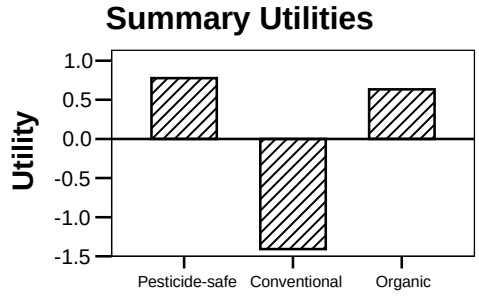


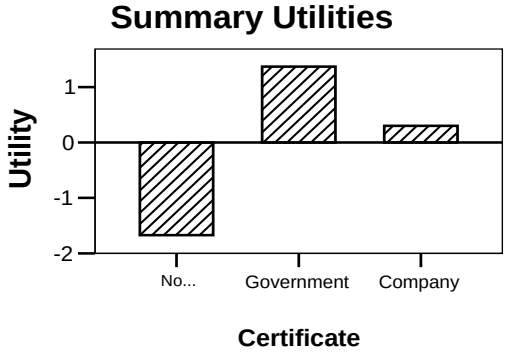
Appendix 20: Results of the conjoint analysis including price attributes by using OLS (Chiang Mai)

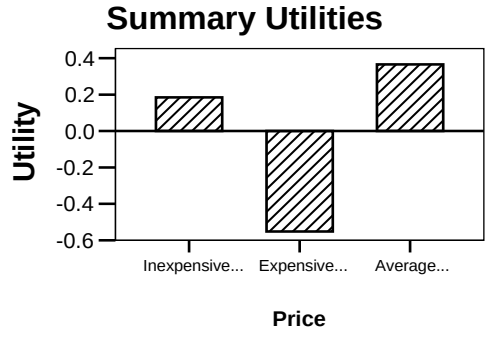
Averaged Importance	Utility	Factor		
		res		Chemical residues
35.57	.7759		--	Pesticide-safe
	-1.4092	---		Conventional
	.6333		--	Organic
		cer		Certificate
49.49	-1.6701	----		No certificate
	1.3701		---	Government
	.3000		-	Company
		price		Price
14.95	.1851			Inexpensive (+25%)
	-.5517		-	Expensive (+100%)
	.3667		-	Average (+50%)
	5.0000	CONSTANT		

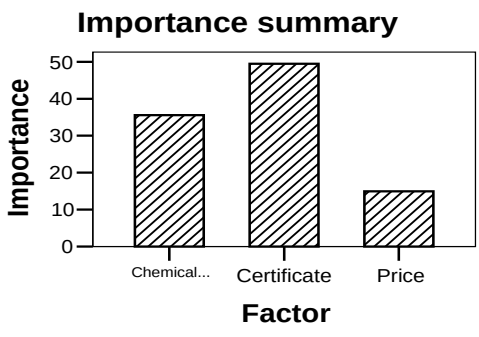
Pearson's R = 1.000 Significance = .0000

Kendall's tau = 1.000 Significance = .0001







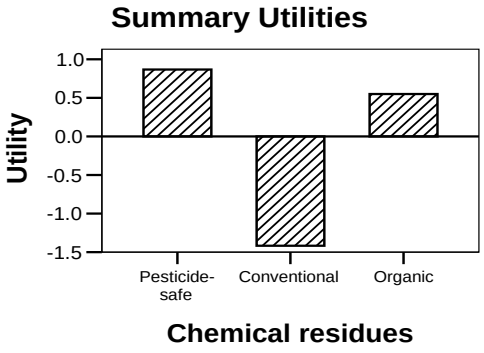


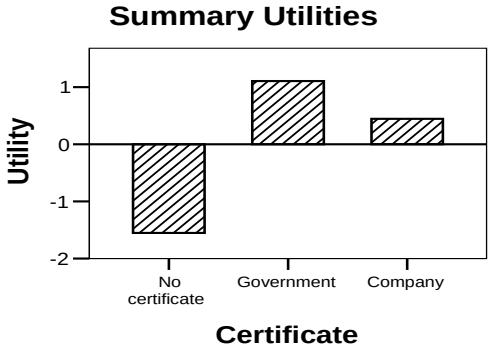
Appendix 21: Results of the conjoint analysis including price attributes by using OLS (Khon Kaen)

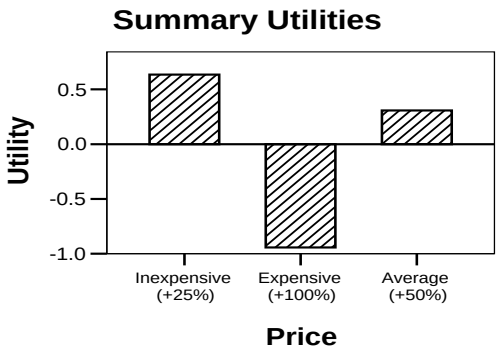
Averaged Importance	Utility	Factor		
		res		Chemical residues
35.04	.8681		--	Pesticide-safe
	-1.4171	----		Conventional
	.5490		-	Organic
		cer		Certificate
40.78	-1.5526	----		No certificate
	1.1070		---	Government
	.4456		-	Company
		price		Price
24.18	.6346		--	Inexpensive (+25%)
	-.9421	--		Expensive (+100%)
	.3075		-	Average (+50%)
	4.9938	CONSTANT		

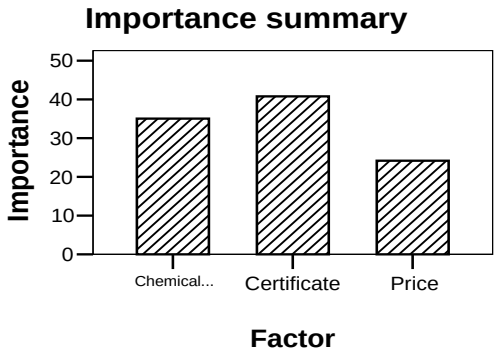
Pearson's R = 1.000 Significance = .0000

Kendall's tau = 1.000 Significance = .0001





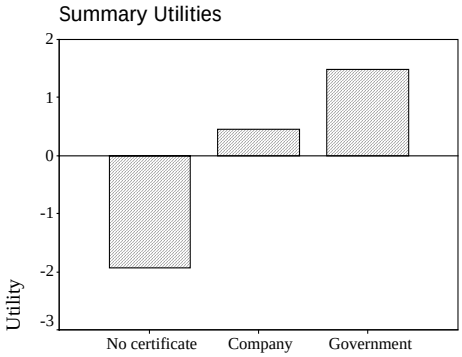


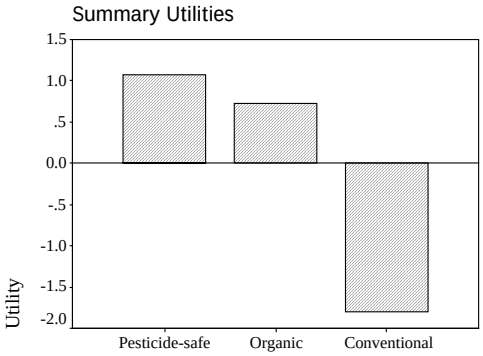


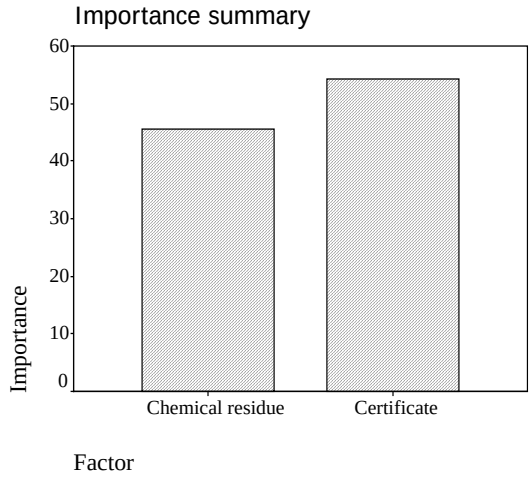
Appendix 22: Results of the conjoint analysis excluding price attribute by using OLS (total subsets)

Averaged Importance	Utility	Factor
	RESI	Chemical residue
45.68	1.0745	Pesticide-safe
	0.7224	Organic
	-1.7969	Conventional
	CERT	Certificate
54.32	-1.9320	No certificate
	0.4495	Company
	1.4825	Government
	4.9994	CONSTANT

Pearson's R = .998 Significance = .0000
Kendall's tau = 1.000 Significance = .0001





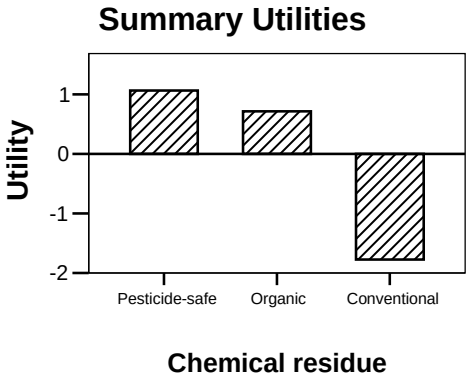


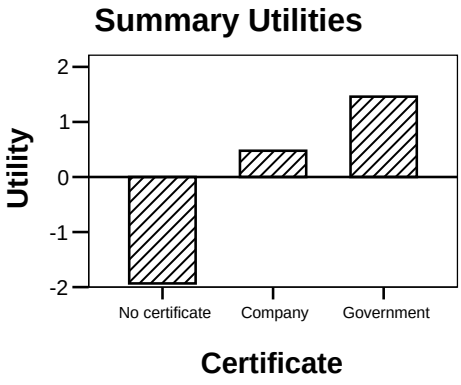
Appendix 23: Results of the conjoint analysis excluding price attributes by using OLS (Bangkok)

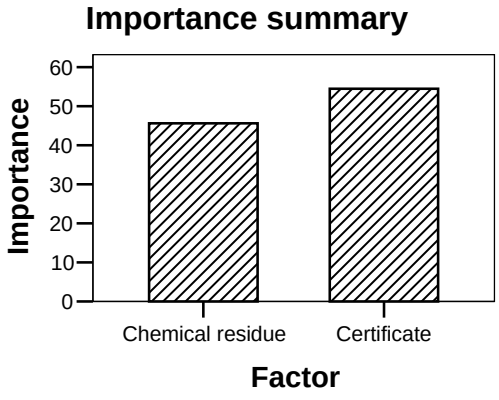
Averaged Importance	Utility	Factor		
		resi		Chemical residue
45.57	1.0632		--	Pesticide-safe
	.7139		-	Organic
	-1.7771	----		Conventional
		cert		Certificate
54.43	-1.9341	----		No certificate
	.4761		-	Company
	1.4580		---	Government
	4.9988	CONSTANT		

Pearson's R = .999 Significance = .0000

Kendall's tau = 1.000 Significance = .0001





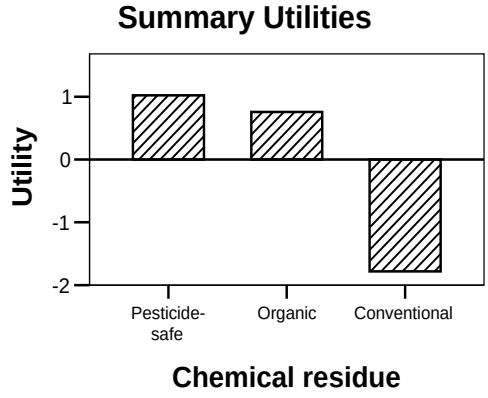


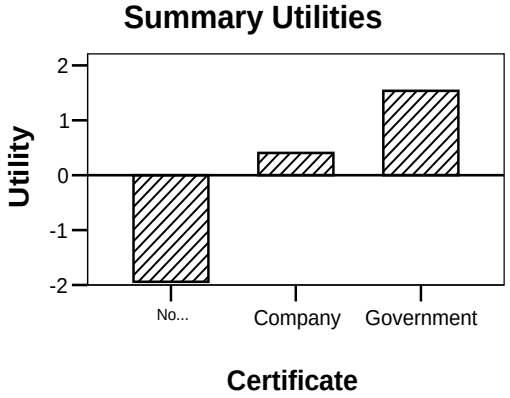
Appendix 24: Results of the conjoint analysis excluding price attributes by using OLS (Chiang Mai)

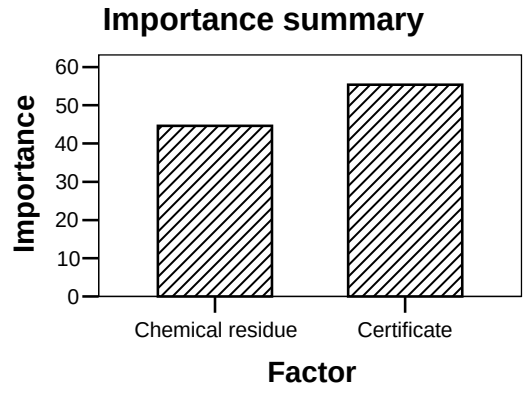
Averaged Importance	Utility	Factor		
		resi		Chemical residue
44.63	1.0225		--	Pesticide-safe
	.7580		--	Organic
	-1.7805	----		Conventional
		cert		Certificate
55.37	-1.9413	----		No certificate
	.4048		-	Company
	1.5365		---	Government
	4.9984	CONSTANT		

Pearson's R = .997 Significance = .0000

Kendall's tau = 1.000 Significance = .0001





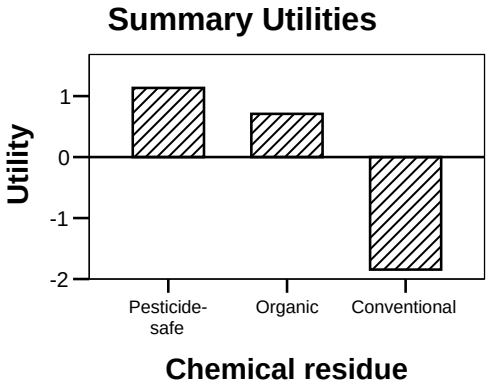


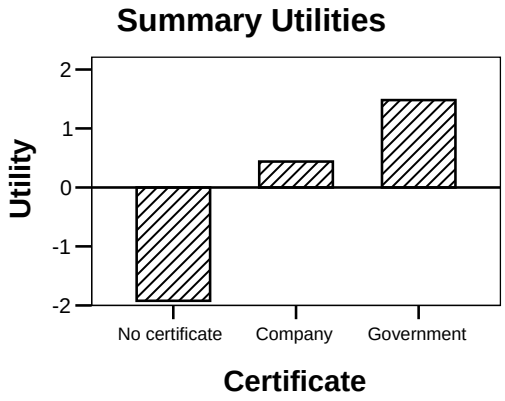
Appendix 25: Results of the conjoint analysis excluding price attributes by using OLS (Khon Kaen)

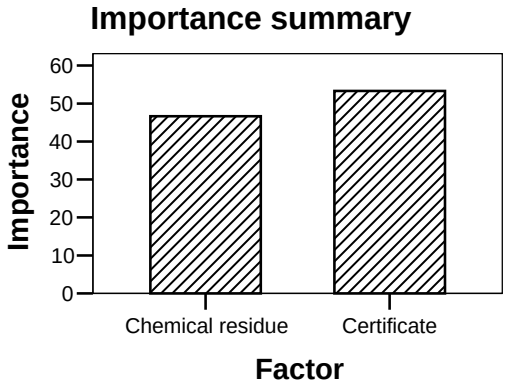
Averaged Importance	Utility	Factor		
		resi		Chemical residue
46.66	1.1336		--	Pesticide-safe
	.7095		-	Organic
	-1.8431	----		Conventional
		cert		Certificate
53.34	-1.9212	----		No certificate
	.4391		-	Company
	1.4822		---	Government
	5.0012	CONSTANT		

Pearson's R = .996 Significance = .0000

Kendall's tau = 1.000 Significance = .0001







Appendix 26: Results of conjoint analysis including price attribute by using MONANOVA (total survey)

Monotone Analysis of Variance

The TRANSREG Procedure
Dependent Variable Monotone(ranking)

Class Level Information

Class	Levels	Values
residue	3	Pest_safe, Conventional, Organic
certificate	3	No_certificate, Government, Company
price premiums	3	25%, 100%, 50%

Number of Observations Read 3708
Number of Observations Used 3708

TRANSREG Univariate Algorithm Iteration History for Monotone(ranking)

Iteration Number	Average Change	Maximum Change	R-Square	Criterion Change	Note
1	0.20147	0.37255	0.34522		
2	0.01193	0.03031	0.37535	0.03014	
3	0.00110	0.00234	0.37544	0.00009	
4	0.00011	0.00022	0.37544	0.00000	
5	0.00001	0.00002	0.37544	0.00000	
6	0.00000	0.00000	0.37544	0.00000	Converged

Univariate ANOVA Table Based on the Usual Degrees of Freedom

Source	DF	Sum of Squares	Mean Square	F Value	Liberal p
Model	6	9273.76	1545.627	370.80	>= <.0001
Error	3701	15427.23	4.168		
Corrected Total	3707	24700.99			

The above statistics are not adjusted for the fact that the dependent variable was transformed and so are generally liberal.

Root MSE	2.04166	R-Square	0.3754
Dependent Mean	4.99865	Adj R-Sq	0.3744
Coeff Var	40.84431		

Appendix26: continued

Monotone Analysis of Variance

The TRANSREG Procedure

Adjusted Multivariate ANOVA Table Based on Conservative Degrees of Freedom
Dependent Variable Scoring Parameters=8 S=6 M=0.5 N=1846

Statistic	Value	F Value	Num DF	Den DF	p
Wilks' Lambda	0.624559	38.02	48	18180	<= <.0001
Pillai's Trace	0.375441	30.86	48	22194	<= <.0001
Hotelling-Lawley Trace	0.601129	46.24	48	12296	<= <.0001
Roy's Greatest Root	0.601129	277.95	8	3699	~ <.0001

The Wilks' Lambda, Pillai's Trace, and Hotelling-Lawley Trace statistics are a conservative adjustment of the normal statistics. Roy's Greatest Root is liberal. These statistics are normally defined in terms of the squared canonical correlations which are the eigenvalues of the matrix H*inv(H+E). Here the R-Square is used for the first eigenvalue and all other eigenvalues are set to zero since only one linear combination is used. Degrees of freedom are computed assuming all linear combinations contribute to the Lambda and Trace statistics, so the F tests for those statistics are conservative. The p values for the liberal and conservative statistics provide approximate lower and upper bounds on p. A liberal test statistic with conservative degrees of freedom and a conservative test statistic with liberal degrees of freedom yield at best an approximate p value, which is indicated by a "~" before the p value.

Appendix 26: continued

Monotone Analysis of Variance

The TRANSREG Procedure

Adjusted Multivariate ANOVA Table Based on Conservative Degrees of Freedom

Dependent Variable Scoring Parameters=8 S=6 M=0.5 N=1846

Statistic	Value	F Value	Num DF	Den DF	p-value
Wilks' Lambda	0.624559	38.02	48	18180	<= <.0001
Pillai's Trace	0.375441	30.86	48	22194	<= <.0001
Hotelling-Lawley Trace	0.601129	46.24	48	12296	<= <.0001
Roy's Greatest Root	0.601129	277.95	8	3699	~ <.0001

These statistics are adjusted in the same way as the multivariate statistics above.

Utilities Table Based on the Usual Degrees of Freedom

Label	Utility	Standard Error	Importance (% Utility Range)	Variable
Intercept	4.9987	0.03353		Intercept
Redidue: Pest_safe	0.8241	0.04742	35.624	Class.residue Pest_safe
Redidue: Conventional	-1.3332	0.04742		Class.residue Conventional
Redidue: Organic	0.5090	0.04742		Class.residue Organic
Certificate: No_certificate	-1.5758	0.04742	45.570	Class.certificate No
Certificate: Government	1.1839	0.04742		Class.certificate Government
Certificate: Company	0.3918	0.04742		Class.certificate Company
Price premiums: 25%	0.4400	0.04742	18.806	Class.price 25%
Price premiums: 100%	-0.6989	0.04742		Class.price 100%
Price premiums: 50%	0.2589	0.04742		Class.price 50%

Appendix 27: Results of conjoint analysis excluding price attribute by using MONANOVA (total survey)

Monotone Analysis of Variance

The TRANSREG Procedure
Dependent Variable Monotone(ranking)
Class Level Information

Class	Levels	Values
residue	3	Pest_safe, Organic, Conventional
certificate	3	No_certificate, Company, Government

Number of Observations Read	3672
Number of Observations Used	3672

TRANSREG Univariate Algorithm Iteration History for Monotone(ranking)

Iteration Number	Average Change	Maximum Change	R-Square	Criterion Change	Note
1	0.25394	0.50809	0.48967		
2	0.02252	0.05352	0.54322	0.05355	
3	0.00341	0.00823	0.54364	0.00042	
4	0.00052	0.00126	0.54365	0.00001	
5	0.00008	0.00019	0.54365	0.00000	
6	0.00001	0.00003	0.54365	0.00000	
7	0.00000	0.00000	0.54365	0.00000	Converged

Univariate ANOVA Table Based on the Usual Degrees of Freedom

Source	DF	Squares	Sum of Square	Mean F Value	Liberal p
Model	4	13294.42	3323.604	1092.13	>= <.0001
Error	3667	11159.53	3.043		
Corrected Total	3671	24453.95			

The above statistics are not adjusted for the fact that the dependent variable was transformed and so are generally liberal.

Root MSE	1.74449	R-Square	0.5437
Dependent Mean	4.99619	Adj R-Sq	0.5432
Coeff Var	34.91634		

Appendix 27: continued

Adjusted Multivariate ANOVA Table Based on Liberal Degrees of Freedom

Dependent Variable Scoring Parameters=7 S=4 M=1 N=1829.5

Statistic	Value	F Value	Num DF	Den DF	p
Wilks' Lambda	0.456349	114.60	28	13201	~ <.0001
Pillai's Trace	0.543651	82.33	28	14656	~ <.0001
Hotelling-Lawley Trace	1.191306	155.71	28	9142.8	~ <.0001
Roy's Greatest Root	1.191306	623.56	7	3664	>= <.0001

The Wilks' Lambda, Pillai's Trace, and Hotelling-Lawley Trace statistics are a conservative adjustment of the normal statistics. Roy's Greatest Root is liberal. These statistics are normally defined in terms of the squared canonical correlations which are the eigenvalues of the matrix H*inv(H+E). Here the R-Square is used for the first eigenvalue and all other eigenvalues are set to zero since only one linear combination is used. Degrees of freedom are computed assuming all linear combinations contribute to the Lambda and Trace statistics, so the F tests for those statistics are conservative. The p values for the liberal and conservative statistics provide approximate lower and upper bounds on p. A liberal test statistic with conservative degrees of freedom and a conservative test statistic with liberal degrees of freedom yield at best an approximate p value, which is indicated by a "~" before the p value.

Appendix 27: continued

Monotone Analysis of Variance

The TRANSREG Procedure

Adjusted Multivariate ANOVA Table Based on Conservative Degrees of Freedom

Dependent Variable Scoring Parameters=8 S=4 M=1.5 N=1829

Statistic	Value	F Value	Num DF	Den DF	p-value
Wilks' Lambda	0.456349	100.00	32	13499	<= <.0001
Pillai's Trace	0.543651	72.02	32	14652	<= <.0001
Hotelling-Lawley Trace	1.191306	136.21	32	9561.6	<= <.0001
Roy's Greatest Root	1.191306	545.47	8	3663	~ <.0001

These statistics are adjusted in the same way as the multivariate statistics above.

Utilities Table Based on the Usual Degrees of Freedom

Label	Utility	Standard Error	Importance (% Utility Range)	Variable
Intercept	4.9962	0.02879		Intercept
Redidue: Pest_safe	1.1408	0.04071	46.853	Class.residue Pest_safe
Redidue: Organic	0.6252	0.04071		Class.residueO rganic
Redidue: Conventional	-1.7660	0.04071		Class.residue Conventional
Certificate: No_certificate	-1.9687	0.04071	53.147	Class.certificate No
Certificate: Company	0.6401	0.04071		Class.certificate Company
Certificate: Government	1.3285	0.04071		Class.certificate Government

Appendix 28: Results of logistic regression (full model)

The LOGISTIC Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD5
Response Variable	Always_buy
Number of Response Levels	2
Model	binary logit
Optimization Technique	Fisher's scoring

Number of Observations Read	1320
Number of Observations Used	1074

Response Profile

	Ordered Value	Always_buy	Total Frequency
(Always)	1	1	472
(Otherwise)	2	2	602

Probability modeled is Always_buy=1.

NOTE: 246 observations were deleted due to missing values for the response or explanatory variables.

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	1475.106	1272.724
SC	1480.085	1382.265
-2 Log L	1473.106	1228.724

R-Square	0.2035	Max-rescaled R-Square	0.2727

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	244.3822	21	<.0001
Score	211.9166	21	<.0001
Wald	170.5624	21	<.0001

Appendix 28: continued

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq	Standardized Estimate	Exp(Est)
Intercept	1	-3.4547	0.5407	40.8307	<.0001		0.032
Eatout	1	-0.4310	0.1490	8.3683	0.0038	-0.1189	0.650
Buy	1	-0.0152	0.0680	0.0499	0.8232	-0.00920	0.985
Prepare	1	0.4730	0.1669	8.0299	0.0046	0.1139	1.605
Vegeta	1	-0.2236	0.3145	0.5054	0.4771	-0.0437	0.800
Macro_chee	1	0.7173	0.2717	6.9687	0.0083	0.1633	2.049
Age	1	0.0283	0.00674	17.6106	<.0001	0.1755	1.029
Pest_con	1	0.2833	0.1534	3.4091	0.0648	0.0764	1.328
Chem_con	1	0.0498	0.1313	0.1436	0.7047	0.0155	1.051
Heavy_con	1	0.0350	0.0357	0.9612	0.3269	0.0394	1.036
Nitrate	1	-0.00816	0.0251	0.1053	0.7456	-0.0128	0.992
Washing	1	0.4933	0.1511	10.6547	0.0011	0.1282	1.638
Defi_or	1	0.3691	0.1792	4.2431	0.0394	0.0793	1.446
Attitude	1	0.1186	0.0266	19.8720	<.0001	0.1807	1.126
Sick	1	-0.0788	0.1583	0.2478	0.6186	-0.0192	0.924
Child	1	-0.0723	0.1205	0.3599	0.5485	-0.0233	0.930
Reason	1	0.8084	0.2623	9.4970	0.0021	0.1184	2.244
Uni	1	0.4195	0.1542	7.3999	0.0065	0.1153	1.521
Occupa	1	-0.0106	0.0514	0.0423	0.8370	-0.00813	0.989
Income	1	0.0278	0.00481	33.3491	<.0001	0.3542	1.028
BKK	1	0.5170	0.1705	9.1968	0.0024	0.1318	1.677
KK	1	0.5592	0.1693	10.9054	0.0010	0.1423	1.749

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
Eatout	0.650	0.485	0.870
Buy	0.985	0.862	1.125
Prepare	1.605	1.157	2.226
vegeta	0.800	0.432	1.481
Macro_chee	2.049	1.203	3.490
Age	1.029	1.015	1.042
Pest_con	1.328	0.983	1.793
Chem_con	1.051	0.813	1.360
Heavy_con	1.036	0.966	1.111
Nitrate	0.992	0.944	1.042
Washing	1.638	1.218	2.202
Defi_or	1.446	1.018	2.055
Attitude	1.126	1.069	1.186
Sick	0.924	0.678	1.260
Child	0.930	0.735	1.178
Reason	2.244	1.342	3.753
Uni	1.521	1.124	2.058
Occupa	0.989	0.895	1.094
Income	1.028	1.019	1.038
BKK	1.677	1.201	2.342
KK	1.749	1.255	2.438

Appendix 28: continued

Association of Predicted Probabilities and Observed Responses

Percent Concordant	76.3	Somers' D	0.528
Percent Discordant	23.5	Gamma	0.529
Percent Tied	0.2	Tau-a	0.261
Pairs	284144	c	0.764

Partition for the Hosmer and Lemeshow Test

		Always_buy = 1		Always_buy = 2	
Group	Total	Observed	Expected	Observed	Expected
1	107	17	12.30	90	94.70
2	107	19	20.55	88	86.45
3	107	29	27.39	78	79.61
4	107	35	33.40	72	73.60
5	107	32	40.76	75	66.24
6	107	39	47.18	68	59.82
7	107	57	55.56	50	51.44
8	107	71	64.36	36	42.64
9	107	77	75.15	30	31.85
10	111	96	95.35	15	15.65

Hosmer and Lemeshow Goodness-of-Fit Test

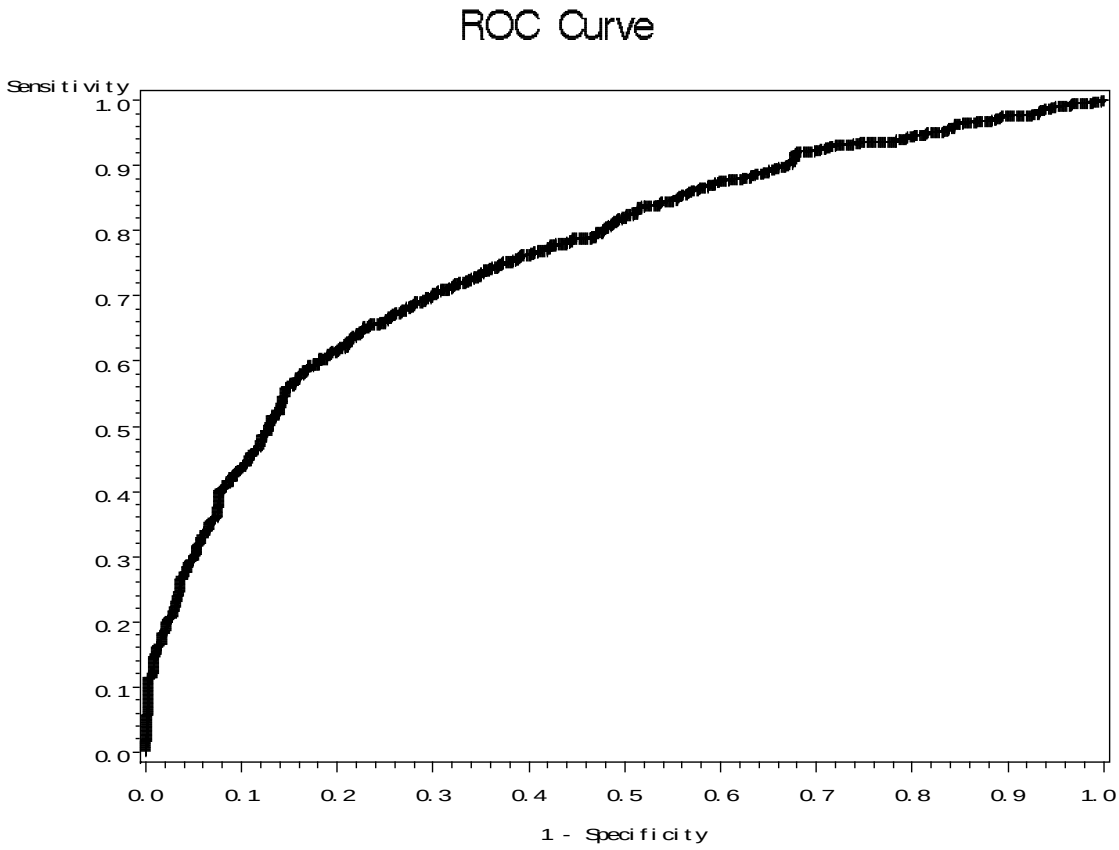
Chi-Square	DF	Pr > ChiSq
9.9725	8	0.2670

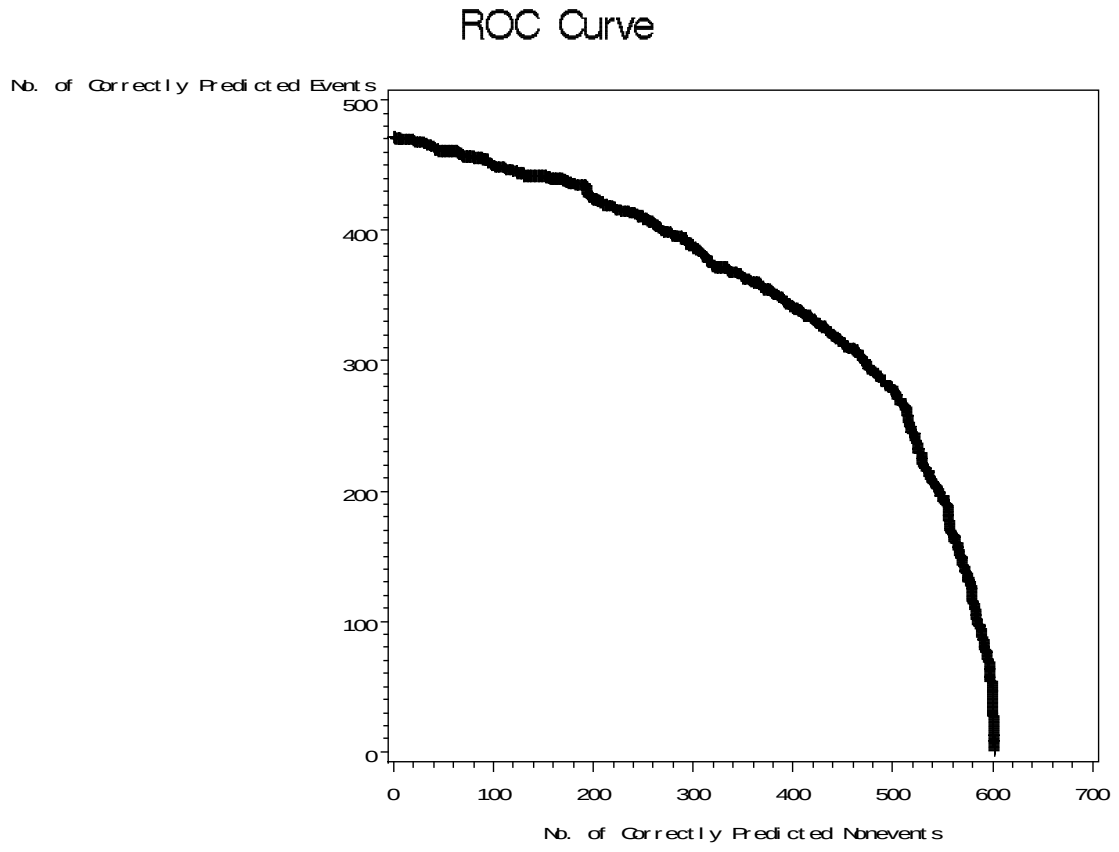
Appendix 28: continued

Classification Table

Prob Level	Correct Event	Correct Non-Event	Incorrect Event	Incorrect Non-Event	Correct	Percentages Sensi-tivity	Percentages Speci-ficity	False POS	False NEG
0.020	472	0	602	0	43.9	100.0	0.0	56.1	.
0.040	472	1	601	0	44.0	100.0	0.2	56.0	0.0
0.060	471	2	600	1	44.0	99.8	0.3	56.0	33.3
0.080	469	13	589	3	44.9	99.4	2.2	55.7	18.8
0.100	465	30	572	7	46.1	98.5	5.0	55.2	18.9
0.120	461	44	558	11	47.0	97.7	7.3	54.8	20.0
0.140	456	64	538	16	48.4	96.6	10.6	54.1	20.0
0.160	450	89	513	22	50.2	95.3	14.8	53.3	19.8
0.180	443	111	491	29	51.6	93.9	18.4	52.6	20.7
0.200	440	138	464	32	53.8	93.2	22.9	51.3	18.8
0.220	433	169	433	39	56.1	91.7	28.1	50.0	18.8
0.240	422	193	409	50	57.3	89.4	32.1	49.2	20.6
0.260	413	209	393	59	57.9	87.5	34.7	48.8	22.0
0.280	402	240	362	70	59.8	85.2	39.9	47.4	22.6
0.300	389	269	333	83	61.3	82.4	44.7	46.1	23.6
0.320	375	300	302	97	62.8	79.4	49.8	44.6	24.4
0.340	368	314	288	104	63.5	78.0	52.2	43.9	24.9
0.360	361	334	268	111	64.7	76.5	55.5	42.6	24.9
0.380	352	350	252	120	65.4	74.6	58.1	41.7	25.5
0.400	337	382	220	135	66.9	71.4	63.5	39.5	26.1
0.420	328	402	200	144	68.0	69.5	66.8	37.9	26.4
0.440	311	424	178	161	68.4	65.9	70.4	36.4	27.5
0.460	302	449	153	170	69.9	64.0	74.6	33.6	27.5
0.480	293	465	137	179	70.6	62.1	77.2	31.9	27.8
0.500	282	473	129	190	70.3	59.7	78.6	31.4	28.7
0.520	265	491	111	207	70.4	56.1	81.6	29.5	29.7
0.540	247	505	97	225	70.0	52.3	83.9	28.2	30.8
0.560	229	516	86	243	69.4	48.5	85.7	27.3	32.0
0.580	217	526	76	255	69.2	46.0	87.4	25.9	32.7
0.600	204	530	72	268	68.3	43.2	88.0	26.1	33.6
0.620	190	538	64	282	67.8	40.3	89.4	25.2	34.4
0.640	175	553	49	297	67.8	37.1	91.9	21.9	34.9
0.660	160	556	46	312	66.7	33.9	92.4	22.3	35.9
0.680	143	563	39	329	65.7	30.3	93.5	21.4	36.9
0.700	129	567	35	343	64.8	27.3	94.2	21.3	37.7
0.720	118	576	26	354	64.6	25.0	95.7	18.1	38.1
0.740	105	580	22	367	63.8	22.2	96.3	17.3	38.8
0.760	90	583	19	382	62.7	19.1	96.8	17.4	39.6
0.780	77	587	15	395	61.8	16.3	97.5	16.3	40.2
0.800	71	592	10	401	61.7	15.0	98.3	12.3	40.4
0.820	63	595	7	409	61.3	13.3	98.8	10.0	40.7
0.840	54	597	5	418	60.6	11.4	99.2	8.5	41.2
0.860	46	599	3	426	60.1	9.7	99.5	6.1	41.6
0.880	37	600	2	435	59.3	7.8	99.7	5.1	42.0
0.900	34	600	2	438	59.0	7.2	99.7	5.6	42.2
0.920	27	600	2	445	58.4	5.7	99.7	6.9	42.6
0.940	19	601	1	453	57.7	4.0	99.8	5.0	43.0
0.960	12	601	1	460	57.1	2.5	99.8	7.7	43.4
0.980	8	601	1	464	56.7	1.7	99.8	11.1	43.6
1.000	0	602	0	472	56.1	0.0	100.0	.	43.9

Appendix 28: continued





Appendix 29: Results of logistic regression (reduced model)

The LOGISTIC Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD4
Response Variable	Always_buy
Number of Response Levels	2
Model	binary logit
Optimization Technique	Fisher's scoring

Number of Observations Read	1320
Number of Observations Used	1268

Response Profile

	Ordered Value	Always_buy	Total Frequency
(Always)	1	1	529
(Otherwise)	2	2	739

Probability modeled is Always_buy=1.

NOTE: 52 observations were deleted due to missing values for the response or explanatory variables.

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	1724.881	1509.276
SC	1730.027	1565.873
-2 Log L	1722.881	1487.276

R-Square 0.1696 Max-rescaled R-Square 0.2282

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	235.6054	10	<.0001
Score	212.4326	10	<.0001
Wald	174.7667	10	<.0001

Appendix 29: continued

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq	Standardized Estimate	Exp(Est)
Intercept	1	-2.9298	0.2714	116.5449	<.0001		0.053
Income	1	0.0225	0.00402	31.2585	<.0001	0.2830	1.023
Age	1	0.0272	0.00593	21.0040	<.0001	0.1705	1.028
Attitude	1	0.0972	0.0233	17.3826	<.0001	0.1506	1.102
Macro_chee	1	0.6193	0.1513	16.7543	<.0001	0.1404	1.858
Washing	1	0.4935	0.1349	13.3789	0.0003	0.1272	1.638
Pest_con	1	0.3874	0.1328	8.5150	0.0035	0.1013	1.473
Uni	1	0.3379	0.1343	6.3324	0.0119	0.0929	1.402
Eatout	1	-0.3236	0.1271	6.4872	0.0109	-0.0892	0.724
BKK	1	0.5304	0.1531	11.9972	0.0005	0.1353	1.700
KK	1	0.4244	0.1526	7.7348	0.0054	0.1082	1.529

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
Income	1.023	1.015	1.031
Age	1.028	1.016	1.040
Attitude	1.102	1.053	1.154
Macro_chee	1.858	1.381	2.499
Washing	1.638	1.257	2.134
Pest_con	1.473	1.136	1.911
Uni	1.402	1.078	1.824
Eatout	0.724	0.564	0.928
BKK	1.700	1.259	2.294
KK	1.529	1.134	2.062

Association of Predicted Probabilities and Observed Responses

Percent Concordant	73.7	Somers' D	0.476
Percent Discordant	26.1	Gamma	0.477
Percent Tied	0.3	Tau-a	0.232
Pairs	390931	c	0.738

Partition for the Hosmer and Lemeshow Test

Group	Total	Always_buy = 1 Observed	Always_buy = 1 Expected	Always_buy = 2 Observed	Always_buy = 2 Expected
1	127	22	16.81	105	110.19
2	127	23	25.95	104	101.05
3	127	35	32.52	92	94.48
4	127	32	38.56	95	88.44
5	127	51	45.23	76	81.77
6	127	46	52.35	81	74.65
7	127	57	60.64	70	66.36
8	127	75	70.58	52	56.42
9	127	84	83.59	43	43.41
10	125	104	102.77	21	22.23

Appendix 29: continued

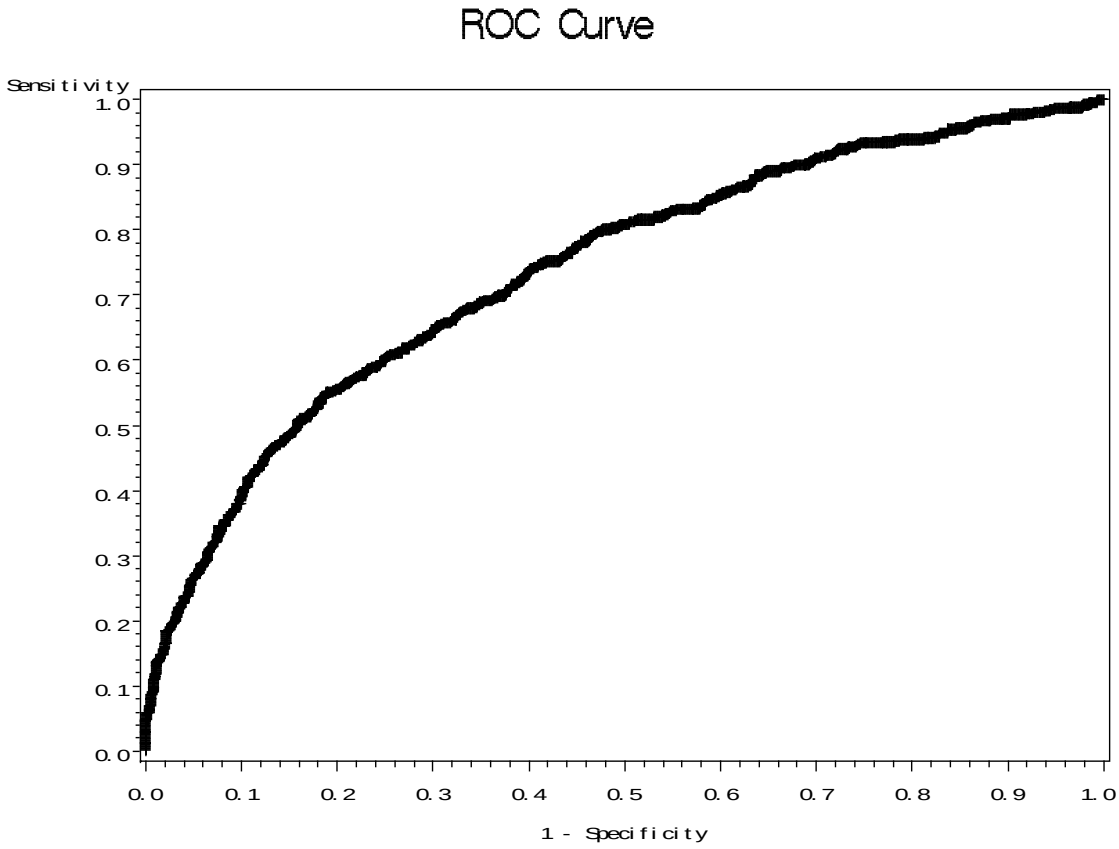
Hosmer and Lemeshow Goodness-of-Fit Test

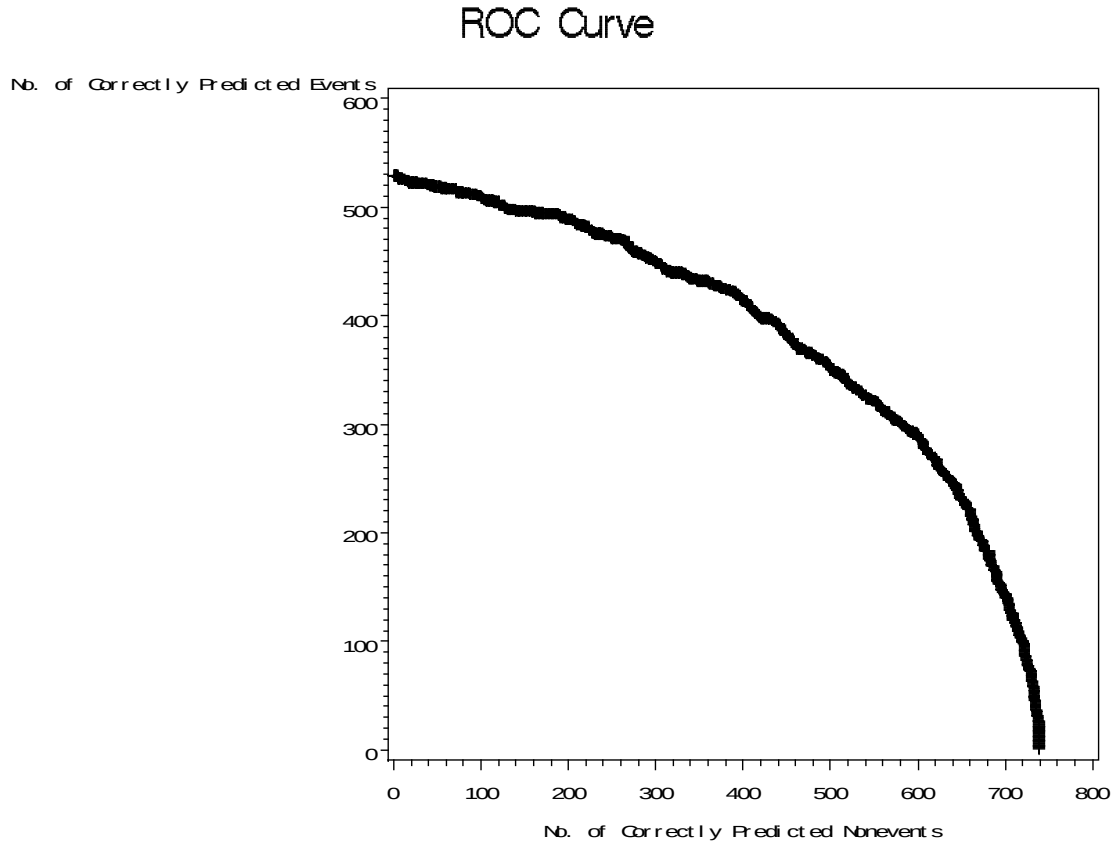
Chi-Square	DF	Pr > ChiSq
7.7092	8	0.4624

Classification Table

Prob Level	Correct Event	Correct Non-Event	Incorrect Event	Incorrect Non-Event	Percentages Correct	Sensi-tivity	Speci-ficity	False POS	False NEG
0.040	529	0	739	0	41.7	100.0	0.0	58.3	.
0.060	529	1	738	0	41.8	100.0	0.1	58.2	0.0
0.080	529	4	735	0	42.0	100.0	0.5	58.1	0.0
0.100	525	11	728	4	42.3	99.2	1.5	58.1	26.7
0.120	521	36	703	8	43.9	98.5	4.9	57.4	18.2
0.140	517	62	677	12	45.7	97.7	8.4	56.7	16.2
0.160	512	87	652	17	47.2	96.8	11.8	56.0	16.3
0.180	503	113	626	26	48.6	95.1	15.3	55.4	18.7
0.200	496	147	592	33	50.7	93.8	19.9	54.4	18.3
0.220	491	183	556	38	53.2	92.8	24.8	53.1	17.2
0.240	476	226	513	53	55.4	90.0	30.6	51.9	19.0
0.260	462	261	478	67	57.0	87.3	35.3	50.9	20.4
0.280	443	297	442	86	58.4	83.7	40.2	49.9	22.5
0.300	434	338	401	95	60.9	82.0	45.7	48.0	21.9
0.320	422	374	365	107	62.8	79.8	50.6	46.4	22.2
0.340	402	405	334	127	63.6	76.0	54.8	45.4	23.9
0.360	381	438	301	148	64.6	72.0	59.3	44.1	25.3
0.380	363	464	275	166	65.2	68.6	62.8	43.1	26.3
0.400	350	495	244	179	66.6	66.2	67.0	41.1	26.6
0.420	331	517	222	198	66.9	62.6	70.0	40.1	27.7
0.440	316	539	200	213	67.4	59.7	72.9	38.8	28.3
0.460	302	567	172	227	68.5	57.1	76.7	36.3	28.6
0.480	290	588	151	239	69.2	54.8	79.6	34.2	28.9
0.500	271	608	131	258	69.3	51.2	82.3	32.6	29.8
0.520	253	625	114	276	69.2	47.8	84.6	31.1	30.6
0.540	242	637	102	287	69.3	45.7	86.2	29.7	31.1
0.560	221	649	90	308	68.6	41.8	87.8	28.9	32.2
0.580	201	664	75	328	68.2	38.0	89.9	27.2	33.1
0.600	184	671	68	345	67.4	34.8	90.8	27.0	34.0
0.620	176	682	57	353	67.7	33.3	92.3	24.5	34.1
0.640	156	685	54	373	66.3	29.5	92.7	25.7	35.3
0.660	144	695	44	385	66.2	27.2	94.0	23.4	35.6
0.680	125	704	35	404	65.4	23.6	95.3	21.9	36.5
0.700	112	711	28	417	64.9	21.2	96.2	20.0	37.0
0.720	101	716	23	428	64.4	19.1	96.9	18.5	37.4
0.740	89	723	16	440	64.0	16.8	97.8	15.2	37.8
0.760	78	724	15	451	63.2	14.7	98.0	16.1	38.4
0.780	68	728	11	461	62.8	12.9	98.5	13.9	38.8
0.800	55	732	7	474	62.1	10.4	99.1	11.3	39.3
0.820	48	733	6	481	61.6	9.1	99.2	11.1	39.6
0.840	41	734	5	488	61.1	7.8	99.3	10.9	39.9
0.860	35	735	4	494	60.7	6.6	99.5	10.3	40.2
0.880	28	737	2	501	60.3	5.3	99.7	6.7	40.5
0.900	22	738	1	507	59.9	4.2	99.9	4.3	40.7
0.920	18	739	0	511	59.7	3.4	100.0	0.0	40.9
0.940	11	739	0	518	59.1	2.1	100.0	0.0	41.2
0.960	10	739	0	519	59.1	1.9	100.0	0.0	41.3
0.980	8	739	0	521	58.9	1.5	100.0	0.0	41.3
1.000	0	739	0	529	58.3	0.0	100.0	.	41.7

Appendix 29: continued





Appendix 30: Results of logistic regression (final model)

The LOGISTIC Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD4
Response Variable	Always_buy
Number of Response Levels	2
Model	binary logit
Optimization Technique	Fisher's scoring

Number of Observations Read	1320
Number of Observations Used	1268

Response Profile

	Ordered Value	Always_buy	Total Frequency
(Always)	1	1	529
(Otherwise)	2	2	739

Probability modeled is Always_buy=1.

NOTE: 52 observations were deleted due to missing values for the response or explanatory variables.

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	1724.881	1519.135
SC	1730.027	1565.442
-2 Log L	1722.881	1501.135

R-Square 0.1604 Max-rescaled R-Square 0.2159

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	221.7460	8	<.0001
Score	201.3321	8	<.0001
Wald	167.2916	8	<.0001

Appendix 30: continued

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq	Standardized Estimate	Exp(Est)
Intercept	1	-2.6455	0.2542	108.2851	<.0001		0.071
Income	1	0.0227	0.00402	32.0537	<.0001	0.2865	1.023
Age	1	0.0270	0.00585	21.3347	<.0001	0.1697	1.027
Attitude	1	0.0961	0.0232	17.1910	<.0001	0.1489	1.101
Macro_chee	1	0.5993	0.1505	15.8519	<.0001	0.1359	1.821
Washing	1	0.4979	0.1341	13.7865	0.0002	0.1284	1.645
Pest_con	1	0.3932	0.1321	8.8666	0.0029	0.1028	1.482
Uni	1	0.3568	0.1335	7.1459	0.0075	0.0981	1.429
Eatout	1	-0.2999	0.1262	5.6499	0.0175	-0.0827	0.741

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
Income	1.023	1.015	1.031
Age	1.027	1.016	1.039
Attitude	1.101	1.052	1.152
Macro_chee	1.821	1.356	2.446
Washing	1.645	1.265	2.140
Pest_con	1.482	1.144	1.919
Uni	1.429	1.100	1.856
Eatout	0.741	0.579	0.949

Association of Predicted Probabilities and Observed Responses

Percent Concordant	72.9	Somers' D	0.460
Percent Discordant	26.8	Gamma	0.462
Percent Tied	0.3	Tau-a	0.224
Pairs	390931	c	0.730

Partition for the Hosmer and Lemeshow Test

Group	Total	Always_buy = 1 Observed	Always_buy = 1 Expected	Always_buy = 2 Observed	Always_buy = 2 Expected
1	127	27	18.78	100	108.22
2	127	26	26.81	101	100.19
3	127	20	32.92	107	94.08
4	127	47	38.80	80	88.20
5	127	43	44.85	84	82.15
6	127	51	51.85	76	75.15
7	127	56	59.99	71	67.01
8	127	69	70.45	58	56.55
9	127	91	82.87	36	44.13
10	125	99	101.68	26	23.32

Appendix 30: continued

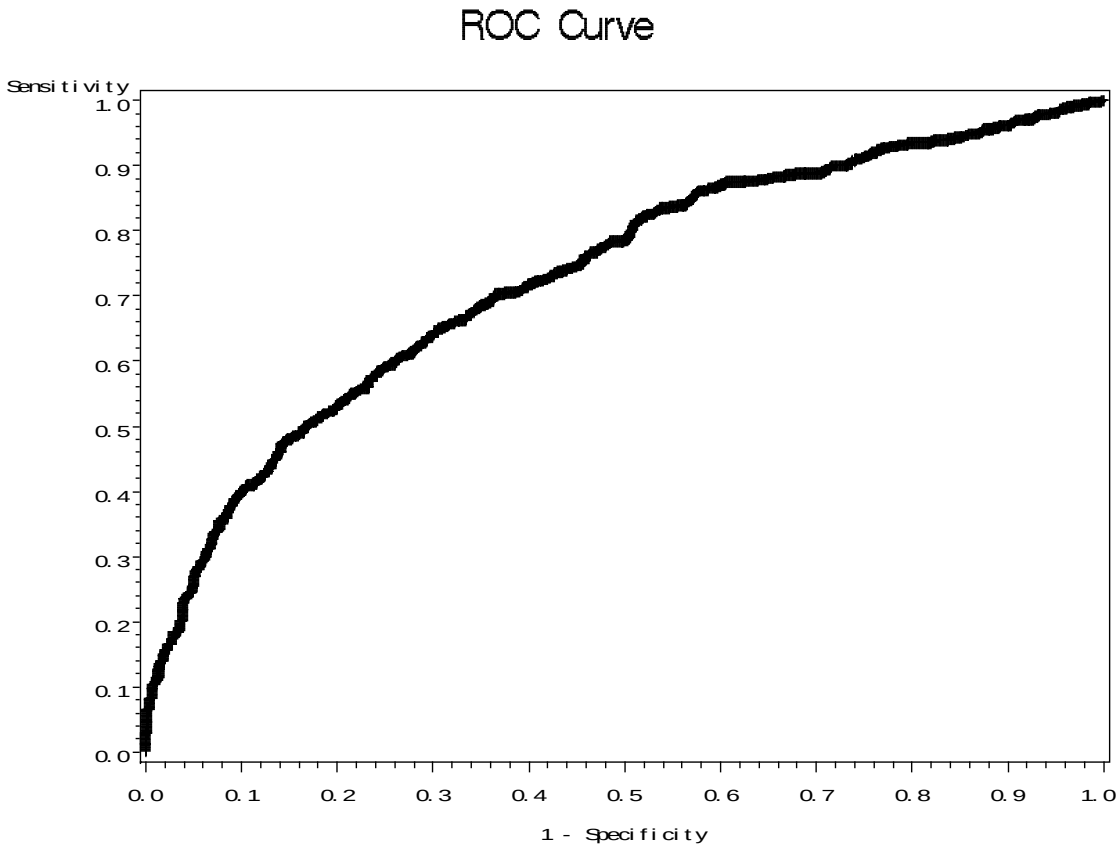
Hosmer and Lemeshow Goodness-of-Fit Test

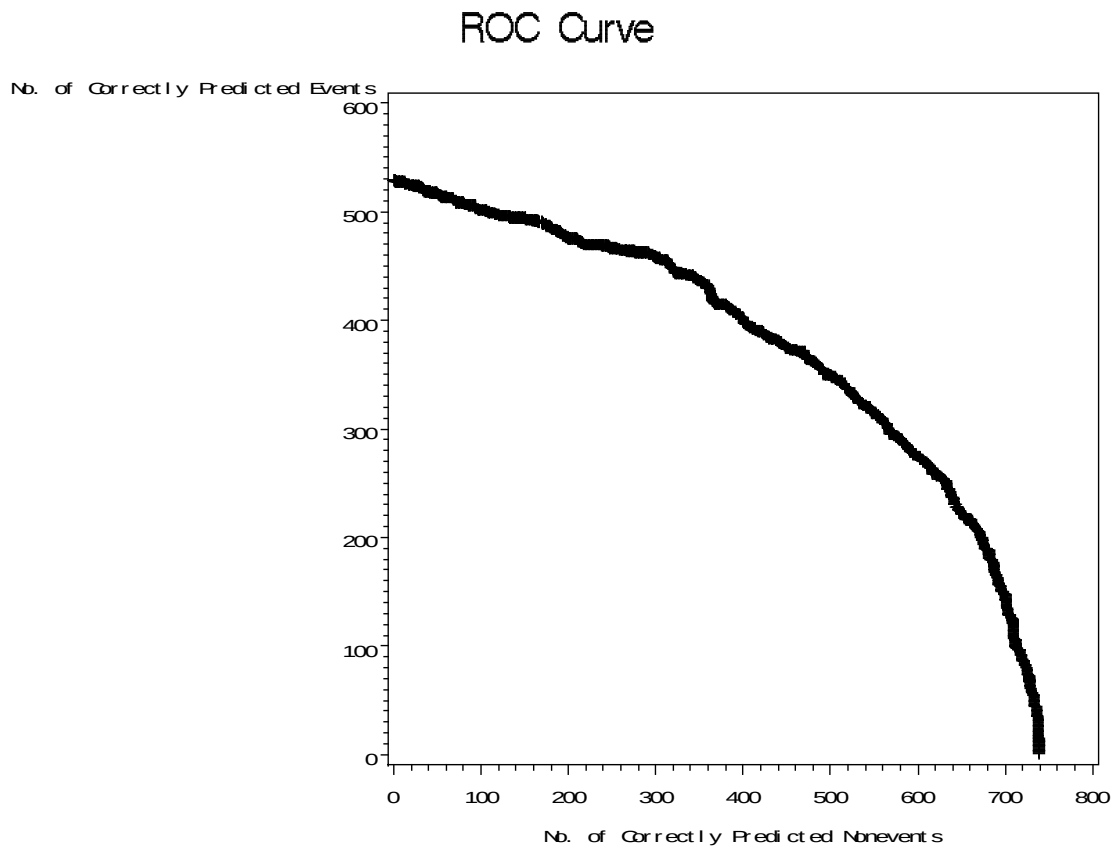
Chi-Square	DF	Pr > ChiSq
16.9864	8	0.0303

Classification Table

	Correct		Incorrect		Percentages				
Prob Level	Event	Non-Event	Event	Non-Event	Correct	Sensi-tivity	Speci-ficity	False POS	False NEG
0.060	529	0	739	0	41.7	100.0	0.0	58.3	.
0.080	529	1	738	0	41.8	100.0	0.1	58.2	0.0
0.100	528	7	732	1	42.2	99.8	0.9	58.1	12.5
0.120	525	16	723	4	42.7	99.2	2.2	57.9	20.0
0.140	519	32	707	10	43.5	98.1	4.3	57.7	23.8
0.160	512	63	676	17	45.3	96.8	8.5	56.9	21.3
0.180	504	94	645	25	47.2	95.3	12.7	56.1	21.0
0.200	495	129	610	34	49.2	93.6	17.5	55.2	20.9
0.220	487	172	567	42	52.0	92.1	23.3	53.8	19.6
0.240	472	205	534	57	53.4	89.2	27.7	53.1	21.8
0.260	465	253	486	64	56.6	87.9	34.2	51.1	20.2
0.280	455	297	442	74	59.3	86.0	40.2	49.3	19.9
0.300	437	341	398	92	61.4	82.6	46.1	47.7	21.2
0.320	413	367	372	116	61.5	78.1	49.7	47.4	24.0
0.340	391	405	334	138	62.8	73.9	54.8	46.1	25.4
0.360	375	435	304	154	63.9	70.9	58.9	44.8	26.1
0.380	363	470	269	166	65.7	68.6	63.6	42.6	26.1
0.400	348	499	240	181	66.8	65.8	67.5	40.8	26.6
0.420	329	521	218	200	67.0	62.2	70.5	39.9	27.7
0.440	308	549	190	221	67.6	58.2	74.3	38.2	28.7
0.460	293	567	172	236	67.8	55.4	76.7	37.0	29.4
0.480	278	586	153	251	68.1	52.6	79.3	35.5	30.0
0.500	265	605	134	264	68.6	50.1	81.9	33.6	30.4
0.520	249	625	114	280	68.9	47.1	84.6	31.4	30.9
0.540	234	635	104	295	68.5	44.2	85.9	30.8	31.7
0.560	218	649	90	311	68.4	41.2	87.8	29.2	32.4
0.580	203	662	77	326	68.2	38.4	89.6	27.5	33.0
0.600	190	675	64	339	68.2	35.9	91.3	25.2	33.4
0.620	173	683	56	356	67.5	32.7	92.4	24.5	34.3
0.640	151	692	47	378	66.5	28.5	93.6	23.7	35.3
0.660	134	701	38	395	65.9	25.3	94.9	22.1	36.0
0.680	122	704	35	407	65.1	23.1	95.3	22.3	36.6
0.700	106	710	29	423	64.4	20.0	96.1	21.5	37.3
0.720	93	713	26	436	63.6	17.6	96.5	21.8	37.9
0.740	84	721	18	445	63.5	15.9	97.6	17.6	38.2
0.760	67	727	12	462	62.6	12.7	98.4	15.2	38.9
0.780	59	729	10	470	62.1	11.2	98.6	14.5	39.2
0.800	50	732	7	479	61.7	9.5	99.1	12.3	39.6
0.820	44	734	5	485	61.4	8.3	99.3	10.2	39.8
0.840	40	736	3	489	61.2	7.6	99.6	7.0	39.9
0.860	33	736	3	496	60.6	6.2	99.6	8.3	40.3
0.880	27	738	1	502	60.3	5.1	99.9	3.6	40.5
0.900	20	738	1	509	59.8	3.8	99.9	4.8	40.8
0.920	14	738	1	515	59.3	2.6	99.9	6.7	41.1
0.940	13	739	0	516	59.3	2.5	100.0	0.0	41.1
0.960	10	739	0	519	59.1	1.9	100.0	0.0	41.3
0.980	8	739	0	521	58.9	1.5	100.0	0.0	41.3
1.000	0	739	0	529	58.3	0.0	100.0	.	41.7

Appendix 30: continued





Appendix 31: Model of exponential distribution: (min, max) without independent variables

The LIFEREG Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD7
Dependent Variable	Log(min)
Dependent Variable	Log(max)
Number of Observations	1247
Noncensored Values	8
Right Censored Values	0
Left Censored Values	0
Interval Censored Values	1239
Name of Distribution	Exponential
Log Likelihood	-2870.52487

Number of Observations Read	1247
Number of Observations Used	1247

Parameter Information

Parameter	Effect
Intercept	Intercept

Algorithm converged.

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	3.6428	0.0285	3.5869	3.6987	16324.1	<.0001
Scale	0	1.0000	0.0000	1.0000	1.0000		
Weibull Scale	1	38.1994	1.0891	36.1233	40.3949		
Weibull Shape	0	1.0000	0.0000	1.0000	1.0000		

Lagrange Multiplier Statistics

Parameter	Chi-Square	Pr > ChiSq
Scale	.	.

Appendix 32: Model of exponential distribution: (lower, upper) without independent variables

The LIFEREG Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD7
Dependent Variable	Log(lower)
Dependent Variable	Log(upper)
Number of Observations	1247
Noncensored Values	0
Right Censored Values	379
Left Censored Values	0
Interval Censored Values	868
Name of Distribution	Exponential
Log Likelihood	-2226.15908

Number of Observations Read	1247
Number of Observations Used	1247

Parameter Information

Parameter	Effect
Intercept	Intercept

Algorithm converged.

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	3.9250	0.0341	3.8582	3.9917	13284.7	<.0001
Scale	0	1.0000	0.0000	1.0000	1.0000		
Weibull Scale	1	50.6509	1.7248	47.3806	54.1469		
Weibull Shape	0	1.0000	0.0000	1.0000	1.0000		

Lagrange Multiplier Statistics

Parameter	Chi-Square	Pr > ChiSq
Scale	.	.

Appendix 33: Model of Weibull distribution: (min, max) without independent variables

The LIFEREG Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD7
Dependent Variable	Log(min)
Dependent Variable	Log(max)
Number of Observations	1247
Noncensored Values	8
Right Censored Values	0
Left Censored Values	0
Interval Censored Values	1239
Name of Distribution	Weibull
Log Likelihood	-1777.783957

Number of Observations Read	1247
Number of Observations Used	1247

Parameter Information

Parameter	Effect
Intercept	Intercept

Algorithm converged.

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	3.7133	0.0079	3.6979	3.7288	221430	<.0001
Scale	1	0.2417	0.0055	0.2312	0.2526		
Weibull Scale	1	40.9908	0.3235	40.3617	41.6298		
Weibull Shape	1	4.1373	0.0934	3.9583	4.3244		

Estimated Covariance Matrix

	Intercept	Scale
Intercept	0.000062272	-0.000008931
Scale	-0.000008931	0.000029753

Appendix 34: Model of Weibull distribution: (lower, upper) without independent variables

The LIFEREG Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD7
Dependent Variable	Log(lower)
Dependent Variable	Log(upper)
Number of Observations	1247
Noncensored Values	0
Right Censored Values	379
Left Censored Values	0
Interval Censored Values	868
Name of Distribution	Weibull
Log Likelihood	-1556.308296

Number of Observations Read	1247
Number of Observations Used	1247

Parameter Information

Parameter	Effect
Intercept	Intercept

Algorithm converged.

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	3.7599	0.0095	3.7413	3.7784	157862	<.0001
Scale	1	0.2632	0.0070	0.2499	0.2772		
Weibull Scale	1	42.9433	0.4064	42.1541	43.7472		
Weibull Shape	1	3.7996	0.1004	3.6079	4.0016		

Estimated Covariance Matrix

	Intercept	Scale
Intercept	0.000089551	-0.000001442
Scale	-0.000001442	0.000048361

Appendix 35: Model of log-logistic distribution: (min, max) without independent variables

The LIFEREG Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD7
Dependent Variable	Log(min)
Dependent Variable	Log(max)
Number of Observations	1247
Noncensored Values	8
Right Censored Values	0
Left Censored Values	0
Interval Censored Values	1239
Name of Distribution	LLogistic
Log Likelihood	-1620.329543

Number of Observations Read	1247
Number of Observations Used	1247

Parameter Information

Parameter	Effect
Intercept	Intercept

Algorithm converged.

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	3.5762	0.0070	3.5625	3.5899	261303	<.0001
Scale	1	0.1301	0.0034	0.1236	0.1370		

Estimated Covariance Matrix

	Intercept	Scale
Intercept	0.000048944	0.000001516
Scale	0.000001516	0.000011598

Appendix 36: Model of log-logistic distribution: (lower, upper) without independent variables

The LIFEREG Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD7
Dependent Variable	Log(lower)
Dependent Variable	Log(upper)
Number of Observations	1247
Noncensored Values	0
Right Censored Values	379
Left Censored Values	0
Interval Censored Values	868
Name of Distribution	LLogistic
Log Likelihood	-1456.839644

Number of Observations Read	1247
Number of Observations Used	1247

Parameter Information

Parameter	Effect
Intercept	Intercept

Algorithm converged.

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	3.6090	0.0086	3.5921	3.6259	175058	<.0001
Scale	1	0.1545	0.0048	0.1454	0.1641		

Estimated Covariance Matrix

	Intercept	Scale
Intercept	0.000074402	0.000007739
Scale	0.000007739	0.000022624

Appendix 37: Model of lognormal distribution: (min, max) without independent variables

The LIFEREG Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD7
Dependent Variable	Log(min)
Dependent Variable	Log(max)
Number of Observations	1247
Noncensored Values	8
Right Censored Values	0
Left Censored Values	0
Interval Censored Values	1239
Name of Distribution	Lognormal
Log Likelihood	-1619.982497

Number of Observations Read	1247
Number of Observations Used	1247

Parameter Information

Parameter	Effect
Intercept	Intercept

Algorithm converged.

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	3.5887	0.0070	3.5748	3.6025	259199	<.0001
Scale	1	0.2321	0.0053	0.2220	0.2426		

Estimated Covariance Matrix

	Intercept	Scale
Intercept	0.000049686	0.000002447
Scale	0.000002447	0.000027641

Appendix 38: Model of lognormal distribution (lower, upper) without independent variables

The LIFEREG Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD7
Dependent Variable	Log(lower)
Dependent Variable	Log(upper)
Number of Observations	1247
Noncensored Values	0
Right Censored Values	379
Left Censored Values	0
Interval Censored Values	868
Name of Distribution	Lognormal
Log Likelihood	-1454.892421

Number of Observations Read	1247
Number of Observations Used	1247

Parameter Information

Parameter	Effect
Intercept	Intercept

Algorithm converged.

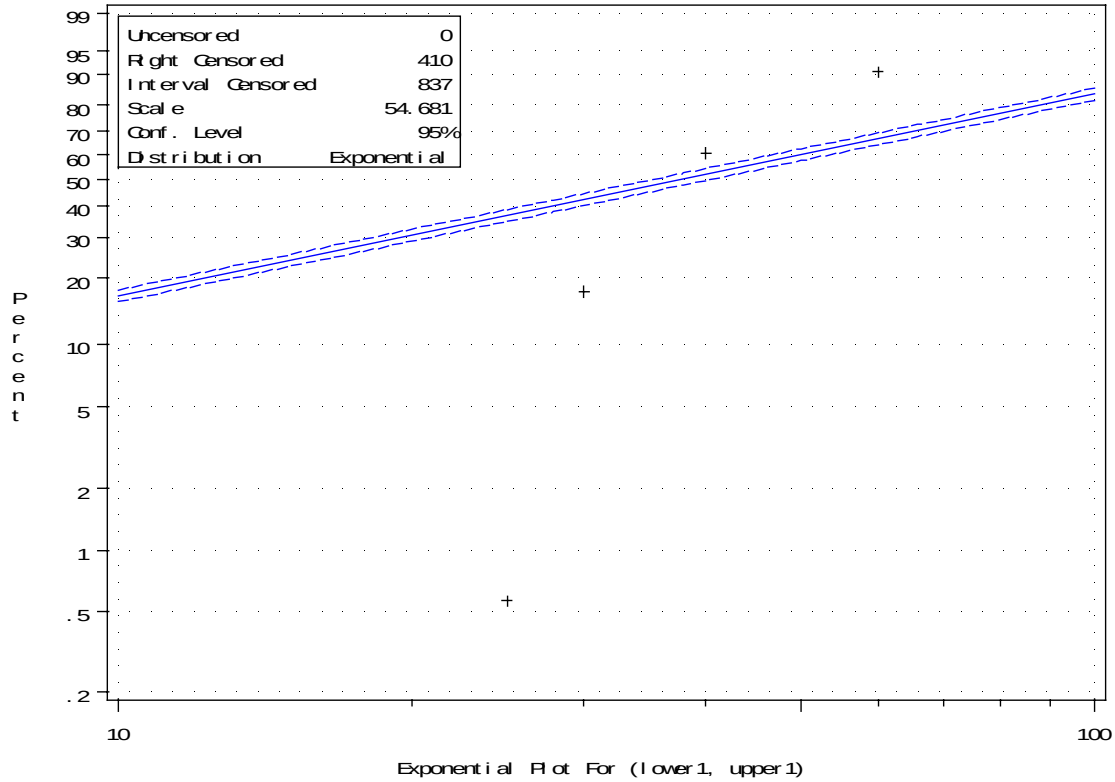
Analysis of Parameter Estimates

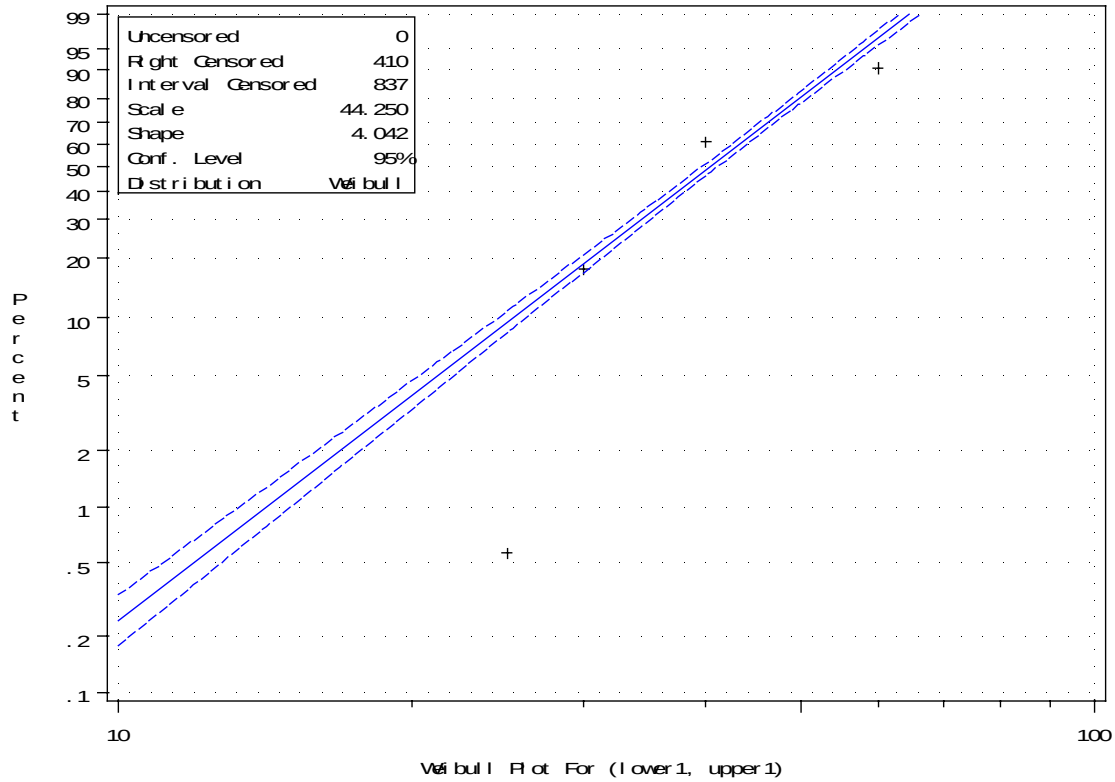
Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	3.6231	0.0087	3.6061	3.6401	173934	<.0001
Scale	1	0.2685	0.0073	0.2546	0.2831		

Estimated Covariance Matrix

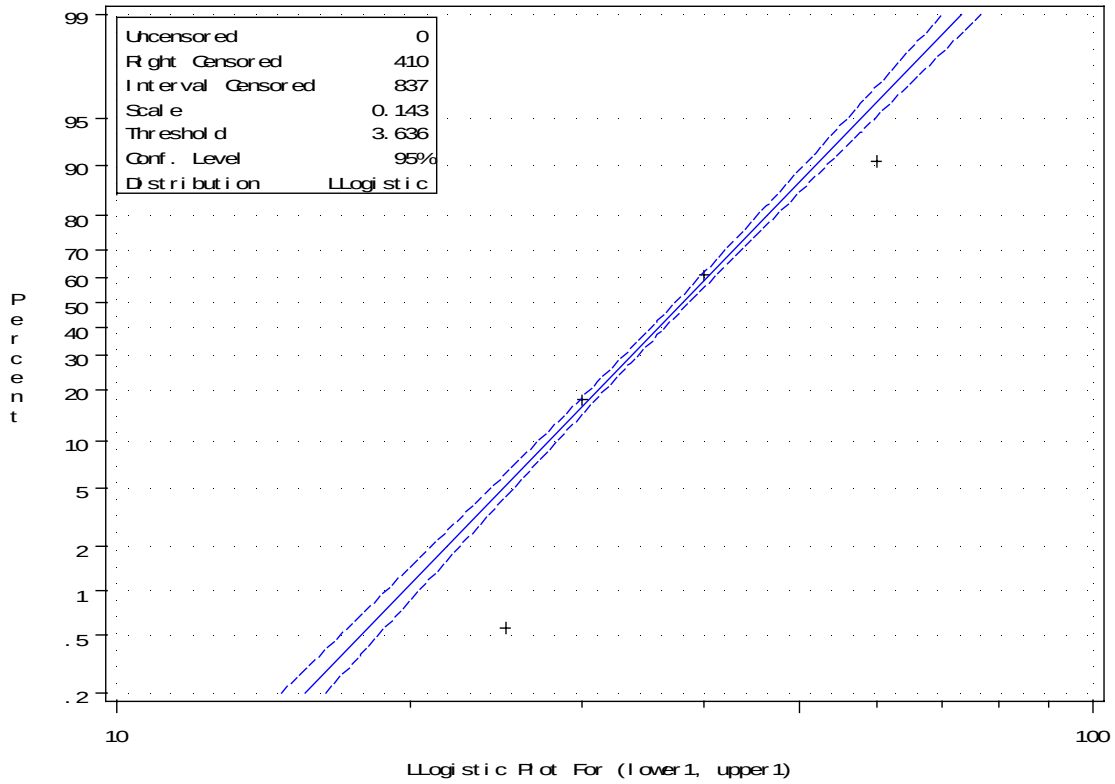
	Intercept	Scale
Intercept	0.000075470	0.000012793
Scale	0.000012793	0.000053037

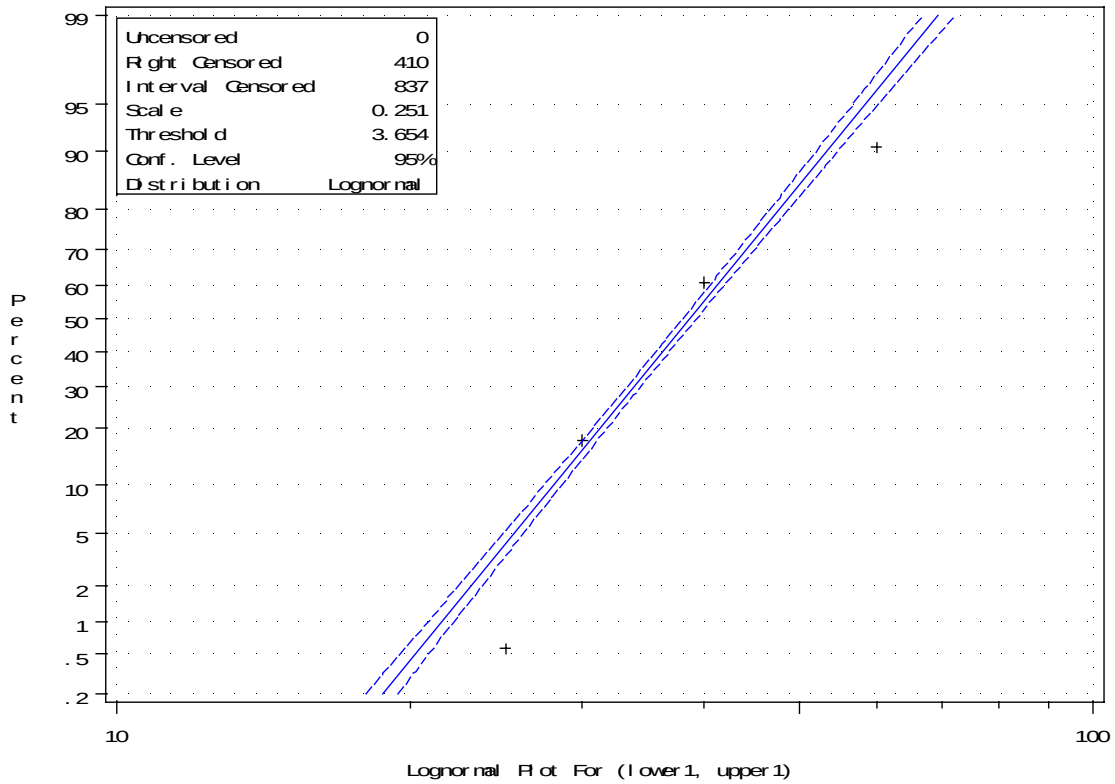
Appendix 39: Probability plots for exponential, Weibull, log-logistic, and lognormal distributions (lower, upper) without independent variables





Appendix 39: continued





Appendix 40: Model of lognormal distribution: (lower, upper) with independent variables (full model)

The LIFEREG Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD7
Dependent Variable	Log(lower)
Dependent Variable	Log(upper)
Number of Observations	1176
Noncensored Values	0
Right Censored Values	379
Left Censored Values	0
Interval Censored Values	797
Zero or Negative Response	71
Name of Distribution	Lognormal
Log Likelihood (without covariates)	-1297.098288
Log Likelihood (with covariates)	-1241.143844

Number of Observations Read	1247
Number of Observations Used	1176

Parameter Information

Parameter	Effect
Intercept	Intercept
Always_buy	Always_buy
Eatout	Eatout
Buy_EFPV	Buy_EFPV
Prepare	Prepare
Vegeta	Vegeta
Macro_chee	Macro_chee
Age	Age
Pest_con	Pest_con
Chem_con	Chem_con
Heavy_con	Heavy_con
Nitrate	Nitrate
Washing	Washing
Defi_or	Defi_or
Attitude	Attitude
Sick	Sick
Child	Child
Reason	Reason
Uni	Uni
Occupa	Occupa
Income	Income
BKK	BKK
KK	KK

Algorithm converged.

Appendix 40: continued

The LIFEREG Procedure

Type III Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
Always_buy	1	13.5009	0.0002
Eatout	1	0.4011	0.5265
Buy_EFPV	1	0.4987	0.4801
Prepare	1	0.1509	0.6976
Vegeta	1	0.4180	0.5179
Macro_chee	1	3.7995	0.0513
Age	1	0.0502	0.8227
Pest_con	1	2.6187	0.1056
Chem_con	1	1.0381	0.3083
Heavy_con	1	0.9538	0.3287
Nitrate	1	0.2452	0.6205
Washing	1	0.6729	0.4120
Defi_or	1	0.8891	0.3457
Attitude	1	7.9104	0.0049
Sick	1	4.8583	0.0275
Child	1	0.2344	0.6283
Reason	1	0.1817	0.6699
Uni	1	3.0827	0.0791
Occupa	1	0.3703	0.5428
Income	1	2.7228	0.0989
BKK	1	4.4269	0.0354
KK	1	6.0169	0.0142

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	3.4863	0.0670	3.3550	3.6177	2706.17	<.0001
Always_buy	1	0.1214	0.0330	0.0566	0.1861	13.50	0.0002
Eatout	1	0.0103	0.0163	-0.0216	0.0422	0.40	0.5265
Buy_EFPV	1	0.0155	0.0219	-0.0274	0.0583	0.50	0.4801
Prepare	1	-0.0071	0.0182	-0.0427	0.0286	0.15	0.6976
Vegeta	1	0.0155	0.0240	-0.0316	0.0626	0.42	0.5179
Macro_chee	1	0.0515	0.0264	-0.0003	0.1033	3.80	0.0513
Age	1	0.0002	0.0008	-0.0014	0.0017	0.05	0.8227
Pest_con	1	0.0310	0.0192	-0.0065	0.0686	2.62	0.1056
Chem_con	1	0.0207	0.0203	-0.0191	0.0605	1.04	0.3083
Heavy_con	1	-0.0188	0.0192	-0.0565	0.0189	0.95	0.3287
Nitrate	1	0.0127	0.0257	-0.0377	0.0632	0.25	0.6205
Washing	1	0.0155	0.0190	-0.0216	0.0527	0.67	0.4120
Defi_or	1	0.0194	0.0206	-0.0209	0.0598	0.89	0.3457
Attitude	1	0.0085	0.0030	0.0026	0.0145	7.91	0.0049
Sick	1	0.0395	0.0179	0.0044	0.0746	4.86	0.0275
Child	1	0.0089	0.0185	-0.0273	0.0451	0.23	0.6283
Reason	1	0.0126	0.0295	-0.0452	0.0703	0.18	0.6699
Uni	1	-0.0316	0.0180	-0.0669	0.0037	3.08	0.0791
Occupa	1	0.0107	0.0176	-0.0237	0.0451	0.37	0.5428
Income	1	-0.0006	0.0004	-0.0014	0.0001	2.72	0.0989
BKK	1	0.0445	0.0211	0.0030	0.0859	4.43	0.0354
KK	1	-0.0574	0.0234	-0.1034	-0.0115	6.02	0.0142
Scale	1	0.2337	0.0064	0.2215	0.2465		

Appendix 40: continued

Estimated Covariance Matrix

	Intercept	Always_buy	Eatout	Buy_EFPV	Prepare
Intercept	0.004491	-0.001474	-0.000149	-0.001155	-0.000201
Always_buy	-0.001474	0.001091	0.000022540	0.000609	-0.000016154
Eatout	-0.000149	0.000022540	0.000265	0.000002954	-0.000022416

Estimated Covariance Matrix

	Vegeta	Macro_chee	Age	Pest_con	Chem_con
Intercept	0.000003732	-0.000075860	-0.000020138	-0.000108	0.000011935
Always_buy	-0.000000583	-0.000027487	-0.000000747	-0.000011487	0.000013875
Eatout	0.000004957	0.000004928	0.000000943	0.000007130	-0.000014033

Estimated Covariance Matrix

	Heavy_con	Nitrate	Washing	Defi_or	Attitude
Intercept	-0.000056396	0.000083361	-0.000215	-0.000056205	-0.000034153
Always_buy	0.000012489	-0.000025420	0.000028885	-0.000015515	0.000000249
Eatout	-0.000001008	0.000001989	0.000006078	-0.000004423	-0.000001994

Estimated Covariance Matrix

	Sick	Child	Reason	Uni	Occupa
Intercept	-0.000284	-0.000139	-0.000184	-0.000130	-0.000065539
Always_buy	0.000003191	-0.000013554	0.000027119	-0.000040481	0.000033507
Eatout	-0.000003312	0.000021104	0.000022543	-0.000020818	-0.000023773

Estimated Covariance Matrix

	Income	BKK	KK	Scale
Intercept	-0.000000661	-0.000205	-0.000254	0.000004534
Always_buy	-0.000000916	0.000010732	-0.000029742	0.000005964
Eatout	0.000000150	-0.000006710	0.000045543	-0.000000347

Appendix 41: Model of lognormal distribution: (lower1, upper1) with independent variables (reduced model)

The LIFEREG Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD7
Dependent Variable	Log(lower)
Dependent Variable	Log(upper)
Number of Observations	1176
Noncensored Values	0
Right Censored Values	379
Left Censored Values	0
Interval Censored Values	797
Zero or Negative Response	71
Name of Distribution	Lognormal
Log Likelihood (without covariates)	-1297.098288
Log Likelihood (with covariates)	-1245.748983

Number of Observations Read	1247
Number of Observations Used	1176

Parameter Information

Parameter	Effect
Intercept	Intercept
Always_buy	Always_buy
Income	Income
Age	Age
Attitude	Attitude
Macro_chee	Macro_chee
Washing	Washing
Pest_con	Pest_con
Uni	Uni
Eatout	Eatout
BKK	BKK
KK	KK

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
Always_buy	1	34.3460	<.0001
Income	1	2.7058	0.1000
Age	1	0.0185	0.8919
Attitude	1	7.9051	0.0049
Macro_chee	1	3.9485	0.0469
Washing	1	0.5688	0.4507
Pest_con	1	4.0752	0.0435
Uni	1	2.8253	0.0928
Eatout	1	0.4428	0.5058
BKK	1	4.1598	0.0414
KK	1	5.0398	0.0248

Appendix 41: continued

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	3.5575	0.0353	3.4884	3.6267	10174.8	<.0001
Always_buy	1	0.1031	0.0176	0.0686	0.1376	34.35	<.0001
Income	1	-0.0006	0.0004	-0.0014	0.0001	2.71	0.1000
Age	1	0.0001	0.0008	-0.0014	0.0016	0.02	0.8919
Attitude	1	0.0084	0.0030	0.0025	0.0142	7.91	0.0049
Macro_chee	1	0.0503	0.0253	0.0007	0.0999	3.95	0.0469
Washing	1	0.0142	0.0188	-0.0227	0.0510	0.57	0.4507
Pest_con	1	0.0341	0.0169	0.0010	0.0671	4.08	0.0435
Uni	1	-0.0280	0.0166	-0.0606	0.0046	2.83	0.0928
Eatout	1	0.0107	0.0161	-0.0209	0.0424	0.44	0.5058
BKK	1	0.0428	0.0210	0.0017	0.0840	4.16	0.0414
KK	1	-0.0514	0.0229	-0.0964	-0.0065	5.04	0.0248
Scale	1	0.2346	0.0064	0.2225	0.2474		

Estimated Covariance Matrix

	Intercept	Always_buy	Income	Age	Attitude
Intercept	0.001244	-0.000009796	0.000000241	-0.000018132	-0.000022908
Always_buy	-0.000009796	0.000310	-0.000001363	-0.000001764	-0.000005015
Income	0.000000241	-0.000001363	0.000000150	-5.514231E-8	-4.654509E-8

Estimated Covariance Matrix

	Macro_chee	Washing	Pest_con	Uni	Eatout
Intercept	-0.000012197	-0.000114	-0.000091514	-0.000119	-0.000147
Always_buy	-0.000041697	-0.000027230	-0.000022880	-0.000028601	0.000018303
Income	0.000000242	0.000000534	0.000000101	-0.000001316	0.000000213

Estimated Covariance Matrix

	BKK	KK	Scale
Intercept	-0.000230	-0.000396	0.000009269
Always_buy	0.000045695	0.000044233	0.000004859
Income	-0.000000897	0.000000352	1.0744771E-8

Appendix 42: Model of lognormal distribution: (lower1, upper1) with independent variables (final model)

The LIFEREG Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD7
Dependent Variable	Log(lower)
Dependent Variable	Log(upper)
Number of Observations	1176
Noncensored Values	0
Right Censored Values	379
Left Censored Values	0
Interval Censored Values	797
Zero or Negative Response	71
Name of Distribution	Lognormal
Log Likelihood (without covariates)	-1297.098288
Log Likelihood (with covariates)	-1257.119653

Number of Observations Read	1247
Number of Observations Used	1176

Parameter Information

Parameter	Effect
Intercept	Intercept
Always_buy	Always_buy
Income	Income
Age	Age
Attitude	Attitude
Macro_chee	Macro_chee
Washing	Washing
Pest_con	Pest_con
Uni	Uni
Eatout	Eatout

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
Always_buy	1	34.1948	<.0001
Income	1	0.7288	0.3933
Age	1	1.1846	0.2764
Attitude	1	11.1128	0.0009
Macro_chee	1	4.8251	0.0280
Washing	1	0.8863	0.3465
Pest_con	1	2.1227	0.1451
Uni	1	2.4930	0.1144
Eatout	1	2.1376	0.1437

Appendix 42: continued

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	3.5230	0.0310	3.4623	3.5837	12929.2	<.0001
Always_buy	1	0.1026	0.0175	0.0682	0.1370	34.19	<.0001
Income	1	-0.0003	0.0004	-0.0011	0.0004	0.73	0.3933
Age	1	0.0008	0.0007	-0.0007	0.0023	1.18	0.2764
Attitude	1	0.0099	0.0030	0.0041	0.0158	11.11	0.0009
Macro_chee	1	0.0559	0.0255	0.0060	0.1058	4.83	0.0280
Washing	1	0.0174	0.0185	-0.0188	0.0537	0.89	0.3465
Pest_con	1	0.0246	0.0169	-0.0085	0.0576	2.12	0.1451
Uni	1	-0.0263	0.0166	-0.0589	0.0063	2.49	0.1144
Eatout	1	0.0234	0.0160	-0.0080	0.0548	2.14	0.1437
Scale	1	0.2368	0.0064	0.2245	0.2498		

Estimated Covariance Matrix

	Intercept	Always_buy	Income	Age	Attitude
Intercept	0.000960	0.000025512	0.000000455	-0.000017695	-0.000019755
Always_buy	0.000025512	0.000308	-0.000001328	-0.000001715	-0.000005211
Income	0.000000455	-0.000001328	0.000000149	-6.637626E-8	-6.678995E-8
Age	-0.000017695	-0.000001715	-6.637626E-8	0.000000559	-6.002187E-8
Attitude	-0.000019755	-0.000005211	-6.678995E-8	-6.002187E-8	0.000008897
Macro_chee	0.000001790	-0.000042554	0.000000189	-0.000001248	-0.000003144
Washing	-0.000048634	-0.000036170	0.000000560	-0.000000890	0.000000786

Estimated Covariance Matrix

	Macro_chee	Washing	Pest_con	Uni	Eatout
Intercept	0.000001790	-0.000048634	-0.000102	-0.000148	-0.000114
Always_buy	-0.000042554	-0.000036170	-0.000024361	-0.000024621	0.000017097
Income	0.000000189	0.000000560	0.000000238	-0.000001409	5.8618989E-8
Age	-0.000001248	-0.000000890	-0.000000970	0.000001764	0.000000203
Attitude	-0.000003144	0.000000786	-0.000008555	-0.000002603	-0.000003225
Macro_chee	0.000648	-0.000006669	0.000001555	-0.000008773	0.000002571
Washing	-0.000006669	0.000342	-0.000020941	0.000014302	-0.000000445

Estimated Covariance Matrix

	Scale
Intercept	0.000007002
Always_buy	0.000005254
Income	2.6534371E-8
Age	-1.439062E-8
Attitude	0.000000465
Macro_chee	0.000003031
Washing	0.000001782

Appendix 43: Model of lognormal distribution: (lower1, upper1) with independent variables (ultimate model)

The LIFEREG Procedure

Model Information

Data Set	WORK.LOGISTIC_STANDARD7
Dependent Variable	Log(lower)
Dependent Variable	Log(upper)
Number of Observations	1176
Noncensored Values	0
Right Censored Values	379
Left Censored Values	0
Interval Censored Values	797
Zero or Negative Response	71
Name of Distribution	Lognormal
Log Likelihood (without covariates)	-1297.098288
Log Likelihood (with covariates)	-1248.633328

Number of Observations Read	1247
Number of Observations Used	1176

Parameter Information

Parameter	Effect
Intercept	Intercept
Always_buy	Always_buy
Macro_chee	Macro_chee
Attitude	Attitude
Sick	Sick
KK	KK
Pest_con	Pest_con

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
Always_buy	1	30.6330	<.0001
Macro_chee	1	4.9912	0.0255
Attitude	1	7.8015	0.0052
Sick	1	4.4375	0.0352
KK	1	21.6289	<.0001
Pest_con	1	3.8474	0.0498

Appendix 43: continued

The LIFEREG Procedure

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	3.5484	0.0224	3.5044	3.5923	25018.6	<.0001
Always_buy	1	0.0928	0.0168	0.0599	0.1257	30.63	<.0001
Macro_chee	1	0.0572	0.0256	0.0070	0.1073	4.99	0.0255
Attitude	1	0.0083	0.0030	0.0025	0.0142	7.80	0.0052
Sick	1	0.0377	0.0179	0.0026	0.0727	4.44	0.0352
KK	1	-0.0818	0.0176	-0.1163	-0.0473	21.63	<.0001
Pest_con	1	0.0329	0.0168	0.0000	0.0658	3.85	0.0498
Scale	1	0.2357	0.0064	0.2235	0.2486		

Estimated Covariance Matrix

	Intercept	Always_buy	Macro_chee	Attitude	Sick
Intercept	0.000503	-0.000081389	-0.000089146	-0.000029692	-0.000245
Always_buy	-0.000081389	0.000281	-0.000042072	-0.000005426	0.000014166
Macro_chee	-0.000089146	-0.000042072	0.000655	-0.000002201	0.000052913
Attitude	-0.000029692	-0.000005426	-0.000002201	0.000008873	0.000002794
Sick	-0.000245	0.000014166	0.000052913	0.000002794	0.000320
KK	-0.000108	0.000030780	0.000022476	0.000006512	-0.000015147
Pest_con	-0.000120	-0.000030726	-0.000004932	-0.000008935	-0.000003944
Scale	0.000006930	0.000004960	0.000003091	0.000000414	0.000003144

Estimated Covariance Matrix

	KK	Pest_con	Scale
Intercept	-0.000108	-0.000120	0.000006930
Always_buy	0.000030780	-0.000030726	0.000004960
Macro_chee	0.000022476	-0.000004932	0.000003091
Attitude	0.000006512	-0.000008935	0.000000414
Sick	-0.000015147	-0.000003944	0.000003144
KK	0.000309	-0.000023923	-0.000005178
Pest_con	-0.000023923	0.000281	0.000000139
Scale	-0.000005178	0.000000139	0.000040881