THESIS APPROVAL

GRADUATE SCHOOL, KASETSART UNIVERSITY

Doctor of Philosophy (Agricultural Economics)
DEGREE

Agricultural Economics
FIELD

Agricultural and Resource Economics
DEPARTMENT

TITLE: Determinants of Consumer Preferences Towards and Willingness to Pay for Safety Fresh Fruits and Vegetables in Bangkok and Chiang Mai Urban Areas

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THESIS

DETERMINANTS OF CONSUMER PREFERENCES TOWARDS AND WILLINGNESS TO PAY FOR SAFETY FRESH FRUITS AND VEGETABLES IN BANGKOK AND CHIANG MAI URBAN AREAS

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A Thesis Submitted in Partial Fulfillment of
the Requirements for the Degree of
Doctor of Philosophy (Agricultural Economics)
Graduate School, Kasetsart University
2010

Rattiya Suddeephong Lippe 2010: Determinants of Consumer Preferences Towards and Willingness to Pay for Safety Fresh Fruits and Vegetables in Bangkok and Chiang Mai Urban Areas. Doctor of Philosophy (Agricultural Economics), Major Field: Agricultural Economics, Department of Agricultural and Resource Economics.
Thesis Advisor: Associate Professor Somporn Isvilanonda, M.A. 208 pages.

Food systems are undergoing a profound change. In particular, the rising demand for fresh produce with specific quality attributes has induced some notable transformation in national and international food markets and along the market chain. Understanding consumer food demand and consumers' valuation and their underlying determinants is an important prerequisite for designing food agricultural policies. It would enable the food sector as a whole to respond effectively to changes in consumers' preferences and meet forecasted or targeted demand. This study analyzes household food demand patterns and demand for fresh fruits and vegetables, disaggregated according to the product and process attributes that characterize the emerging supply chain sectors. These are "place of purchase", "safety and quality indications", "convenience attribute" and "source of production". Consumers' willingness to pay for certain safety and quality attributes was also estimated and the underlying determinants of consumers' preferences were identified and described. The analysis is based on data from a comprehensive survey of 500 households in urban areas of Bangkok and Chiang Mai.

The aggregate demand analysis of entire food bundles demonstrates the shift in urban household food consumption patterns from staple foods towards high-value foods such as fruits, vegetables and meats. A further analysis, of demand for disaggregated fresh fruits and vegetables reveals that demand for fresh produce from modern retailers, fresh produce with formal indications and minimally processed fresh produce have a relatively high income, own-price and education elasticities, compared to traditional ones. Lower income households consume domestic fresh fruits and vegetables in higher quantities. Urban households have a positive willingness to pay for safety and quality attributes of cabbage and NamDokMai mango, which the study selected as representatives of fresh vegetables and fresh fruits, respectively. Preference for pesticide-safe cabbage and NamDokMai mango is related to higher household income, the education of household head and certifications of safety and quality. These suggest that a rapid economic development and higher education levels would likely spur a trend in domestic demand for fresh fruits and vegetables toward a greater emphasis on product safety, quality and convenience.

The findings hold important implications for supply actors and policy makers. The significant change in consumers' preferences presents an opportunity for producers to grow the products that have an increasing demand. For the retailers, traditional retail outlets could build on the favorable situation to create customer trust and raise their competitiveness by developing safety and quality standards and upgrading fresh produce. Modern retail outlets, on the other hand, should maintain their reputation and improve product lines with premium standards to reach consumers in the higher class segments. Development strategies for fresh produce should include product differentiation in terms of safety attributes. Farmers could try to directly access the end consumer markets by making direct sales of fresh produce in the local markets. Economic growth and development, and policies that foster income growth and better education as well programmes that strengthen the competitiveness of the agribusiness sector will contribute to better nutrition, higher food quality and further dietary diversification. Government support and intervention would ensure effective communication with consumers by establishing reliable and credible certification and labeling systems.

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Student's signature Thesis Advisor's signature

ACKNOWLEDGEMENTS

My foremost thank goes to the German Research Foundation (DFG) for the generous financial support as a PhD scholar of the subproject E4.1 “Quality and food safety issues in markets for high-value products in Thailand and Vietnam” through the SFB 564 “The Uplands Program”.

I am deeply indebted to many people who have helped and accompanied me during my study and work on this thesis. Most importantly, I would like to express my deepest appreciation and gratitude to my supervisor, Associate Professor Somporn Isvilanonda. Without his encouragement, guidance, suggestions and valuable comments during my study, I could not have come this far. I have been very lucky to learn many valuable lessons from him during the time under his supervision. Furthermore, I would like to give my warmest gratitude to Professor Dr. Matin Qaim, my German co-supervisor, for giving me the opportunity to be a member of the Uplands Program and to support my study time in Germany. The invaluable suggestions he offered me for the analysis process during this time are gratefully acknowledged. My appreciation and special thanks go to Dr. Orachos Napasintuwong Artachinda, for giving me her spirits and the invaluable inputs during the different stages of my PhD study and thesis preparation time. I am also grateful to Associate Professor Saran Wattanutchariya and Dr. Kanchana Sripruetkiat, for their useful comments and suggestions on my thesis.

A note of thanks must go to all assistants who helped me to conduct the household surveys in Bangkok and Chiang Mai. Without their dedications, the survey and collected datasets would have never been compiled. I would like to express my gratitude to Dr. Marcus Mergenthaler and Ms. Christin Shipmann for their valuable suggestions and guidance through the questionnaire development and the statistical analysis and especially as my research partners of the subproject E4.1. A special thank also goes to Assistant Professor Holger Seebens for his help in revising my first and second paper and his advice concerning econometric modeling. I would like to extend my thanks to Dr. Pepijn Schreinemachers and Dr. Olivier Ecker for initial discussions on model analysis.

I am forever indebted to my mother who gave me unlimited blessings, love and support during my study. Finally, my unending gratitude is dedicated to Melvin Lippe for his unconditional love, understanding, and spirit and help to finish this work.

Rattiya Suddeephong Lippe
May 2010

TABLE OF CONTENTS

	Page
LIST OF TABLES	iii
LIST OF FIGURES	viii
CHAPTER I INTRODUCTION	1
Problem Statement	1
Research Objectives	8
Expected Benefits	8
Scope of the Study	9
CHAPTER II LITERATURE REVIEW	12
Demand Theory and Analytical Approaches	12
Consumer behavior and demand theory	12
Demand analysis	15
Consumers' valuation by State Preference approach	33
Background and Related Fruits and Vegetables Studies	47
Changing patterns of consumer food demand	50
Growing importance of safety and quality in fresh fruits and vegetables	53
Marketing system and supply chain-related attributes for fresh fruits and vegetables	55
Cabbage and mango	60
CHAPTER III METHODOLOGY	66
Analytical Framework and Empirical Model	66
Completed demand analysis	66
Consumers' valuation and determinant factors	80
Data Collection	86
Sampling procedure	86
Design of the questionnaire	87

TABLE OF CONTENTS (CONTINUED)

	Page
CHAPTER IV RESULTS AND DISCUSSION	92
Data Description	92
Household characteristics	93
Expenditure consumption patterns for aggregated food items	96
Expenditure consumption patterns for fresh fruits and vegetables from different supply chain-related attributes by location and expenditure quartile	101
Expenditure consumption patterns for fresh fruits and vegetables from different supply chain-related attributes by education of household head	107
Consumers' attitude toward safety and quality attributes	110
Empirical Results	113
Completed demand analysis	113
Consumers' valuation and determinant factors	130
CHAPTER V CONCLUSIONS AND RECOMMENDATIONS	141
Conclusions	141
Recommendations and Directions for Future Research	146
REFERENCES	149
APPENDICES	172
Appendix A Available data and estimated results	173
Appendix B Correlation structure of commodity prices	182
Appendix C Sampling procedure and questionnaire design	185
Appendix D Questionnaire	193
BIOGRAPHICAL DATA	208

LIST OF TABLES

Table		Page
2.1	Gross Domestic Product (Million Baht) at 1998 Prices	49
2.2	Planted and harvested areas, product quantity and cabbage yield from year 1998 to 2009	61
2.3	Planted and harvested areas, product quantity and mango yield from year 1998-2009	64
2.4	Planted area, harvested area and mango yield by variety in 2005	64
3.1	Variable used in the estimation of first budgeting stage	67
3.2	Variable used in the estimation of aggregate demand system	71
3.3	Variable used in the estimation of disaggregate demand system	74
3.4	Explanatory variable used in the estimation of WTP models	81
3.5	The set of price bid for contingent valuation survey	89
3.6	Attributes and levels in Choice Experiments	90
4.1	Household characteristics by location and expenditure quartile	95
4.2	Share of aggregate food items by location and expenditure quartile	97

LIST OF TABLES (CONTINUED)

Table		**Page**
4.3	Annual average per capita consumption (kilogram) of aggregate food items by location and expenditure quartile	98
4.4	Budget share, annual expenditure per capita and annual average per capita consumption (kilogram) of local and non-local fruits by location and expenditure quartile	99
4.5	Budget share, annual expenditure per capita and annual average per capita consumption (kilogram) for kinds of vegetables by location and expenditure quartile	100
4.6	Budget shares of fresh fruits and vegetables from different place of purchase by location and expenditure quartile	102
4.7	Budget shares of fresh fruits and vegetables from different direct safety indications by location and expenditure quartile	103
4.8	Budget shares of fresh fruits and vegetables for convenience attribute by location and expenditure quartile	105
4.9	Budget shares of fresh fruits and vegetables from different source of production by location and expenditure quartile	106
4.10	Budget shares, expenditure and quantity of disaggregate fresh fruits and vegetables by education of household head	108
4.11	Proportion of sample households with their attitude for fresh fruits and vegetables related to quality and safety attributes	110

LIST OF TABLES (CONTINUED)

Table		**Page**
4.12	Proportion of sample households with their attitude for fresh fruits and vegetables in relation to labels and brands	112
4.13	Demand estimation for broad group expenditure	114
4.14	Conditional aggregate demand system estimates for food categories	116
4.15	Demand elasticities for different food categories	118
4.16	Conditional disaggregate demand system estimates for fresh fruits and vegetables from different supply chain-related attributes	122
4.17	Disaggregate demand elasticity for fresh fruits and vegetables from different supply chain-related attributes	124
4.18	Growth assumptions used to project high-value fresh fruits and vegetables	128
4.19	The projection of fresh fruits and vegetables (kilogram per capita per annual) under different growth assumptions by supply chains related attribute	129
4.20	The percentage of four response groups according obtained by two sequential bids.	130
4.21	The estimation results of WTP model and mean WTP	132

LIST OF TABLES (CONTINUED)

Table		**Page**
4.22	Comparison of mean WTP among different segmentations	134
4.23	Conditinal Logit Model estimation for cabbage and NamDokMai mango	136
4.24	Mixed Logit Model estimation for cabbage and NamDokMai mango	138
4.25	Implicit prices of each attribute level for cabbage and NamDokMai mango	139
Appendix Table		
A1	Land use in Thailand (Unit: Rai)	174
A2	The estimated regression of unit value	176
A3	Probit estimation of the decision to purchase aggregate food item of food at home	178
A4	Probit estimation of the decision to purchase disaggregate fresh fruits and vegetables item of food at home	179
A5	The comparison of demand elasticities with the other studies	181
C1	The calculation of sampling household in Bangkok by district	186

LIST OF TABLES (CONTINUED)

Appendix Table		**Page**
C2	The calculation of sampling household in urban areas of Chiang Mai by districts/sub-districts	187
C3	The calculation of sampling households by road in Bangkok	187
C4	The calculation of sampling households by road in Chiang Mai	188
C5	Choice set of cabbage	191
C6	Choice set of NamDokMai mango	192

LIST OF FIGURES

Figure		Page
1.1	Scope of the study	10
2.1	The four possible outcome groups from a double-bounded approach	36
2.2	Export value for fresh and processed fruits and vegetables (Million Baht)	50
2.3	Imported values for fresh fruits and vegetables and juice (Million Baht)	59
2.4	Retail price of conventional cabbage from January 2007 to July 2009	62
2.5	The harvested area (Rai) of the important fruit crops in Thailand in 2005	63
3.1	Analytical framework of demand system analysis	79
3.2	Analytical framework of pesticide safe fresh produce	82
3.3	Analytical framework of multi-attributes for fresh produce	83
4.1	Distribution of lower and upper values willingness to pay for cabbage	131
4.2	Distribution of lower and upper values willingness to pay for NamDokMai mango	131

LIST OF FIGURES (CONTINUED)

Appendix Figure		Page
C1	Framework of survey design in Bangkok and Chiang Mai urban areas	186
C2	Rama II Soi 24 in Jom Thong District, Bangkok	190

CHAPTER I

INTRODUCTION

This chapter contains the problem statement, objectives and expected benefits and the scope of the study. The final section describes how the thesis report is organized.

Problem Statement

Economic growth, urbanization, modern lifestyles, and globalization have led to a profound change in consumers' preference away from staples towards high-value agricultural products[1]. Rising health consciousness and environmental concerns has bundled nutrition, safety and quality of food and the way the food has been farmed or produced, processed and transported into the decision of consumers to buy or not to buy and how much they might be willing to pay for a food item. This trend has emerged in developed countries and is now increasingly common in growing urban areas of developing and transitional countries (Pingali, 2007). An increasing demand for processed and convenience food has also contributed to this trend (Unnevehr, 2003). In particular, demand for fresh products with specific quality attributes has induced a transformation of national and international food markets. The challenging task has been laid down for countries' regulators and local food industry to respond effectively to such changes, in order to maintain or increase their share in national and international markets.

Fruits and vegetables are among the group of high-value agricultural products that have a significant influence on marketing channels and small-scale farmers (Gulati *et al*., 2005). The shares of fruits and vegetables have become much more

[1] The products are typically perishable and have specific high-value attributes sold through specialized markets. These can include fruits, vegetables, livestock and diary products (Gulati *et al*., 2005; Weinberger and Lumpkin, 2006; CGIAR, 2004).

important than traditional agricultural crops (Aksoy, 2005). Their importance is further boosted by the well-known health benefits of fruits and vegetables that include maintaining a healthy body weight (FAO and WHO, 2004). Beyond mere quantitative growth, the shift in Asian diets towards perishable high-value products embodies changes in product characteristics (Gulati *et al*., 2005). The food safety issue has been brought into focus as consumer's awareness of health risks from unsafe food products has heightened in the past decade (Unnevehr, 2003). Diseases caused by food-borne pathogens have a significant impact on people's health and, in a wider sense, a country's development. As fruits and vegetables are perishable and susceptible to contamination, the major concern is likely to be related to safety aspects. Pesticide residues and microbial contamination are important hazards in fresh produce (Unnevehr, 2000). An efficient way to ensure food safety and prevent food- borne diseases in fresh horticultural produce is to generate an additional value by, among others, low or zero pesticide content and freedom from pest and pathogen contamination.

Changes in lifestyles, usually accompanied by the "westernization of diet," have led to an increasing demand for processed and convenience products. Consumers are spending more money on convenience food whereas other types of expenses are reduced such as time-related cost (Schroder, 2003). High and middle-income consumers tend to purchase more packaged fresh produce in the supermarkets rather than raw commodities in the traditional fresh markets (Pingali, 2007). Such additional values present an opportunity for sustainable income growth in the agricultural sector especially for small scale farmers when integrated with other marketing mechanisms (Birthal *et al*., 2005; Eaton and Sheperd, 2001). Value-addition also plays an important role as an employment generator in rural development, poverty reduction strategies and sustainable agricultural movement (Mergenthaler, 2008; Weinberger and Lumpkin, 2006; Kramol *et al*., 2006). Likewise, an increasing emphasis on quality and safety attributes can create social benefits; grading and standards systems could reduce the negative externalities of poor quality and unsafe food products.

Food safety and quality are not only intrinsic to the product, but also the result of production and distribution processes (Trienekens and Zuurbier, 2008). The development of markets for high value agricultural fresh products has been accompanied by the emergence of new institutional arrangements along the supply chain and the expansion of standards and regulatory schemes which aim to ensure safety and quality levels. The emergence of private food safety and quality standards has introduced new approaches into the supply chains. Private sector-initiated standards and certification systems usually assume greater importance when public institutions and regulatory systems are weak or not in place. This trend, widely recognized in industrialized countries, is now occurring in the agricultural food systems of developing countries (Henson and Reardon, 2005). Moreover, local producers are now facing increasing competition in international markets as well as in their own domestic market as a result of market liberalization and free trade agreements. In developing countries, adaptation to the changes in demand patterns are more easily met by imports (Reardon *et al*., 2003). These developments have heightened competition in domestic food markets and among the international supply actors, especially at the retail level. They have also impacted on small farmers in many ways but in particular on their ability to bear the cost of meeting product standards or complying with increasingly stringent certification schemes.

In Thailand, urbanization has been observed to be associated with the changes in household food consumption patterns. An increasing trend towards nutritive food items, e.g. meat, fruit and vegetable has been noted together with a declining consumption of basic food items, especially among high-income households (Isvilanonda and Kongrith, 2008; Kosulwat 2002; Agribusiness Research unit 1997; SEP 1992a; Patamasiriwat and Poldee 1990). Additionally, consumers have become more concerned with higher quality food products as demonstrated by several studies (Roitner-Schobesberger *et al*., 2008; Sanglestsawai, 2006; Vanit-Anunchai and Schmidt, 2004). This shows the development potential for domestic high-value market segments as consumers are increasingly able to afford higher-priced improved quality foods.

The government has responded by promoting policies related to safety and quality issues as an overarching national agenda in Thailand since 1997. Consumers are made more aware of and knowledgeable with food safety issues to prevent harm to individuals and the family. A proper food quality and safety management scheme in food production, processing, preservation and distribution of nutritious food ensures food security (Varanyanond, 2000). The Department of Agriculture of the Ministry of Agriculture and Cooperatives also promotes a "Good Agricultural Practice (GAP)" policy to reduce or eliminate the use of agrochemicals. In addition, different government agencies are promoting organic farming and providing the technical assistance and services support to farmers. Various schemes of certification exist to inform consumers of the production processes, safety and quality attributes of the products. It confirms that many public agencies are aware of the impacts of agricultural production-related chemical residues in conjunction with an increasing demand for safety and quality food products (Kramol *et al*., 2006).

Meanwhile, demand for safety and quality fresh produce has spurred the supply side actors at the retail level into devising strategies to meet the new market demand. Particularly, food safety and quality has received attention in the private sector such as supermarkets. The evidence is the increasing shelf-space for fresh produce that are certified for safety and quality (Wiboonpongse and Sriboonchitta, 2004). Modern retailers try to promote safe produce by winning consumers' confidence (Oates, 2006). They have implemented strategies to control the process of setting safety and quality standards, generally by complying with government regulations, to build consumers' confidence, provide convenience, one-stop shopping and offer a wider variety of products (Jitsanguan *et al*., 2004; USDA, 2004; Boselie *et al*., 2003). The competition at the retail level has impacted on the composition and competitiveness of the traditional food retail outlets as they are not yet well adapted and integrated into this modern marketing system.

Consumers' needs for convenience are correlated with food choice (Ragaert *et al*., 2004). Minimally processed fresh fruits and vegetables[2] have become popular, particularly among better educated consumers, young consumers and working women who have less time for preparing food, especially in large cities (Kanlayanarat and McGlasson, 2003). In the Thai domestic market, the supply of fresh-cut produce has increased in traditional and modern retail markets (Rattanapanone *et al*., 2000), indicating the growing demand for such product group. This attribute can be considered as an option to differentiate products and satisfy consumers' requirements, especially in the urban areas. The shift in Asian diet is also characterized by increased consumption of temperate fruits and vegetables (Pingali, 2007). This trend provides an opportunity for increased trade among neighboring countries along with the globalization trends in fruits and vegetables trade. However, it also heightens competition with local supply actors. In sum, the increasing role of food safety and quality standards, modern retail outlets and the differentiation of product characteristic and origin can characterize the change in domestic demand. A proper and effective response by the national supply chain requires detailed information on changes in consumers' preferences and consumption habits. Such information will provide a deeper understanding of their determinants, which would enable producers, processors and traders to derive more benefits from new demand patterns.

Various aspects of consumer demand, market development and related policies have been addressed in the Thai economic literature. But only a small number of in-depth analyses exist in which consumers' preferences for specific quality attributes have been identified and described. In the Thai context, research has rarely focused on demand analysis of specific food quality attributes, indicating a current local research gap. A high aggregation of food items or a partial look at selected food items cannot provide the necessary degree of detail. Additionally, data for previous consumers' preference studies had been mostly obtained from purchasers in specialized retail outlets and in that sense are not representative of larger population

[2] Minimal processing of fresh produce such as fruits and vegetables increases their functionality by washing, cutting, mixing and peeling (Ragaert *et al*., 2004).

segments of urban areas. Therefore, available information for food producers and retailers does not exist that would achieve and strengthen their competitiveness in local markets. As a consequence of this research gap in terms of economic literature and current situation in Thailand, the following two research questions are raised:

(1) How can the food consumption patterns be characterized in urban areas of Thailand, its demand elasticity magnitude evaluated and future trends assessed for fruits and vegetables?

(2) What is the consumers' willingness to pay for safety and quality attributes and factors affecting the purchase decision?

Usually, urban areas play a leading role in the food system transformation of a country (Pingali, 2007), as urban households in general have a higher purchasing power than those in rural areas. Regional production systems for fruits and vegetables are characteristically clustered in areas with favorable growing conditions or close to the areas of demand. Bangkok as the capital city imports more than 80 percent of its vegetables from other regions (Hardeweg and Waibel, 2006). Chiang Mai, which has recently experienced a high economic growth, is the main destination of fruits and vegetables produced in Northern Thailand. Therefore, the majority of households have been sampled in urban areas of both provinces. A relatively large sample was taken to ensure that a minimum number of households is included that consumed the food items covered by the study.

In line with the first research question, the interview-based survey of urban Thai households focused on household consumption for food-at-home items including fresh fruits and vegetables, food away from home and non-food items. The demand analysis emphasized on aggregate food-at-home items and fresh fruits and vegetables with a high level of disaggregation in terms of product and processes attributes. The disaggregate analysis differentiates fresh produce by "place of purchase" focused on traditional and modern retail outlets, "safety and quality indications" with emphasis on observable informal and formal indications, "minimally processed" as a special

convenience attribute that allows consumers to save time on food preparation, and "source of production" by their being produced locally or imported. Changes in consumers' preference can be captured from elasticities magnitude between fresh produce from traditional and modern supply sector. The information on disaggregate demand elasticities is also instructive for projection of future trend in Thai domestic fresh fruits and vegetables from modern supply sectors.

The second research question is addressed in the analysis of stated preference. Special considerations on safety and quality attributes go to cabbage and yellow mango in NamDokMai variety, which represent widely consumed vegetables and fruits in Thai households. Cabbage offers an attractive short-run profit especially to small scale farmers in the upland areas of the northern region. In order to improve the productivity and quality of cabbage especially in the off-season, chemical fertilizers and pesticides are often used in the conventional production system (Junsongsang, 2004). Mango is one of the more economically important tropical fruits. It has with a high potential to meet local and overseas market demands. The NamDokMai variety is high-yielding and known as an exotic product particularly in some trading partners such as Japan and South Korea. The rising demand for this tropical fruit has led to increased production and heavier competition among mango exporting countries. A higher demand for mango in the future is expected, especially with low pesticide and chemical residue levels (Jedele, 2002). Supply side actors need to supply safe products and defend their interest in transparent and equivalent standards. However, an essential missing link in the consumers' valuation of quality attributes for both fresh produce (i.e. vegetables and fruits) exists to explain in more detail and depth consumers' purchase decision. Therefore, valuing consumers' preferences for safety and quality attributes is further analyzed for these products by the inclusion of contingent valuation module and choice experiment.

Research Objectives

In order to answer the research questions, this study shall have the following objectives:

- To analyze household food demand patterns, demand for, and determinants of safety and quality attributes of fresh fruits and vegetables in urban areas.

- To elicit consumers' willingness to pay and determinants on consumers' preferences for specific quality attributes of selected horticultural products.

Expected Benefits

The findings of this study can be used to inform the adoption of strategies by players along the supply chain and the development of programs and policy by government. Specifically,

- Producers and traders can adapt their strategies according to new patterns of demand to achieve, maintain or increase competitiveness in the domestic markets.

- Appropriate policies can be identified to support local producers and traders to comply better with quality regulations and standards; and the information can be used to educate consumers.

- The study could provide indications and guidelines for a broader research agenda on the economics of high-value agricultural commodities in Thailand and other developing countries.

Scope of the Study

The analyses were carried out on the cross sectional data obtained from a survey of individual households in urban areas of Bangkok and Chiang Mai. The survey was conducted by the author through personal interviews. Conceptually, the research attempts to investigate household food demand patterns and consumers' preferences for fruit and vegetable produce, with emphasis on safety and quality aspects (Figure 1.1). According to the objectives, the scope of the study is categorized into two major sections. Firstly, the complete demand analysis based on revealed preference data is carried out to investigate the effects of price and non-price factors, deriving results of demand elasticities for food at home items (fresh and preserved food groups) and disaggregate fresh produce. The disaggregate product attributes of fresh fruits and vegetables comprised place of purchase, safety and quality indications, minimally processed and source of production. The demand quantity for fresh produce from emerging supply sectors is projected employing derived disaggregate demand elasticities. Secondly, consumers' willingness to pay and underlying determinants are identified using data on stated preference. Two representative fresh produce were chosen, namely, cabbage and yellow mango of the variety NamDokMai. The quality and safety aspects focus on the chemical residue levels and certification attributes.

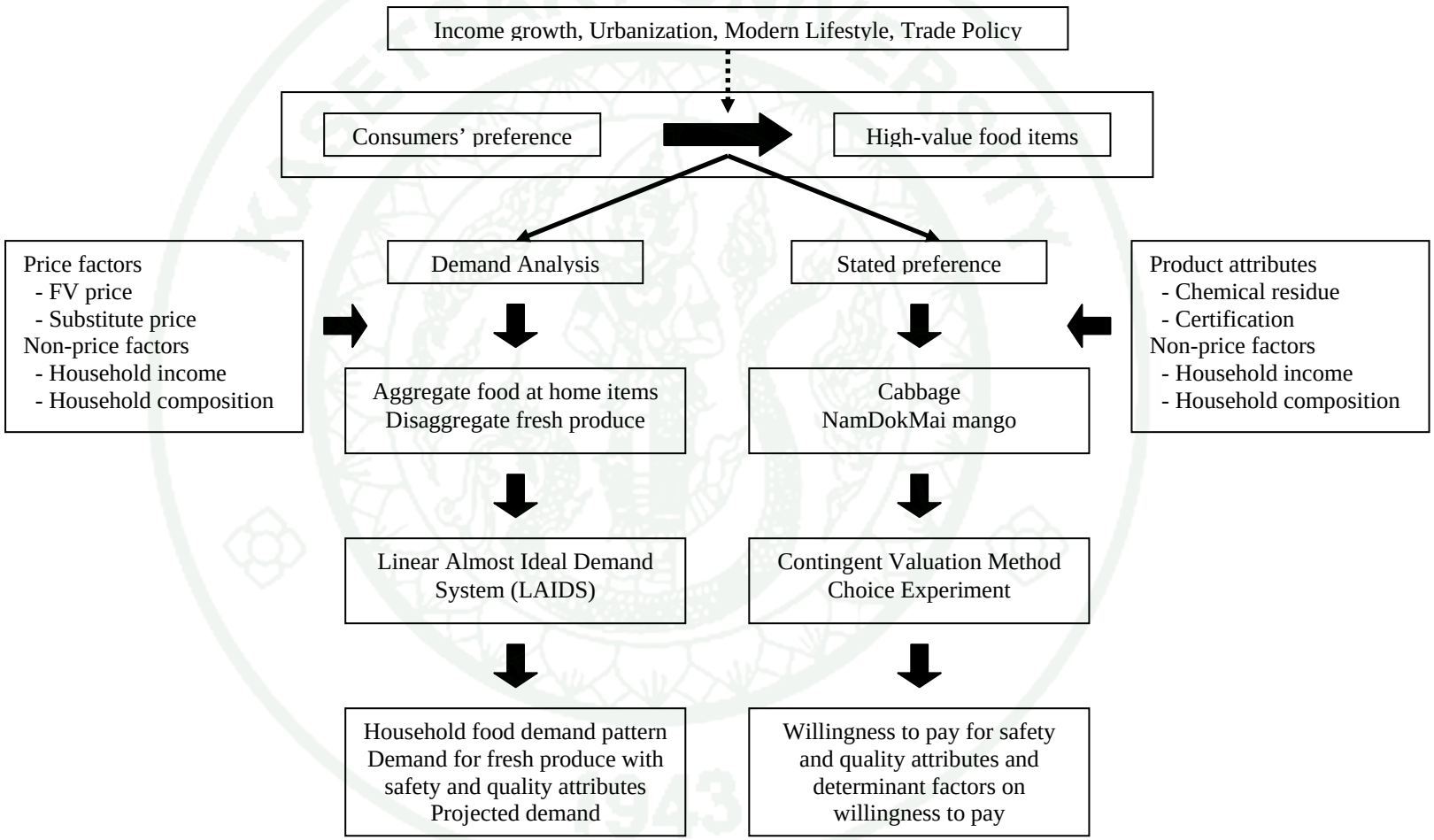


Figure 1.1 Scope of the study

Organization of the thesis report

This thesis consists of five chapters. Chapter 2 starts with the consumer demand theory and the underlying theoretical concepts according to the main objectives. It gives an overview of the production and marketing of fruits and vegetables based on official statistics from different Thai government agencies and on relevant studies on food demand consumption particularly on quality attributes of fresh horticultural produce. The research methodology is described in Chapter 3. Chapter 4 discusses the result of the descriptive and empirical analysis; the discussion from empirical analysis is in two sub-sections in line with the main objectives of the study: (i) aggregate and disaggregate demand analysis among urban households in Thailand, and (ii.) consumers' valuation on specific quality attributes of selected horticultural food products. Chapter 5 draws the conclusions from the findings and gives recommendations for policy, action by government, producers, processors and traders, and future research direction.

CHAPTER II

LITERATURE REVIEW

The chapter is organized into two major sections. The first section gives a brief background of theoretical concept of demand and analytical approaches of demand analysis and consumers' valuation. The second section summarizes the relevant literature on food demand consumption, fruits and vegetables with specific quality attributes, and technical information on cabbage and mango.

Demand Theory and Analytical Approaches

Consumer behavior and demand theory

Consumer behavior explains how consumers allocate their income for purchasing goods and services. It consists of three distinct steps (Pindyck and Rubinfeld, 2009). One of the key determinants is consumers taste or preference. Three basic assumptions are drawn about preferences in economic theory. The assumption is completeness; for two or more bundles of goods, consumers are able to state which of two options is preferred. The second assumption deals with transitivity. For instance, a consumer who prefers chicken to pork, and pork to beef, must also prefer chicken to beef. The third assumption is that consumers always prefer more of any good to less. It normally applies to food purchasing especially when dealing with items with a reasonable shelf life.

Preference relations for all combination of goods or services can be graphically represented by a set of indifference curves. Any point on an indifference curve represents the marginal rate of substitution, which indicates the rate at which consumers are willing to exchange one good for another. A diminishing and convex preference for a pair of food items implies that if more than one good is consumed, consumers would prefer to give up fewer units of the second good to obtain additional units of the first one. Knowing consumer's preferences would help to determine

where consumers spend more on change. However, preferences do not explain all consumer behaviors as budget constraint limits the ability to consume in light of the prices for various good and services (Phindyck and Rubinfeld, 2009; Schroder, 2003).

Demand analysis can be described as a science of consumer choice or preference among different goods or services (Seale *et al*., 2003). A great deal in consumer demand analysis is built on the assumption of a simple linear budget constraint (Deaton and Muellbauer, 1980a). Considering *n* consumption food items that can be chosen by a consuming household, the equality form of linear budget constraint can be expressed as $x = \sum_i p_i q_i$ with household's total expenditure (nominal income) x, prices p_i, quantities q_i and *i=1, 2, …., n*. Given preferences and the conventional linear budget constraint, consumers choose a combination of goods or services that will maximize their satisfaction with the standard maximization utility problem:

(2.1) $\quad Maximize\ u(q) \qquad subject\ to \sum_i p_i q_i = x$

The solution of the first-order condition for utility maximization in respect to budget constraint is a Marshallian demand function, as in the form of

(2.2) $\quad q_i = q_i(p_1, p_2, ..., p_n, x) \qquad i = 1, 2, ..., n$

However, the general analysis of demand function in equation 2.2 turns out to be extremely difficult for the following reasons. Firstly, the case that vertical axis is a part of the indifference curve and the normal situation for all consumers for some parts of the budget; consumers do not buy any goods. Secondly, non-convex preference or the case of perfect substitutes causes the demand function in 2.2 to be discontinuous (Deaton and Muellbauer, 1980a). The utility maximization problem can be rephrased in the problem of minimizing total cost (expenditure), with the so-called dual problem.

(2.3) $Minimize \sum_i p_i q_i = x \qquad subject\ to\ v(q) = u$

The yield of dual solution is the Hicksian or compensated demand which expresses as a function of price and required utility level (Nicholson, 2004). It tells us how quantity is affected by prices with utility held constant.

(2.4) $q_i^* = q_i(p_1, p_2, ..., p_n, \bar{u}) \qquad i = 1, 2, ..., n$

Both Marshallain and Hicksian demand functions satisfy the restrictions imposed by demand theory. Each of those demand solutions can be substituted back into their respective problems. Substituting the Marshallian demand function into the direct utility function $u(q)$, yielding the indirect utility function, $u^* = v(p_i, x)$ which specifies the maximum level of utility, can be obtained at given income and market prices. Both direct and indirect utility functions are equivalent representations of the preference preordering (Barnett and Apostolos, 2008; Ecker, 2008). The Marshallian demand can be directly derived from indirect utility function using Roy's identity, $q_i = \frac{\partial v / \partial p_i}{\partial v / \partial x}$ (Nicholson, 2004 cited Roy, 1947). On the side of dual solution, substituting the Hicksian demand function into the dual objective function yields the expenditure or cost function, $x^* = x(p_i, \bar{u})$, representing the expenditure minimization to reach the utility level at given market prices. Meanwhile, the Hicksian demand can also be derived from expenditure function using Shepard's lemma, $q_i = \frac{\partial x}{\partial p_i}$ (Nicholson, 2004 cited Shepard, 1953). Indirect utility function and cost function are intimately related as they can invert to each other.

To comply with the theoretical framework of demand theory, a reasonably general characterization of demand properties is needed. Firstly, "adding up restriction of Engel aggregation condition" is explained that the sum of income elasticity weighted by its expenditure share is equal to 1 ($\sum_i w_i e_{iy} = 1$). Secondly,

"symmetry restriction" implies that the cross price derivative or the Hicksian demand is symmetric for all $i \neq j$ ($\frac{\partial q_i^*(u,p)}{\partial p_j} = \frac{\partial q_j^*(u,p)}{\partial p_i}$). Thirdly, "homogeneity restriction" describes that the sum of the direct and all cross-price elasticities for a particular commodities equal to the negative of its income elasticity ($\sum_j \varepsilon_{ij} = -e_{iy}$). Lastly, "negativity restriction" indicates that an increase in price with utility held constant must cause demand for that good to fall or at least remain unchanged ($\varepsilon_{ii} + w_i e_{iy} \leq 0$). All demand restrictions do not only reduce the dimensionality of the parameter space, they also ensure that the estimated elasticities are consistent with the neoclassical demand theory (Nicholson, 2004; Deaton and Muellbauer, 1980a).

Demand analysis

There are two basic approaches to estimate the demand parameter for goods or services. The first is known as the single demand model, which has an amount of a single or an aggregate good as dependent variable. The model is in a pragmatic fashion with recourse to economic theory. For instance, the total vegetable consumption, q_{veg} is a function of its price, p_{veg} and price of other commodities p_j, total expenditure per capita x and household characteristics z_k. The basic specification can be written as:

(2.5) $$q_{veg} = \alpha_{veg} + \beta_{veg} x + \sum_{veg} \gamma_{veg,j} p_j + \sum_k \delta_{veg,k} z_k$$

This reduced-form single demand approach is attractive in its simplicity but limited in the theoretical concepts for several reasons. Firstly, the choice of functional form and incorporated variables is arbitrary. The guidelines are usually a combination of common sense, interest in specific elasticity, computational convenience and goodness of fit criteria, which leaves doubts about the theoretical foundation in consumer demand. Secondly, the estimated elasticity can be true only over a short range of prices and income. Finally, the quantity projection obtained does not fully

satisfy demand theory, particularly on the budget constraint (Sadoulet and Janvry, 1995).

For this purpose, a full demand system estimation can consistently take into account the mutual interdependence of various commodities for the consumers' choices (Sadoulet and Janvry, 1995). The relative illustrative power, consistent with economic theory and its simplicity of estimation are important criteria for selecting a demand model. Several demand system approaches have received considerable attention in economic literature. The first example of Marshallian demands equation is the Linear Expenditure System (LES). It was introduced by Stone (Deaton and Muellbauer, 1980a cited Stone, 1954) derived from the Stone-Gary utility function. It is a general linear formulation of demand and imposed theoretical restriction of additivity, homogeneity and symmetry. LES does not allow for inferior goods and implies that all are gross complement goods. Its weakness is that the obtained marginal budget shares from the estimation are constant with the change in income. This property is known as "homothetic" which leads to an income elasticity of necessities that actually increases with rising income (Seale *et al*., 2003). In this context, LES is the best option to estimate demand for goods with independent marginal utilities such as large basket of goods or large categories of expenditures i.e. clothing, housing, food and durables (Deaton and Muellbauer, 1980a).

The Rotterdam model was proposed by Theil (Deaton and Muellbauer, 1980a cited Theil, 1975; 1976). It approximates the demand relationship without imposing any assumptions on the structure of utility function. The model is also left with the rejections of homogeneity which may simply reflect the quality of the approximation rather than any inherent property on the data. The Rotterdam model shows linearity in its parameters, which produces constant price and expenditure elasticities similar to LES. As such, it can lead to counterintuitive results in regard to income change, especially if cross sectional data are drawn (Ecker, 2008; Seale *et al*., 2003).

The Working-Leser Model was discussed by Working (1943) and Leser (1963). The basic model expresses budget share as a linear function of total expenditure and also acknowledges the adding-up restriction. The model is expressed as equation (2.6):

(2.6) $$w_i = \alpha_i + \beta_i \log x + \varepsilon_i$$

where w_i is a budget share of a commodity group *i*, x is total expenditure, ε_i is the random disturbances assumed with a zero mean and constant variance, and α_i, β_i are the parameters of the adding-up properties. This model does not directly provide the estimate income elasticity as prices are constant. The relationship between consumption and income is referred to as the Engel function, which has several desirable properties. It satisfies the budget constraint as the share dependent variable for every commodity in the system adds up to unity. Moreover, the approach is able to represent luxuries, necessities and inferior goods where the proportion of income spending on food will decline as household income increase (Sadoulet and Janvry, 1995).

The Almost Ideal Demand System (AIDS) was developed by Deaton and Muellbauer (1980b) which to date is widely applied. The demand system is derived by use of duality concepts from a particular cost function. The price-independent, generalized-logarithmic (PIGLOG) class is represented via cost or expenditure function as equation (2.7):

(2.7) $$\log C(u, p) = (1-u)\log\{a(p)\} + u\log\{b(p)\}$$

where *u* denotes the utility lines between 0 (subsistence) and 1 (bliss). The function *a(p)* and *b(p)* are the costs of subsistence and bliss, respectively. The price aggregator functions are specified as follows:

$$(2.8) \qquad \ln a(p) = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij}^{*} \ln p_i \ln p_j$$

$$(2.9) \qquad \ln b(p) = \ln a(p) + \beta_0 \prod_i p_i^{\beta_i}$$

The specific function form of ln a(p) and ln b(p) are taken in (2.7), the AIDS cost function:

$$(2.10) \quad \log c(u, p) = \alpha_0 + \sum_i \alpha_i \ln p_i + \tfrac{1}{2}\sum_i \sum_j \gamma_{ij}^{*} \ln p_i \ln p_j + u\beta_o \prod_i p_i^{\beta_i}$$

The demand functions can be derived directly from equation (2.10) by multiplying both sides with $P_i / c(u, p)$ therefore, the budget share as a function of prices and utility develops as:

$$(2.11) \qquad \begin{aligned} w_i &= \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i u \beta_0 \Pi p_i^{\beta i} \\ \gamma_{ij} &= \tfrac{1}{2}(\gamma_{ij}^{*} + \gamma_{ji}^{*}) \end{aligned}$$

where w_i is a budget share for i^{th} good category.

For the maximum utility of consumer, which is total expenditure *(x) = c(u,p)*, equation (2.11) has to be inverted to give *u* as a function of *p* and *x* (indirect utility function). By using the Shepherd Lemma approach, the AIDS demand functions in budget share form as follows:

$$(2.12) \qquad w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log\left(\frac{x}{P}\right)$$

where P is an aggregate price index

$\frac{x}{P}$ is the real total expenditure

p_j is the price of j-th good

Almost Ideal Demand system (AIDS) is appropriate for food demand analysis for several reasons: the equations are consistent with economic theory as the demand equation can be derived from a well-behaved utility function;. it is relatively easy to impose symmetry restriction in cross-price terms and homogeneity; AIDS provides inelastic income elasticity for necessity good as expenditure decreases, which is particularly interesting for food consumption pattern studies. In comparison to the Linear Expenditure System (LES), AIDS is characterized as non-additive, implying that consumption of item *i* would affect the marginal utility of item *j*. Lastly, it is easy to approximate in linear terms without observing significant differences between parameters obtained from the AIDS and the approximate linear AIDS model (Chalfant, 1987; Blanciforti and Green, 1983; Deaton and Muellbauer, 1980b).

Recent empirical analyses on micro-data suggest that demand system should be rank three. It would be able to display a greater variety of shapes of the Engel curve than rank two models (Bank et. al., 1997). Following Bank (1997), the Quadratic Almost Ideal Demand System (QUAIDS) model is based on the indirect utility function (V) as (2.13):

$$\ln V = \left\{ \left[\frac{\ln x - \ln a(p)}{b(p)} \right]^{-1} + \lambda(p) \right\}^{-1} \tag{2.13}$$

The first term in the right hand side of the equation (2.13) is the indirect utility function of a PIGLOG demand system. *x* is total expenditures and *p* is a vector of prices. In particular, *ln a(p)* is the translog form of the classical AIDS model and *b(p)* is the simple Cobb-Douglas price aggregator as (2.14)

$$b(p) = \prod_i p_i^{\beta_i} \tag{2.14}$$

The λ term in the AIDS model is set to zero in order to construct a system which should be as similar as possible to the conventional AIDS model, but also able to capture more varieties in the Engel curve. Bank et. al. (1997) defined λ term as equation (2.15).

(2.15) $$\lambda(p) = \sum_i \lambda_i \ln p_i \qquad where \quad \sum_i \lambda_i = 0$$

To apply Roy's identity in equation (2.13), the QUAIDS expenditure shares can be expressed as in equation (2.16) with the so-called rank three demand system as (2.16):

(2.16) $$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln\left[\frac{x}{a(p)}\right] + \frac{\lambda_i}{b(p)}\left\{\ln\left[\frac{x}{a(p)}\right]\right\}^2$$

Recent studies used the QUAIDS model to examine consumers' behavior instead of AIDS model (Ecker, 2008; Bopape and Mgers, 2007; Kedir and Girma, 2007; Gould and Villarreal, 2006; Michelini, 1999). The main advantage of rank three QUAIDS model is the ability to capture more varieties in Engle curves compared to AIDS and Rotterdam approaches (Decoster and Vermeukn, 1998). Nevertheless, the presence of the quadratic term does not imply that the model is better *per se* compared to other specifications (Gould, 2006). Model performance often depends on data distribution properties, the size of observations and the occurrence of missing data.

1. Separable preference and stepwise budgeting

The investigation of household consumption patterns involves decisions on an immense number of commodities and services. The consumer allocation problem is more complex in econometric estimation requiring huge quantities of datasets (Edgerton, 1997). The group aggregation of single commodities can reduce the number of equations. It results in more easily manageable demand system estimation

through two theoretical approaches: (i.) composite commodity theorem and (ii) separable preferences with two-stage budgeting.

The composite commodity theorem was proposed by Leontief, it was later suggested by Hick that if a group of prices move in parallel, the corresponding commodities can be grouped together (Deaton and Muellbauer, 1980a cited Leontief 1936; Hick, 1936). The expenditure function is derived by price and quantity indices which also satisfies the usual properties of expenditure function[3]. However, the usefulness of this theorem lies in the limitation of empirical studies with the fact that relative prices show large fluctuations. Additionally, some aggregated commodities are based on the composite commodity theorem, which is difficult to justify. For instance, the relatively volatile price of vegetables prevents its classification with other food commodities. The definition of aggregates would shift with institutional changes such as internal government policy and alterations in tariffs (Deaton and Muellbauer, 1980a). Lewbel (1996) proposed a way to relax the condition of perfect price correlations by generalizing the composite commodity theorem with an extension of the original Hicks-Leontief idea. The assumption is that the distribution of the price of an individual commodity is independent of the composite group price. The tests for generalized composite commodity theorem are based on co-integration relations between individual commodity's prices and its group price index (Bopape, 2006). However, the applicability of this theorem remains limited, particularly in food demand studies in developing countries. Such aggregation cannot be efficient if sufficient data on market prices are not available for all commodities (Ecker, 2008).

Alternatively, separability defines commodity groups by using consumer's preference. It is usually used to address problems of large variety of commodities in household consumption decisions. This approach implies that commodities can be partitioned into groups. Commodities which closely interact in yielding utility can be grouped together, while commodities that only interact in a general way through the budget constraint are kept in a separate group (Sadoulet and Janvry, 1995). Thus, preference within groups can be described independently of the quantities in other

[3] The increase in utility and prices, concave in prices and linearly homogenous (Nicloson, 2004).

groups (Deaton and Muellbauer, 1980a). For separable preference, total utility for household consumption is a combination of sub-utility function for each group commodity. By considering that three board groups in the household consumption exist with food at home (fah), food away from home (fafh) and non-food (nf), and assuming two commodities in each group, the total utility can be expressed as (2.17)

(2.17) $$u = v(q_1, q_2, q_3, q_4, q_5, q_6) = f[v_{fah}(q_1, q_2), v_{fafh}(q_3, q_4), v_{nf}(q_5, q_6)]$$

If any subset of commodities appears only in a separable sub-utility function, the Marshallian subgroup demand can be derived from the outcome of maximizing $v_{fah}(q_1, q_2)$ subject to $p_1q_1 + p_2q_2 = x_{fah}$. The controversial result is the existence of a subgroup demand function, implying "weak separability" as (2.18)

(2.18) $$q_i = g_{fah(i)}(x_{fah}, p_1, p_2)$$

When the direct utility functions are additively combined, it is so-called "strong separability". In this case, there is only one good in each group and preferences are said to be additive.

(2.19) $$u = f[v_1(q_1) + v_2(q_2) + v_3(q_3) + v_4(q_4) + v_5(q_5) + v_6(q_6)]$$

Strong separability is usually reserved for the case of multi-good groups. The Linear Expenditure System (LES) is derived from the utility function, which can be easily seen to additive preferences (Deaton and Muellbauer, 1980a).

The second important idea for demand system estimation is the concept of a utility tree proposed by Strotz (Deaton and Muellbauer 1980a cited Strotz 1957, 1959) allowing consumers to divide a decision into multiple steps. Separable preference is closely related to two-stage budgeting. It occurs when consumers can allocate total expenditure in two stages. The budgeting process implies that the relationship between price and expenditure elasticities is calculated at a different

budget level. Separable preferences and two-stage budgeting are intimately related to each other. Weak separability is both necessary and sufficient for the second stage of a two-stage budgeting approach. If the assumption of weak separable holds, demand models can be drawn to estimate separately at each budgeting stage. The consistent overall demand can be obtained by summing up individual demands (Deaton and Muellbauer, 1980a).

2. The exogenous variables in the complete demand system models

Income, price and socio-demographic variables are the key determinants of food consumption patterns. In order to obtain consistent estimates, appropriate approaches to incorporate all exogenous variables in the demand system models are needed. Considering original AIDS model as (2.20):

$$w_i = \alpha + \sum_j \gamma_{ij} \log p_j + \beta_i \log\left(\frac{x}{P}\right) \quad (2.20)$$

where price index *(P)* can be expressed as:

$$\log P = \alpha_0 + \sum_i \alpha_i \log p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \log p_i \log p_j \quad (2.21)$$

From the equation (2.21), α_0 and α_i are the estimated parameters. It shows that the relationship between index price and prices of individual good is non-linear resulting in a “complicated” non-linear estimation. In contrast to the Almost Ideal Demand System, the LAIDS is commonly linearized by applying the Stone’s price index as equation 2.22 (Shiptsova et. al., 2004; Piumsombun, 2003; Brosig, 2000; Gould et. al., 1990 etc.).

$$\log(P^S) = \sum w_i \log p_i \quad (2.22)$$

However, recent studies have indicated that Stone's price index may yield inconsistent estimates proposing the Laspeyres and Tornqvist index as alternative (Buse and Chan, 2000; Moschini, 1995). The selection of an appropriate price index should be carried out by examining the correlation structure of price (Buse and Chan, 2000). Laspeyres price index is appropriate for strong positive co-linearity whereas the Tornqvist index performs well under zero or mixed co-linearity.

The Laspeyres price index is the geometrically weighted average of price as (2.23):

$$\ln P_h^L = \sum_{i=1}^{n} w_i^0 \ln p_{ih} \tag{2.23}$$

The Tornqvist price index uses logarithmic change techniques to measure price change between any two periods. Items are weighted together in this equation by the arithmetic average of their relative expenditures in these periods. However, applying Tornqvist price index in cross sectional data, the formula can be expressed as (2.24):

$$\ln P_h^T = \frac{1}{2}\sum_{i=1}^{n}(w_{ih} + w_i^0)\ln\frac{p_{ih}}{p_i^0} \tag{2.24}$$

where

P_h^T is the Tornqvist price index

w_{ih} is the budget share of food item *i* in each individual household *h*

w_i^0 is the mean budget share of food item *i*

p_{ih} is the price of food item *i* in each individual household *h*

p_i^0 is the mean price of food item *i*

Several studies assumed that price is constant especially in the cross-sectional data surveys containing no price variation. In reality, Prais and Houthakker

(1955) argue that price has a variation due to the region, season, price discrimination and different quality. The causes of cross-sectional price variation should be identified in order to interpret correctly the effect of prices in the demand analysis. The definition of price variables is a major problem when employing household survey data to estimate a demand system. Many approaches were introduced to approximate price and to retrieve price effects in demand systems.

Cox and Wohlgenant (1986) proposed an approach by assuming that deviations of unit value from regional or seasonal mean price reflected "quality effects". Quality effects were induced by household characteristics and non-systematic supply-related factors. Following Cox and Wohlgenant and Gao (1995), to regress the mean deviated unit values on household characteristics as (2.25):

$$\ln v_i = \alpha_i^{'} + \beta_i^{'} \ln x + \sum_{s=1}^{S} \gamma_{is}^{'} H_s + \varepsilon_n^{'} \qquad (2.25)$$

To denote $\alpha_i^{'}$, $\beta_i^{'}$ and $\gamma_{is}^{'}$ are parameters estimated by OLS and $\varepsilon_n^{'}$ is an error term from related unit-value equations. It filters the quality effects of the unit-value in order to obtain the quality adjusted price ($\hat{\pi}_n^{CW}$) as (2.26):

$$\hat{p}_n^{CW} = \ln v - \hat{\beta}_n^{'} \ln x - \sum_{s=1}^{S} \hat{\gamma}_{is}^{'} H_s = \hat{\alpha}_i^{'} + \hat{\varepsilon}_n^{'} \qquad (2.26)$$

The approximated prices from (2.26) were calculated from the sum of OLS estimated constant term in (2.25) and its residual. Noteworthy is the measurement error in the unit value, implying that it still correlates with the household expenditures. For zero consumption, missing unit values are ignored or replaced by ad hoc procedures. Huang and Lin (2000) remarked that adjusted prices are random and vary across households. It ignores the fact that households in the same cluster could face a similar price in a short survey period.

Deaton (1988) employed the residuals of estimated unit value and expenditure share equations to obtain a system of demand equations. The unit value in his equation is defined as the ratio of expenditure to quantity. There are two equations to estimate the coefficient parameters: the first refers to budget share and the second links to a unit value equation as (2.27) and (2.28):

(2.27) $$w_{ihc} = \alpha_i + \beta_i \ln x_{hc} + \gamma_i H_{hc} + \sum_j \theta_{ij} \ln p_{jc} + f_{ic} + \varepsilon_{ihc}$$

(2.28) $$\ln v_{ihc} = \alpha^*_i + \beta^*_i \ln x_{hc} + \gamma^*_i H_{hc} + \sum_j \phi_{ij} \ln p_{jc} + \varepsilon^*_{ihc}$$

where

w_{ihc} is the budget share of item good *i* for h^{th} household in cluster *c*

v_{ihc} is the unit value of item good *i* (the expenditure of the item *i* divided by the quantity household h bought) for h^{th} household in cluster *c*

x_{hc} is the total expenditure on good and services

H_{hc} is the vector of household characteristics

p_{jc} is the price of good *j* in a total of *n* goods

f_{ic} is a cluster-fixed effect for good item *i*

This approach assumes that each household in a cluster faces the same prices for market goods. It is not possible to estimate directly the price coefficient as price variables p_{jc} are not observable in the model. Deaton (1988) presented a multi-stage budgeting process of consumer decision making. To consider the budget allocation of a representative household, subscript *h* in cluster *c* has to be temporarily cut off referring to the equations of cluster means in equation (2.29) and (2.30)

(2.29) $$w_{ic} = \alpha_i + \beta_i \ln x_c + \gamma_i H_c + \sum_j \theta_{ij} \ln p_{jc} + f_{ic} + \varepsilon_{ic}$$

(2.30) $$\ln v_{ic} = \alpha^*_i + \beta^*_i \ln x_c + \gamma^*_i H_c + \sum_j \phi_{ij} \ln p_{jc} + \varepsilon^*_{ic}$$

The fixed effect and the cluster invariant price are removed in order to subtract the cluster means equations from the cluster equations.

(2.27) – (2.29) $(w_{ihc} - w_{ic}) = \beta_i(\ln x_{hc} - \ln x_c) + \gamma_i(H_{hc} - H_c) + (\varepsilon_{ihc} - \varepsilon_{ic})$

(2.28) – (2.30) $(\ln v_{ihc} - \ln v_{ic}) = \beta^*_i(\ln x_{hc} - \ln x_c) + \gamma^*_i(H_{hc} - H_c) + (\varepsilon^*_{ihc} - \varepsilon^*_{ic})$

In a separable assumption, the equations can derive information about price effect from the estimated covariance of residuals. Nevertheless, Deaton's approach does not guarantee that accurate estimates of price responses can be obtained as price is not the only influence on residuals covariance (Alfonzo and Peterson, 2006).

Huang and Lin (2000) defined utility as a function of quantity which should be adjusted by quality effects. The quantity adjusted by quality effect as $\lambda_i q_i$ which λ_i is the ratio of unit value to average price of *i*-th commodity. The utility function of food at home is $U = \sum_i \alpha_i \ln(\lambda_i q_i)$ where i imply to commodity. To consider the duality properties of demand relationships, the demand equation from a cost function ($C = \sum_i p_i \lambda_i q_i$) can be derived by minimizing the cost given utility level. The cost function which can be used to generate a demand system is obviously a function of unit values and utility level. It concludes that unit value can substitute for price in the demand system. Therefore, Huang and Lin adopt the cost function as suggested by Deaton and Muellbauer by replacing unit value of price in the model. However, Deaton (1988) advised that using unit value as price could lead to inconsistent estimates of price elasticity. Unit value is not only a function of commodity price but also includes the quality choice with the so-called "quality shading effect".

A recent study by Alfonzo and Peterson (2006) introduced a consistent approach to approximate the commodity market price index. The quality-corrected prices as the portion of unit value are invariant within the group of observations or cluster. The unit value of consuming households is regressed on socio-demographic variables and cluster dummies, assuming households in the same cluster should face a similar price.

(2.31) $$\ln V_n = \alpha_n + \beta_n \ln x + \sum_{r=1}^{R} \kappa_{nr} Z_r + \sum_{c=a}^{C-1} \varphi_{nc} D_c + \varepsilon_n$$

where V_n The unit value

x The group total expenditure

Z_r Household characteristics

D_c Dummy variables indicating the cluster

ε_n Stochastic component

r The number of household characteristic variables

n The commodity n

β_n, κ_{nk}, φ_{nc} are the estimated parameters

The estimated coefficients are used to calculate predicted market prices. As such, only dummies of cluster are used and the values for socio-demographic variables are set to zero:

(2.32) $$\ln \hat{p}_n = \hat{\alpha}_n + \sum_{c=a}^{C-1} \hat{\varphi}_{nc} D_c$$

In this approach, the same prices for all households can be generated in one cluster disregarding consumption. The approximated price implies that households in one cluster face a similar price.

Socio-demographic variables are expected to influence household consumption patterns besides income and price. Several procedures were introduced to incorporate such variables, such as demographic translating, demographic scaling and Gorman. The procedures can be used in conjunction with any completed demand systems (Pollak and Wale, 1980, 1981). In this study, the translating and scaling approaches were reviewed which are mainly useful for incorporating in completed demand systems (Mergenthaler et. al., 2009a; Chern et. al., 2003; Liu and Chern, 2001; Brosig, 2000; Gould, 1990; Heien and Wessells, 1990). Following Pollak and

Wales (1981), an original class of demand system starts with $q_i = \bar{h}^i(P, x) \quad i = 1,2,....n$. P's denote prices, q's are quantity and x is total expenditure. They assumed that these original systems are "theoretically plausible". Demographic translating and demographic scaling firstly introduced n parameters $(\eta_1,.....,\eta_n)$ into the original demand system and postulating the newly introduced parameters.

Generally, "*demographic translating*" is an approach to incorporate demographic variables into classes of demand systems developed by Pollak and Wale (1980). The original demand system is replaced by the demographic translating as (2.33):

(2.33) $$h^i(P, x) = d_i + \bar{h}^i(P, x - \sum p_k d_k)$$

where d's are translation parameters. It depends on the demographic variables as $d_i = D^i(\eta)$. The direct utility function is $U(X) = \bar{U}(x_1 - d_1,....., x_n - d_n)$. For convenience of the translating parameters, the function does not included constant term in the definition of linear demographic translating as in equation (2.34). Pollak and Wale (1981) described that "*the constant term is better treated as part of the specification of the original demand system than as part of the demographic specification*". To use the demographic translating into the complete demand system, a close relationship exists between the effects of change in demographic variables and the effects of changes in total expenditure.

(2.34) $$D^i(\eta) = \sum_{r=1}^{n} \delta_{ir} \eta_r$$

where δ's are the associated parameters

η_r are the demographic variables which r = 1,2,…..,n

Alternatively, "*demographic scaling"* was first proposed by Barten (1964) and discussed in more detail by Muellbauer (1977). Demographic scaling introduces scaling factors into the original class of demand system (Pollak and Wales, 1980). The original demand system is replaced by the modified system as (2.35):

(2.35) $$h^i(P,x) = m_i \bar{h}^i(p_1 m_1, p_2 m_2, ..., p_n m_n, x)$$

where *m*'s are scaling parameters which depend on the demographic variables as $m_i = M^i(\eta)$. The direct utility function is $U(X) = \bar{U}(\frac{x_1}{m_1}, ..., \frac{x_n}{m_n})$.

The linear demographic scaling is given by

(2.36) $$M^i(\eta) = 1 + \sum_{r=1}^{n} \varsigma_{ir} \eta_r$$

The effects of change in demographic variables are closely related to the effects of price change under the demographic scaling approach. The relationship shows clearly in elasticity format. However, the demographic translating approach preserves the linearity of the system, whereas the demographic scaling is a highly nonlinear specification (Pollak and Wales, 1981).

3. Censored data

Cross-sectional micro data have been widely used in estimating household consumption patterns. The crucial problem to deal with micro data and estimating disaggregate demand system models is the occurrence of zero observation of dependent variables. The two principal reasons for zero consumption are households at corner solution and the limited survey leading to infrequency of purchase (Meyerhoefer *et al*., 2005). For the latte, a shorter reference survey period would lead to a higher opportunity of revealing non-consumption for a particular commodity. Heckman (1976) indicated that not adjusting for sample section may cause biased demand parameter estimates. In a single-demand equation, Maximum-Likelihood

estimation of the Tobit model can be drawn in a straightforward manner for the limited dependent variable. On the other hand, the direct Maximum-Likelihood estimation for system of equations remains difficult when censoring occurs (Shonkwiler and Yen, 1999).

Given the corner solution household consumption problem, two general approaches were introduced. The benchmark approach starts with the primal (Kuhn-Tucker) approach of Wales and Woodland (1983). Followed by its dual version (virtual-price) approach of Lee and Pitt (1986) and the Tobit system suggested by Amemiya (1974) and implemented by Wales and Woodland (1983). The main issue of using the Kuhn-Tucker approach and its dual version is the derivation of an estimable demand system. Nevertheless, it is not an easy task to specify direct or indirect utility functions for some system specification. Meanwhile, the Amemiya-Tobin approach generates a simpler framework of imposition of coherency condition (Dong *et al*., 2004). However, each of these approaches requires a formulation of a likelihood function based on composite distribution. The direct Maximum-Likelihood estimation requires the evaluation of a partially integrated multivariate normal probability density function. Hence, it imposes a high computational burden and limits the feasibility of approach, especially in a demand system with many censored equations (Ecker, 2008; Meyerhoefer *et al*., 2003; 2005). Recently, Perali and Chavas (2000) have developed a consistent approach to the problem based on Generalized Method of Moments (GMM) techniques. Meyerhoefer (2005) extended this framework to consistently estimate longitudinal censored demand systems.

The situation of corner solution may arise from price and inventory effects as well as by a short survey period. It assumes that households may not purchase a particular food item during the survey period, but do generally prefer such food items. Heckman sample selection model does not distinguish between non-preference and corner solution (Asatryan, 2003; Park and Capps 2002). Given the complexity of estimating under Lee and Pitt and the Amemiya-Tobin approach, the alternative approach of so-called two-step models have been adopted for censored demand system estimation (Dong *et al*., 2004). Additionally, infrequency consumption in

household demand modeling also requires such a model for each commodity group that govern the discrete outcomes of consumption and non-consumption (Ecker, 2008). Heien and Wessels (1990) suggest a simpler way of dealing with Heckmann models in the demand system. Consider the general relationship in equation (2.37):

(2.37) $$d_{ih} = z_{ih}^{'}\alpha + v_{ih}$$

where d_{ih} is equal to 1 if household h consumes food item i and 0 otherwise, $z_{ih}^{'}$ denotes a vector of socio-demographic variables and error term, v_{ih} is assumed to be normally distributed. The parameters are estimated by using a probit model based on maximum likelihood for all observations (zero and non-zero consumption). The correction factor, so-called Inverse Mill Ratio (IMR) will be estimated for households that consume food items and households with zero consumption in equation 2.38 and 2.39, respectively.

(2.38) $$IMR_{ih}^{1} = \frac{\phi(z_i^{'}\hat{\alpha}_i)}{\Phi(z_i^{'}\hat{\alpha})}$$

(2.39) $$IMR_{ih}^{0} = \frac{\phi(z_i^{'}\hat{\alpha}_i)}{1-\Phi(z_i^{'}\hat{\alpha})}$$

where, $\phi(z_i^{'}\hat{\alpha})$ is univariate standard normal probability function

$\Phi(z_i^{'}\hat{\alpha})$ is cumulative distribution function

The calculated IMRs are used as the independent regressor in the second stage of the LAIDS which is demonstrated as equation (2.40):

(2.40) $$w_{ih} = \alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\ln p_{jh} + \beta_i \ln\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh} + \sum_{i=1}^{n-1}\rho_i IMR_{ih} + \varepsilon_i$$

Nevertheless, Shokwiler and Yen (1999) pointed out that the estimated results using Heckmann procedure leads to biased estimators and proposed a new consistent two-step procedure. Their procedure is a multivariate generalization of Amemiya's type two tobit model which allows for both Maximum-Likelihood and Seemingly Unrelated Regression to estimate the demand system. SY procedure has been widely used in recent works (Ecker, 2008; Yen and Lin, 2006; Shiptsova *et al.*, 2004; Pittman, 2004; Asatryan, 2003; Yen *et al.*, 2002; Su and Yen, 2000). The procedure consists of two steps. Firstly, define d_{ih} is equal to 1 if household *h* consumes food item *i* and 0 otherwise, as in equation 2.37. $\phi(z_i^{'}\hat{\alpha})$, a univariate standard normal probability function, and $\Phi(z_i^{'}\hat{\alpha})$ denotes the associated cumulative distribution function are formed using the estimated parameters from probit estimation. The second step involves transforming the original demand estimation equation as equation (2.41):

(2.41) $$w_{ih}^{*} = \Phi(z_i^{'}\hat{\alpha})w_{ih} + \varphi\hat{\phi}(z_i^{'}\hat{\alpha}_i) + \xi_i$$

Consumers' valuation by State Preference approach

State Preference (SP) approaches are well-known techniques to estimate economic value for ecosystem and environmental services as well as goods which are not directly traded in the markets. These are also applied to access consumer demand for hypothetical products or products that do not appear in every market. SP techniques rely on asking individual in a consumer survey about their potential willingness to pay (WTP) for products or their choices from sets or possible options. *Consumers' willingness to pay* literature for food with specific quality attributes has quickly developed in recent years. Two main classes of State Preference techniques are discussed in this study namely Contingent Valuation Method (CVM) and Choice Modeling (CM).

1. Contingent Valuation Method

Contingent Valuation Method (CVM) describes a possible product or policy to respondents and asks them how much they would be willing to pay for it. It can be applied to estimate use and non-use values. The policy change or salient attributes are determined by researcher and presented as a whole package with all salient attributes to respondents (Bateman *et al*., 2002). Recently, CV techniques have been increasingly employed in food products with specific quality attributes (Mergenthaler *et al*, 2009b; Sadashivappa and Qaim, 2009; Lin *et al*., 2006; Lusk, 2003; Qaim and Janvry, 2003; Vanit-Anunchai and Schmidt, 2004; Tsu-Tan *et al*., 1999). There are two major methods of survey designs to ask respondents to state the valuations for products. An open-ended question asks respondents to specify the maximum of their willingness to pay for the option under consideration. However, the valuation task may be complex and the consumer is unfamiliar particularly to non-market goods. These would lead to an unreliable and non actual reflected value of their true willingness to pay (Kaye-Blake, 2006; Bateman *et al*., 2002; Cameron *et al*., 2002). Alternatively, a dichotomous choice question is asked of respondents to determine whether or not they would be willing to pay a given amount (bid). This technique consists of various types of elicitation question such as single bounded and double bounded discrete choice. The expected answer is ether yes or no and the valuation task is generally easier than with the open-ended format (Bateman *et al*., 2002; Cameron *et al*., 2002). Hanemann (1991) showed that the coefficient estimates from the double-bounded model are asymptotically more efficient than the single-bounded model.

The section starts with a review of the single bounded approach in order to explain the basic idea to formulate the statistical model. In replying to a single bound question, each respondent states whether her maximum willingness to pay is above or below a given amount. The respondents will response “yes” or “no” to a certain price (B_I). Cameron (1988) considers WTP as a form of indirect expenditure function (2.42) with the improvement in product quality from q^0 to q^1.

(2.42) $WTP = e(p, u^0, q^0) - e(p, u^0, q^1)$

WTP is also considered as a continuous random variable consisting of two components of so-called normal censored model as equation (2.43) (Greene, 2000).

(2.43) $WTP = \beta X_i + \varepsilon_i$

where β is the vector of coefficients measuring the influences of the exogenous variables. X is the vector of exogenous variables such as household characteristics. The error term (ε_i) is assumed to have a normal distribution with mean zero and variance σ^2 [$\varepsilon_i \sim$ N $(0, \sigma^2)$].

In CVM, the endogenous variable is WTP which is reported as "yes" or "no" and I_i denoting the indicator dummy variable. The respondent is asked for her willingness to pay which is above or below to certain price (B_I). If the respondent says "yes" $I_i = 1$ $(WTP > B_I)$ otherwise $I_i = 0$. Then,

(2.44) $\Pr(I_i = 1) = \Pr(WTP_i > B_I) = \Pr[\varepsilon_i > (B_I - \beta X_i)]$

with probability of observation $I_i = 1$ given by;

(2.45) $$\Pr(I_i = 1) = \Pr\left[z_i > \left(\frac{B_I - X_i \beta}{\sigma} \right) \right]$$

(2.46) $$\Pr(I_i = 1) = 1 - F\left[\left(\frac{B_I - X_i \beta}{\sigma} \right) \right]$$

Where σ is standard variation of the error term.

$F(\cdot)$ is cumulative distribution function of WTP

The model cannot estimate censoring characteristic with OLS method because the endogenous variable introduces a distortion into conventional statistic (Greene, 2003). Thus, log-likelihood function for single bounded dichotomous choice model can be derived from two possible outcome groups expressed as (Vanit-Anunchai, 2004):

$$Ln\ L = \sum_{i=1}^{n} \left\{ I_i \ln\left[1 - F\left(\frac{B_I - X_i\beta}{\sigma}\right)\right] + (1 - I_i)\ln\left[F\left(\frac{B_I - X_i\beta}{\sigma}\right)\right]\right\} \quad (2.47)$$

Double-bounded CVM approach is extended from the single-bounded approach by Hamemann (Vanit-Anunchai, 2006 cited Hamemann 1985). Two sequential price bids are proposed to respondents. If the respondent answers "yes" to initial price bid (P_1), a second higher bid (P_{2H}) is offered. While the respondent answers "no" to initial price bid, the question will be followed by the second lower bid (P_{2L}). In the double bounded approach, observable outcomes can be expressed into four different intervals, as depicted in figure 2.1.

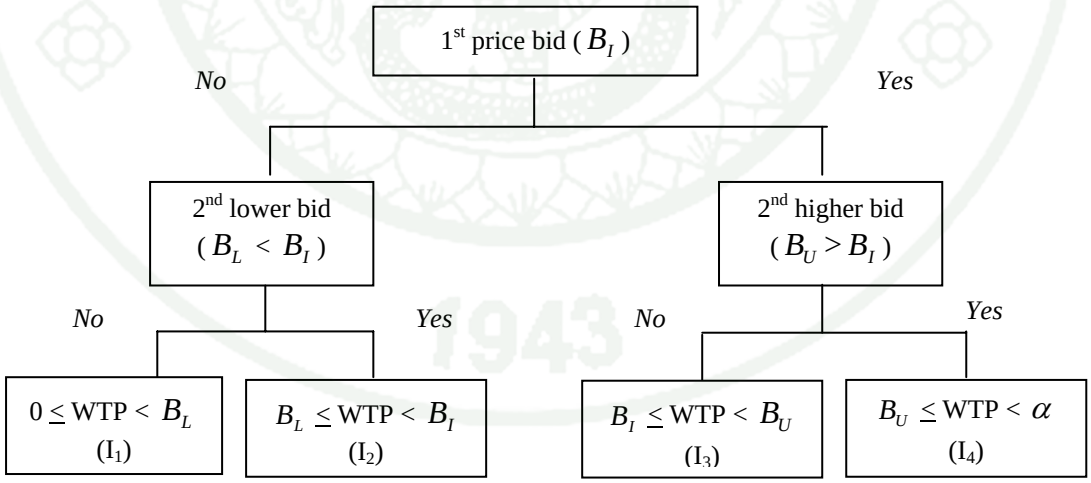


Figure 2.1 The four possible outcome groups from a double-bounded approach

It denotes I_1 as no-no answer, I_2 as no-yes answer, I_3 as yes-no answer and I_4 as yes-yes answer. The four possible outcomes can be represented by the probability function and cumulative distribution function as equation (2.48) to (2.51):

(2.48) $\Pr ob\,(no/no) = \Pr ob(WTP < B_L) = F(B_L)$

(2.49) $\Pr ob\,(no/yes) = \Pr ob(WTP < B_I) - \Pr ob(WTP \geq B_L) = F(B_I) - F(B_L)$

(2.50) $\Pr ob\,(yes/no) = \Pr ob(WTP < B_U) - \Pr ob(WTP \geq B_I) = F(B_U) - F(B_I)$

(2.51) $\Pr ob\,(yes/yes) = \Pr ob(WTP \geq B_U) = 1 - F(B_U)$

The log-likelihood double-bound function will have a probability joint density function. The function is derived by multiplying every probability which can be specified in the form:

(2.52) $$L = [\Pr ob(no/no)][\Pr ob(no/yes)][\Pr ob(yes/no)][\Pr ob(yes/yes)]$$

It follows that the log-likelihood function is equal to the sum of logarithms of the probabilities for all respondents:

(2.53) $$\ln L = \sum_{i=1}^{n} \begin{Bmatrix} I_1\,[\ln \Pr ob\,(no/no)] + I_2\,[\ln \Pr ob\,(no/yes)] + \\ I_3\,[\ln \Pr ob\,(yes/no)] + I_4\,[\ln \Pr ob\,(yes/yes)] \end{Bmatrix}$$

From equation (2.52) and (2.53) the log-likelihood function is rewritten:

(2.54) $$\ln L = \sum_{i=1}^{n} \begin{Bmatrix} I_1 \ln[F(\frac{B_L - X\beta}{\sigma})] + I_2 \ln[F(\frac{B_I - X\beta}{\sigma}) - F(\frac{B_L - X\beta}{\sigma})] + \\ I_3 \ln[F(\frac{B_U - X\beta}{\sigma}) - F(\frac{B_I - X\beta}{\sigma})] + I_4 \ln[1 - F(\frac{B_U - X\beta}{\sigma})] \end{Bmatrix}$$

I symbol is a binary indicator variable of the four possible response outcomes. It is equal to 1 in case of appropriate range, otherwise it is 0. The β coefficient can be directly interpreted as marginal effects of the explanatory variables on WTP. Hence, the mean WTP is calculated similarly as in Qaim and Janvry (2003).

(2.55) $Mean(WTP) = \hat{\beta}\,\overline{X}$.

2. Choice Modeling

Choice Modeling (CM) technique was developed by Louviere and Woodworth (1983) linked in two ways to economic theory (Bateman *et al*., 2002). Firstly, CM is based on Lancaster's characteristics theory of value which states that "*any good can be described as a bundle of characteristics and the levels they take*" (Bateman *et al*., 2002 cited Lancaster, 1966). Consumers rationally purchase goods that deliver a utility maximization bundle of attributes and subject to a budget constraint. Hence, the demand for products is derived from the demand for attributes (Senauer *et al*., 1993). However, it seems to be difficult to completely describe anything in terms of its attributes as errors could occur in measuring the attributes. This relates to economic theory via Random Utility Maximization (RUM) theory. RUM separates out the conventional utility function into two parts: one deterministic and observable (V_{ij}) and the error part (ε_{ij}), yielding $U_{ij} = V_{ij} + \varepsilon_{ij}$ (MaFadden, 2001). CM gives a certain advantage for elicitation of consumers' willingness to pay especially for innovative products or products with new attribute combination. CM allows valuation of non-monetary attributes and generates willingness to pay for separated attributes while CVM generates valuation as whole bundle of attribute (Kaye-Blake, 2006; Bateman *et al*., 2002; Bannet and Blamey, 2001)

CM differs from CVM by the type of valuation exercise and generated data. Different alternatives are presented to respondents who are asked to either choose one preference or rank them. "Paired Comparison" refers to respondents designating a preferred alternative. While "Contingent Ranking" and "Contingent Rating" refer to respondents which are asked to rank the alternative or provide rating scale on those

alternatives. “Choice Experiment” (CE) respondents are usually presented two alternatives versus the status quo and asked to choose the most preferred one. The CE approach yields welfare-consistent estimates because (i) it forces respondents to trade-off changes in attribute levels against the costs of making these changes, (ii) respondents can choose the status quo, (iii.) the applied econometric technique is exactly parallel to the theory and consistent with RUM theory as respondents are required to select one option from a choice set and (iv) compensating and equivalent surplus from the output can be derived. Choice experiment predicts a consumer’s choice by determining the relative importance of various attributes in consumers’ choice process (Bateman *et al*., 2002).

The discrete choice models are based on utility maximization. Individual *i* maximize her utility under a budget constraint. The chosen destination must give an individual greater utility compared to others. If the utility of individual *i* chooses alternative j denotes as U_{ij}, then $U_{ij} > U_{ik}$ for $i \neq k$. As the researcher is not completely informed about all considered elements of respondents, utility can be divided into two components, expressed as equation (2.56):

(2.56) $$U_{ij} = V_{ij} + \varepsilon_{ij}$$

where

U_{ij} is the overall utility of individual *i* for choice *j*

V_{ij} is the indirect utility function in systematic component

ε_{ij} is the random utility component which comprises unobserved individual taste observations, measurement errors and unobserved attributes

To propose the utility function and to specify the formal relationship between the explanatory variables and choice behaviors, the systematic component can be generally expressed as a linear equation (Champ *et al*., 2003; Louviere, 2001):

(2.57) $$V_{ij} = \alpha_j + \vec{\beta}_j \vec{X}_{ij};$$

with α_j is a vector of J-1 intercept terms for J options or coefficients representing the Alternative Specific Constant (ASC). ASC reflects the difference in utilities for each alternative relative to the base when all attributes are equal. It picks up a mixture of status quo bias effects and the impacts of unobserved attributes (Bateman *et al*., 2002). Typically, at least one intercept term is estimated. It therefore allows a zero mean error term (Kaye-Blake, 2006). $\vec{\beta}_j$ refers to estimated parameters that weight exogenous variables in determining the utility. $\vec{X}$ is a row vector of exogenous variables. Following Louviere (2001), *" $\vec{X}_{ij}$ can be defined as (i) a matrix of attributes which relate to choice options, (ii) a matrix of individual characteristics, (iii) a matrix of interactions of attributes with individual characteristics and (iv) the vector of interaction of individual characteristics with choice option intercept."*

Probabilistic statements about consumers' preference can be derived by the presence of the random component. Under the Random Utility model, individual *i* will decide to choose alternative *j* from all J alternatives. Hence, alternative *j* is a maximum value. The probability function of individual *i*'s choice of the alternative *j* is (Louviere, 2001; McFadden, 1974) given as (2.58):

(2.58) $$P_i(j/J) = P(U_{ij} > U_{ik}) \quad = P(V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}) \quad ; \quad \forall_k \in J \text{ and } \quad k \neq j$$

The interactions between the equation (2.58) and the linear systematic component can be rewritten as;

(2.59) $$P_i(j/J) \quad = P(\vec{\beta}\vec{X}_{ij} + \varepsilon_{ij} > \vec{\beta}\vec{X}_{ik} + \varepsilon_{ik}) \quad ; \quad \forall_k \in J \text{ and } \quad k \neq j$$

$$= P(V_{ij} - V_{ik} > \varepsilon_{ik} - \varepsilon_{ij}) \quad ; \quad \forall_k \in J \text{ and } \quad k \neq j$$

$$= P(\Delta V > \varepsilon)$$

Green (2003) and Bateman *et al.* (2002) suggested that linear regression models cannot be used on such data sets because no suitable dependent variables to regress against the explanatory variables exist. To solve the equation (2.58), researchers need to impose a probability density function on ε_{ij}. Different kinds of probability distribution of ε_{ij} induce different discrete choice models. The most common method for estimating a model from choice experiment data is the Conditional Logit Model (CLM) developed by McFadden (1974). It is expressed as probability that individual *i* chooses alternative *j* as a function of attributes varying in alternative and unknown parameters. Therefore, if the $\vec{X}_{ij}$ is used as attributes vector of alternative *j*, the probability that individual *i* chooses alternative *j* is demonstrated as equation (2.60):

$$P_i(j/J) = \frac{\exp(\vec{\beta}_j \vec{X}_{ij})}{\sum_{k=1}^{J} \exp(\vec{\beta}_k \vec{X}_{ik})} \quad (2.60)$$

Note that the CLM depends on the differences among alternative characteristics, but the attributes which do not vary by alternative do not affect probabilities (Haab and McConnell, 2003). On the contrary, the Multinomial Logit Model will give the probability that individual *i* chooses alternative *j* as a function of individual's socio-economics (*Z*) and unknown parameters as equation (2.61):

$$P_i(j/J) = \frac{\exp(\vec{\beta}_j \overline{Z}_i)}{\sum_{k=1}^{J} \exp(\vec{\beta}_k \overline{Z}_i)} \quad (2.61)$$

This model uses individual characteristics to explain the choice of alternatives. The J-1 parameter will be estimated for J-1 of the alternatives because one of the parameter vectors is typically normalized to zero.

In order to derive an explicit expression for this probability, it is necessary to know the distribution of the error term (ε). Focusing on the basic of McFadden's Condition Logit model, the distribution of the error terms can be assumed as the Independent and Identically Distributed (IID) Gumbel (Type I extreme value distribution). It is similar to a normal distribution, but the mathematics is easier to tract. The cumulative distribution function of $\varepsilon_{ik} - \varepsilon_{ij}$ is given by (Bateman *et al*., 2002):

(2.62) $$F(\varepsilon) = \exp[-\exp(-\varepsilon)]$$

The choice probabilities of individual *i* can be solved as a closed-form expression of:

(2.63) $$P_i(j/J) = \frac{\exp(\mu V_{ij})}{\sum_{k=1}^{J} \exp(\mu V_{ik})}$$

where, μ is the scale parameter which is inversely proportional to the standard deviation on the error distribution. For convenience, we assumed that μ is equal to 1 (Ben-Akiva and Lerman, 1985). Therefore, the probability that the decision-maker *i* selects choice *j* among the set of J alternatives is given by the Conditional Logit model:

(2.64) $$P_i(j/J) = \frac{\exp(V_{ij})}{\sum_{k=1}^{J} \exp(V_{ik})} = \frac{\exp(\vec{\beta}_j \vec{X}_{ij})}{\sum_{k=1}^{J} \exp(\vec{\beta}_k \vec{X}_{ik})}$$

The Conditional Logit model can be estimated by conventional maximum likelihood procedures (Green, 2003 and Bateman *et al*., 2002). The log-likelihood function which individual *i* chooses alternative *j* from *J* alternatives is given as equation (2.65):

$$\log L = \sum_{i=1}^{I}\sum_{j=1}^{J} y_{ij} \log\left[\frac{\exp(V_{ij})}{\sum_{k=1}^{J}\exp(V_{ik})}\right] \quad (2.65)$$

The indicator variable (y_{ij}) is the response variable for individual *I*'s choice of alternative *j*. y_{ij} can be adjusted in terms of dummy variables as y_{ij} =1 if individual chooses alternative j, otherwise y_{ij} = 0. Additionally, the assumptions for basic CLM are needed (Champ *et al*., 2003). Firstly, preference structure is homogenous over respondents. Secondly, choices conform to the Independence from Irrelevant Alternatives Assumption (IIA). Thirdly, all errors have the same scale parameters. In this study, two major assumptions for choice model estimation are discussed.

The assumption of basic CLM defined preferences is identical for all respondents. This assumption restricts the estimated parameters to be equal for all populations or fixed nature of the parameters. In reality, choices may differ systematically from individual to individual. It is also interesting to determine the impact of an individual's characteristics. This simplifying assumption can be altered by different modifications (Champ *et al*., 2003). The simplest one is to include the individual's characteristics by an interaction term as they cannot be directly entered in the model because these variables do not vary across alternatives. The interaction terms can be set between characteristics (Z_i) and attribute levels (X_{ja}) or characteristic (Z_i) and Alternative Specific Constant (ASC) term, allowing for the possibility that the individual has different mean values for the alternatives (Kaye-Blake, 2006). In particular, the empirical specification which individual *i* chooses alternative *j*, where attribute *a* is given in equation (2.66).

$$V_{ij} = \beta_a X_{ja} + (Z_i * X_{ja})\psi + (Z_i * ASC)\varphi + \delta P_j \quad (2.66)$$

where

X_{ja} is the vector of attribute level *a* associated with the alternative *j*

Z_i is the vector of individual's characteristic

ψ and φ are the estimated associate parameter.

δ is the marginal utility of income

P_j is the price level in alternative *j*

However, this simple approach assumes that researchers already know the factors that lead to heterogeneity (Champ *et al*., 2003).

The alternative approach to identify preference heterogeneity is based on the assumption that parameters are random for the deterministic portion of utility and drawn from a distribution across the population of respondents (Champ *et al*., 2003; Rigby and Burton, 2003).This approach is referred to as "Random Parameter Logit (RPL) or Mixed Logit Modeling (Champ *et al*., 2003). The heterogeneity in the sample can be captured by estimating mean and variance, which are estimated for each choice attribute. Considering the probability expression from the Conditional Logit Model of alternative *j* for individual *i*, $P_i(j/J) = \frac{\exp(\vec{\beta}_j \vec{X}_{ij})}{\sum_{k=1}^{J} \exp(\vec{\beta}_k \vec{X}_{ik})}$ which is modified to reflect the fact that the estimated parameter ($\vec{\beta}_j$) has a distribution as Mixed Logit. Thus, choice probability is conditional on the values that respondent attach to the choice attribute. The estimated parameters therefore may have different values among respondents defined by distributing conditional probability (conditional on $\vec{\beta}_j$) integrated over value of $\vec{\beta}_j$, expressing as equation (2.67) (Train, 2003; MaFadden and Train, 2000):

(2.67) $$P_i(j/J) = \int \tau_j(\beta)\ f(\beta)\ d(\beta)$$

where $\tau_j(\beta)$ denotes standard logit function and $f(\beta)$ is the joint density function of the coefficient vector. Given a choice of specific distribution of parameters such as normal distribution, the estimation of choice probabilities proceeds with mean and variance estimates of this parameter assumed to be random (Champ *et al*., 2003). If $f(\beta)$ is constant, the model is reduced to the basic Conditional Logit model. This equation is a multi-dimensional integral having no close-form solution. Hence, it must be solved through simulation (Christiadi and Cushing, 2007).

Another criticism of standard logit model is the violation of IIA property. This property is evident in the odds ratio calculation of choosing one alternative relative to another by:

(2.68) $$\frac{P_i(j/J)}{P_i(k/J)} = \exp(U_{ij} - U_{ik})$$

This relative probability of choosing between two alternatives (*i and k*) is unaffected by any other option in the choice set (McFadden, 1974). One option to test this property was developed by Hausman and McFadden (1984). It consists of computing likelihood ratios for different sets of parameters. Several models are proposed to relax this assumption such as Nested Logit Model (Louvier *et al*., 2000), Multinomial Probit model and Mixed Logit model (Train, 1998).

A Nested Logit Model is appropriate for choice situation that can be represented by a hierarchical structure (Louviere *et al*., 2000). The model relaxes the IIA assumption by allowing the unobserved factors, ε_{ij} are correlated and have a different result compared to the conventional one. The full set of alternatives can be grouped and divided into categories. Initially, an individual chooses one category from among given categories, then determines a specific preferred alternative from the chosen category (nest) (Mogas *et al*., 2005). The model allows ε_{ij} having the same correlation within the category or nest, but maintains independence across nests.

However, the data would determine whether or not a nesting is appropriate (Christiadi and Cushing, 2007).

Unlike the Nested Logit model, the Mixed Logit model fully relaxes the IIA assumption (Christiadi and Cushing, 2007). As mentioned above, Mixed Logit model can be also used to estimate the parameter if preferences are heterogeneous. Another way to describe the model is by representing the utility function as an error component specification. Following Train (1998), the conditional utility function of individual *'s* choice of alternative *j* can be expressed as equation (2.69):

(2.69) $$U_{ij} = \tilde{\beta} X_{ja} + \eta_i X_{ja} + \varepsilon_{ij}$$

where ε_{ij} is an IID extreme value error term which is consistent with the logit framework. $\tilde{\beta}$ denotes the population mean impact of attribute level *a* on utility for individual *i* choosing alternative *j*. η is a deviation around the means which differs across individuals, representing the individual's tastes relative to the average. This deviation term is assumed constant for a given individual across all choices they make, but not constant across individual. This implies that IIA is not a property of Mixed Logit model (Colombo *et al*., 2005). The inclusion of $\eta_i X_{ja}$ in the stochastic component of the utility function allows alternative specific elements to enter the stochastic portion of utility. It therefore allows for the examination of various correlations of unobserved effects (Champ *et al*., 2003). If the component term, $\eta_i X_{ja}$ is identically zero, the model reduces to basic Conditional Logit model. Additionally, when the researcher restricts the mean value term, $\tilde{\beta}$ follows the normal distribution then the model is a close approximation of the Multinomial Probit model (Train, 2003).

Choice experiment allows for more than one attribute to be included in the survey. The important aspect of interpretation from results is the notion of the "part-worth". The parameter estimates do not have a direct interpretation. However, they are needed to combine the identification of monetary values associated with the

change in each attribute levels. In the present study, the monetary value is price of fresh produce which is entered into the model and varying with the kind of attribute level. Let us consider the basic linear indirect utility function in equation (2.66): the discrete change in an attribute level, *ceteris paribus*, can be determined by the negative of estimated parameter for attributes divided by the estimated parameter for price. The resulting values are known as "implicit price" or the "marginal willingness to pay" (Champ *et al*., 2003) as equation (2.70):

$$MWTP_{jk} = -\frac{\beta_{jk}}{\delta_j} \tag{2.70}$$

Additionally, the welfare measure "compensating surplus (CS)" can be obtained from different considerations (Bateman *et al*., 2002) as:

$$CS = \frac{\ln \sum_i \exp(V_{j1}) - \ln \sum_i \exp(V_{j0})}{\delta} \tag{2.71}$$

with V_{j1} and V_{j0} as calculated values for the deterministic part of utility function under the change in attribute and the initial level, respectively.

Backgrounds and Related Fruits and Vegetables Studies

Over the last decade, the agricultural sector has played a major role in income generation and creating job opportunities in the Thai economy. The total agricultural production area was 130.35 million rai in 2007, which encompasses 41 percent of the total land area of country (Appendix Table A1). The agricultural sector has assured the food security of the nation. In general, the agricultural sector comprises six major sub-sectors, namely, crops, livestock, fisheries, forestry, processed products and agricultural services. Crop production contributed 69 percent to the agriculture GDP in 2008 (Table 2.1). Traditionally, rice and fiber crops have been consumed locally as staple food sources but are also exported (rice especially is the major agricultural

export of Thailand). Food products from the horticultural sub-sector have steadily increased their share to the income of farmers and retailers. This fact is also influenced by the diet of the Thai people as well as by the rise in the volume and variety of exported horticulture products. These circumstances have occurred together with the improvement of crop varieties and better production technology with assistance from various government programs and services.

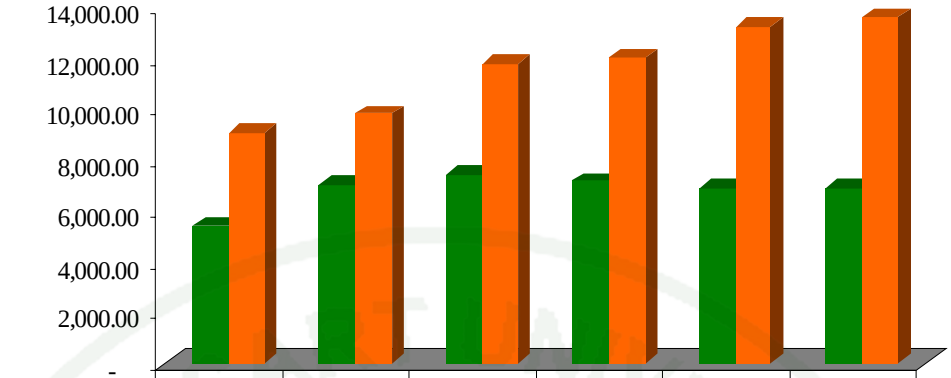
The contribution of crops to the overall agricultural sector has only minimally declined since 2003. Meanwhile, the share of fruits and vegetables in the crop sector has behaved in a similar range for the past 5 years. These commodities are less important than rice and staple food crops. Nevertheless, the volume of production and area planted to horticultural food products have grown from 1990 and 2005 (Liao *et al*., 2001). Different types of fresh fruits and vegetables have been introduced in the North and Northeastern regions of Thailand. The cool hilly areas are especially favorable for growing tropical and sub-topical as well as some temperate food crops. In general, horticultural products are considered as an alternative to field crops particularly in irrigated agricultural areas with the potential to significantly contribute to the income of farmers. Higher economic returns compared to rice and fiber crops are the main incentives for switching to horticulture crops. Nonetheless, numerous problems remain to be resolved. These include the need for farmers to modernize production techniques and develop appropriate harvesting methods, and the high investment required to produce fruits and vegetable crops (Isvilannoda, 1992). New attributes of fresh horticultural produce are a possible option for value-adding through product differentiation aimed at satisfying consumer needs.

Table 2.1 Gross Domestic Product (Million Baht) at 1998 Prices

	2003	2004	2005	2006	2007	2008
GDP	3,468,200	3,688,200	3,855,100	4,052,000	4,244,600	4,370,056
Agriculture	363,033	354,431	347,892	366,842	370,030	383,079
Crop	254,838	251,009	239,397	249,258	252,850	264,577
- Fruits	24,764	26,842	26,633	28,162	29,866	27,944
- Vegetables	23,460	24,171	24,634	24,730	24,209	25,204
- Other Crops	206,614	199,996	188,129	196,365	198,775	211,429
Agri/GDP	10.5	9.6	9.0	9.1	8.7	8.8
Crop/Agri	70.2	70.8	68.8	67.9	68.3	69.1
Fruit/Crop	9.7	10.7	11.1	11.3	11.8	10.6
Veg/Crop	9.2	9.6	10.3	9.9	9.6	9.5

Source: Office of the National Economic and Social Development Board, Office of the Prime Minister, Thailand

The structural change in fruits and vegetables production is caused by an increasing demand in domestic consumption and its export value. To date, export products include significant volumes of fresh as well as processed fruits and vegetables. The export value of horticultural food products has steadily risen especially for fresh and pre-processed fruits and vegetables (Figure 2.2). However, the overall consumption pattern of domestic demand also directly influences the marketing and production systems of horticultural food products. Most are consumed locally due to the essential role of fruits and vegetables in the Thai diet. In this regard, this section reviews literature on the changing patterns of consumer demand, the growing importance of safety and quality in fresh horticultural products, and marketing systems and supply chains of fruits and vegetables. In addition, the selected horticultural fresh produce, namely, cabbage and mango, are briefly described.



	2003	2004	2005	2006	2007	2008
Vegetables	5,418.52	7,034.21	7,386.97	7,154.20	6,867.14	6,886.52
Fruits	9,092.38	9,789.38	11,814.31	12,038.63	13,200.08	13,583.15

Figure 2.2 Export value for fresh and processed fruits and vegetables (Million Baht)
Note: The values only include pre-cooled, frozen and dry horticultural products
Source: Ministry of Commerce, Thailand

Changing patterns of consumer food demand

Several studies on food demand patterns and the changes in consumers' preferences have been carried out in the recent past as the information is important for designing food and agricultural policies. Consumer trends have important implications for farmers and retailers. Notably, food systems are undergoing profound changes on a global scale. The changes in both developed and developing countries are largely driven by household economic conditions in conjunction with income growth. A better educated population and modern lifestyle especially among people in growing urban areas have led to consumers' preference towards high-value food items (Pingali, 2007; Regmi and Dyck, 2001; Huang and David, 1993). High-value food products have unique characteristics related to sensory attributes, nutritional content, food safety assurances, product origin and processing practices (USDA, 2005). In high welfare nations, high-value food items have a larger budget share whereas in poorer countries staple foods are accounting for a larger share of the food budget (Seale *et al*., 2003).

In the Asian context, many authors have put emphasis on this issue. For instance, Chern (2003) reported that the Japanese meat consumption patterns have followed westernized habits supported by similar expenditure and price elasticity ranges comparable to Western countries. Food consumption pattern has considerably changed in urban China. Younger consumers tend to consume more meat and fruits and less staple food and vegetables (Yen and Fang, 2004). In Vietnam, urbanization and higher incomes in urban areas have led to structural changes in food consumption behavior. Vietnamese consumers are increasingly demanding better quality food and the demand is expected to increase for high-value food products such as meat, fruits and aquatic food (Le, 2008; Ali *et al*., 2006). In Malaysia, food consumption patterns are experiencing continuous changes, moving towards meats, fruits and vegetables as income levels rise (Tey *et al*., 2008).

In Thailand, the increasing trend towards more high-value food items occurred together with a declining trend in rice consumption especially common for middle- and high-income households (Isvilanonda and Kongrith, 2008; Kosulwat, 2002; Agribusiness Research Unit 1997; SEP, 1992a; Patamasiriwat and Poldee, 1990). Results are in line with the well-known regularity of "Bennett's Law" which states that income growth leads to changes in diets. The proportion of calories from starch staple foods as a ratio of total calories declines as income increases (FAO, 2006). On the other hand, health-conscious consumers are more likely to demand more functional food and pay more attention to nutritional content.

Among the high-value food commodities, fruits and vegetables fit into the group of food with health benefits from a sufficient daily diet. The increased consumption of fruits and vegetables is also a part of consumers concern with obesity and diet related illnesses such as diabetes (Johnson *et al.*, 2008). A recent survey indicated that 98.8 percent of Thai respondents older than 6 years frequently consumed fruits and vegetables with their meals (National Statistic Office, Thailand, 2005).

A number of studies in Thailand on fruit and vegetable consumption behavior have been carried out in recent years. In 2002, Schmidt and Isvilanonda estimated food consumption expenditure structures employing the concept of Engel's Law for vegetables. They found that additional food expenditure moved towards vegetables in the positive direction within the prepared-food-at-home expenditure. Kaewsuk (2004) confirmed fresh vegetables as an important good in Thai households by estimated positive expenditure elasticities. For fresh fruits, studies have shown that household income and household size were the main factors influencing fruit consumption pattern, resulting in inelastic expenditure elasticity (Daroonpate *et al*., 2005; Purithewate, 2004). In sum, the structure of fresh fruits and vegetables consumption of Thai consumers is strongly income driven. Other household characteristics such as household size, education, age and difference of inhabitance also influence the consumption spending for horticultural food products.

A comprehensive study has indicated that the difference in consumption patterns of these fresh products may be attributed to the varying degree of importance of fruits and vegetables. The study also noted the shift in consumption pattern from lower grade fruits and vegetables to higher qualities with a marginal propensity to consume fruits higher than for vegetables (SEP, 1992b). Demand for horticultural fresh produce especially vegetables will become more differentiated in terms of safety, quality and convenience (Johnson *et al*., 2008). These attributes have been emphasized in the development of the Thai fruits and vegetables sector.

Growing importance of safety and quality in fresh fruits and vegetables

Fresh horticultural products are non-homogenous and differ from staple crops in trade patterns. The diversification of fresh fruits and vegetables with specific quality attributes has received attention in domestic and international markets. Consumers have become more conscious of food safety and quality issues, mostly observable in developed countries (Gregory, 2000; Knowles *et al*., 2007). In 2000, the highest organic food sales occurred in the United States, followed, in descending order, by Germany, United Kingdom and Italy (International Trade Center, 2001). This trend is confirmed by a recent study which found that European countries continue to be the world's leading importers of quality fruits and vegetables owing to a high per capita income, seasonal variation in production and an ageing population (Tranter *et al*., 2009; USDA, 2004). Besides organic products, high- and middle income consumers are more likely to purchase low chemical and pesticide residue contaminated products compared to conventional, processed and packed fruits and vegetables products. Moreover, food safety and quality concerns have intensified in developing countries in conjunction with households' rising incomes and the associated higher education of household members, and urbanization (Pingali, 2007). For instance, Chinese consumers which experienced higher incomes increasingly demand a high level of food safety and quality attributes (Gale and Huang, 2007). In responding to these trends, the Chinese government has established an array of national standards including certification systems for safety and quality management systems (Calvin *et al*., 2006). Kishna and Qaim (2008) calculated that Indian consumers are willing to pay for leafy vegetables with low pesticide residues between 46 and 75 percent above current market price. Meanwhile, Vietnamese consumers are likely to purchase safe and quality fresh produce as household incomes increase (Mergenthaler *et al*., 2009a).

The government of Thailand has also responded with occasionally mandatory programs for food safety and the development of various food quality standards. The objective of the Eighth National Economic and Social Development Plan issued in 1997 was "the promotion of good health by understanding and knowledge to protect

individuals and families, and society as a whole from diseases and afflictions". The improvement in food availability through food production, processing, preservation and distribution of nutritious food had to be guaranteed to ensure food security (Varanyanond, 2000). The Ministry of Public Health declared 2004 as the "Year of Health for All" and launched public campaigns for consumption of "Clean and Healthy Food" to overcome the emerging health problem of malnutrition. Several public forums were organized to raise public awareness of the impact of pesticides and chemicals on human health, the environment and its influence to social welfare (Kramol *et al*., 2006). Institutions and policies supported supply side actors to establish proper production practices and to achieve and maintain competitive position in the market of food safety and quality.

Several studies noted a shift in Thai consumers' preference to environmentally friendly fresh produced commodities such as organic and low-pesticide residue products. USDA (2006) found that more than 70 percent of organic food consumers are employed women living in urban areas. Meanwhile, Roitner-Schobesberger (2008) demonstrated that purchasers of organic products in Bangkok were members of higher income households. Moreover, buyers were older and more highly educated than those not purchasing organic fresh products. Furthermore, the principal motives to purchase organic food among consumers in Bangkok are health benefit, fashionable product and taste. When considering low-pesticide residue products, recent studies highlighted consumers' willingness to pay for pesticide-free fresh products at premium price levels (Sanglertsawai, 2006; Patweekonga, 2004; Vanit-Anunchai and Schmidt, 2004; Chaobankor, 2002; Thong-Ngam *et al*., 2002). The driving factors of such purchase decisions are mainly income, education, age and label indications. However, this assumption cannot stand nationwide as the people in the northeastern region show a robust unmet demand for safe vegetables (Posri *et al*., 2007).

Marketing system and supply chain-related attributes for fresh fruits and vegetables

To reiterate, the focus of this study is the analysis of demand pattern for fresh fruits and vegetables. As most fresh produce are meant for the domestic market, the shifts in the food system can be prominently observed in the domestic demand. In this sense, knowing the characteristics of the domestic marketing system for fresh fruits and vegetables also provides a better understanding of the dynamics of the supply chain.

In most developing countries, fruits and vegetables are supplied for three types of market facilities: domestic traditional, modern urban and export oriented (Narrod *et al*., 2007). Export oriented markets display strict regulations and standards compared to domestic markets. Producers have to comply with various protocols relating to pesticide residues, production area and packinghouse operations, and traceability. The standards and protocols are often required by the importing country, or are provisions in the Codex Alimentarius. The Thai domestic market comprises three traditional channels for fresh fruits and vegetables: local markets, Bangkok markets and other provincial markets. The marketing system for each fruit and vegetable varies among food products depending on demand, market practice and storage period (Jealviriyapan, 2001; Liao *et al*., 2001). Generally, the domestic marketing system for fresh fruits and vegetables is less complex than that for other agricultural commodities. Moreover, various kinds of fruits and vegetables have different characteristics (Isvilanonda 1992b).

The marketing chain of horticultural products encompasses the production and procurement of raw materials, handling, processing, trading, retailing and consumer purchase. Differences exist among the number of intermediate steps and stakeholders in the supply chain. In the traditional marketing chain, primary fresh products are distributed to end consumers in different ways. One way is that fresh produce are collected by a middlemen at the local or district markets and sent to central wholesale markets or local food markets. On the other hand, the modern supply chain aims to be

short and efficient, with fewer steps and an efficient logistic system. The latter is more selective and usually specifies quality attributes of fresh products. These specialized systems usually work closely with farmers under a contract farming scheme. Modern retail outlets will buy all fresh products that are certified according to their specific needs and requirements (Johnson *et al*., 2008). The procedure of modern supply chain actors is less complex. Product safety and quality are controlled along the supply chain and production systems. Nevertheless, there is concern that the higher quality standards and consumer expectations may exclude small-scale farmers because of the higher cost of compliance to modern supply chain protocols and standards.

The diversification of fresh fruits and vegetables with specific quality attributes is posing a challenge for supply side actors to increase returns by value addition. The changing consumer preferences forces supply side actors to adopt strategies to meet new demand patterns. Food with specific quality attributes can contribute to a new income-earning potential for the agricultural sector, especially farmers (Birthal *et al*., 2005; Eaton and Sheperd, 2001). The increasing attention to quality and safety attributes also benefits society; a grading and standard system can reduce the negative externalities from quality deficiencies and unsafe food products. However, quality and safety can generate value only if these are directly linked to consumer demands. As safety attributes are often credence attributes, the identification of products need to be preserved at all levels along the food production chains. These developments have important implications for all local stakeholders involved in food supply chains (Mergenthaler, 2008). Therefore, four examples of emerging supply chain-related attributes are reviewed in this thesis and serve as a further reference in the analysis.

Health risks from pesticide residues in food products have long term detrimental effects, although assessments and evaluations can be fraught with uncertainty. Usually, freshness and appearances are key consumer criteria to purchase fruits and vegetables (Penau *et al*., 2006; Sakagamiet *et al*., 2006). However, there is a growing role of public and private food safety and quality standards (Henson and Reardon, 2005). These standards tend to be increasingly important as consumers use

them as decision reference for purchasing fresh produces (Grunert, 2005). In Thailand, various brands and certification schemes exist in the market; these inform consumers about production processes and safety and quality levels. Several certificates are issued by different government agencies (i.e. the Department of Agriculture, Department of Agricultural Extension, Department of Medical Science the National Bureau of Agricultural Commodity and Food Standards and the Ministry of Health). A survey of population health care behavior revealed that 64 percent of consumers use the "food safety" sign by the Ministry of Health as an indicator of preferable food products (National Statistic Office, Thailand 2005). About 40 percent of interviewed consumers in urban areas (n = 1,320) knew about and purchased vegetables that are certified and sold under the logo of the Department of Agriculture (Hygienic vegetables, pesticide-safe vegetables) and 25 percent for products certified by the Department of Agricultural Extension (pesticide-safe vegetables). Additionally, almost 75 percent of all consumers knew about and purchased products certified by the Royal Project Foundation under "Doi Kham" brand (Vanit-Anunchai 2006). A small number of private producers and retailers, i.e. Aden, Walter and Doctor's Vegetable are using their own logo besides government certificates in order to win consumers' confidence in their products. For all types of formal labels, certain consumer groups are normally targeted, particularly people who have a high willingness to pay for quality and safety attributes.

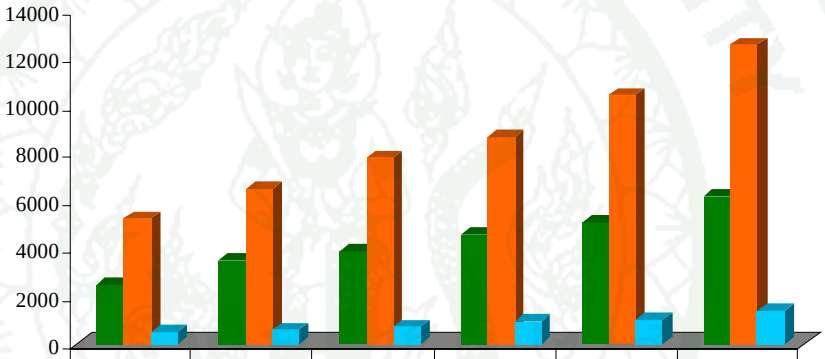
The growing demand for food safety and quality has also received attention from modern retail outlets such as supermarkets, observable by an increasing shelf-space for these products (Wiboonpongse and Sriboonchitta, 2004). Modern retail outlets try to promote safe produce targeting on consumers' confidence (Oates, 2006). Following the trend in South East Asia, the importance of modern retail outlets in Thailand is growing fast (Weinberger and Lumpkin, 2006). Thai consumers however continue to purchase fresh products in traditional markets because of the perception of products as fresh and cheap (USDA, 2004). Nonetheless, the emerging modern retail outlets, particularly supermarkets and specific stores, have an increasingly influence on the composition of traditional food retail sectors. In contrast to the traditional ones, modern retailers have implemented strategies to control the process of setting safety

and quality standards by following government regulations to build consumers' confidence, provide a convenient one-stop shopping, and offer a wide variety of products (Jitsanguan *et al*., 2004; USDA, 2004; Wiboonpongse and Sriboonchitta, 2004; Boselie *et al*., 2003). Tokrisna (2006) revealed that the share of modern retailers rose from 26 percent in 1997 to 53.2 percent in 2001, while the share of traditional retailers declined from 74 percent to 47 percent over the same period. Modern retailers have reached every socio-economic level of society and have especially penetrated the higher educated and younger consumer groups (Gorton *et al*., 2009). About 90 percent of urban Thai shoppers use the format of modern retailers at least once in a month (USDA, 2007).

Additionally, the range of fresh products has been characterized by a strong diversification towards specialized convenience in the form of canned fruits, frozen vegetables and minimally processed fruits and vegetables. Vinning and Tshering (2005) distinguished convenience into two elements: "convenience in terms of products" such as anything that reduces preparation time and "convenience in terms of shopping". Increasing levels of education and more disposable income have led to an increasing desire for convenient fresh products especially in large cities such as Bangkok (Kanlayanarat and McGlasson, 2003). A major reason is the overall greater convenience provided to suit consumers' modern life style (Sa-nguanpuag *et al*., 2007). "Modern societies" show changes of perception of time value and task duration, which directly affect the purchase behavior of fruit and vegetable selection requiring less time, good taste and reasonable prices (Florkowski, 2006). The variety of minimally processed fresh produces has increased in traditional markets and supermarkets especially fresh-cut fruit, which relieves preparation inconvenience (Rattanapanone *et al*., 2000). Convenience is thus an option for supply side actors to differentiate products and raise prices.

High-income households tend to consume more fruits and vegetables because of their increased concern over healthy eating. Moreover, higher income levels have enabled consumers to purchase a greater variety of fresh products like off-season or exotic fruits. These shifts in food demand patterns towards high-value fresh produce

are also providing increased trade opportunities among neighboring countries because of the globalization trends in the fruit and vegetable trade. There are indications that demand for high-value food products in developing countries might be met by imports because the national supply chains have not adapted fast enough to the new challenges (Reardon *et al*. 2003). Recent free trade agreements, for example, between China and ASEAN member countries, have led to an increasing national and international competition, partly influencing domestic price fluctuations. A significant increase in imported fruits and vegetables can be observed for the past six years (Figure 2.3).



	2003	2004	2005	2006	2007	2008
Vegetables	2491.48	3522.29	3879.29	4604.81	5122.52	6193.85
Fruits	5281.91	6486.48	7775.32	8682.79	10414.5	12507.1
Juice	530.1	618.4	742.72	939.69	1039.8	1403.78

Figure 2.3 Imported values for fresh fruits and vegetables and juice (Million Baht)
Source: Ministry of commerce, Thailand

Most of these imported products are temperate fruits and vegetables which cannot be produced domestically or do not satisfy the local quantity demand. About 49 percent of imported fruits are from China such as apple, peach, grape and orange while imported vegetables include carrot, cabbage, broccoli and others (National Food Institute 2009). Thais are consuming more temperate fruits, i.e. apples from China. These imported products have not replaced domestic tropical fruits but have increased total fruit consumption (Putthawong *et al*., 2008). However, product characteristics

with different country origin can induce various consumption behaviors as a country origin could be perceived as a quality cue.

The preceding review also highlights the rising awareness among Thai consumers of health risks associated with hazardous substances in fresh horticultural food products. The premium willingness to pay for fresh products with safety and quality attributes signals a development potential for domestic high-value food markets. Thus, the change in food preferences of Thai consumers not only influences the shift to functional food of high nutritive value but also impacts on market structures. Undoubtedly, the demand for fresh fruits and vegetables with safety and quality attributes has assumed an increasing importance in the domestic food markets. However, most food demand analyses have only taken a partial look at certain foods or food groups, using descriptive statistics or single-equation econometrics model. The analyses are not fully consistent with economic theory. High aggregation of food items or a partial look at selected food items cannot provide the necessary degree of detail, especially in regard to safety and quality attributes. This study seeks to augment the existing literature with an approach that includes the entire food bundle, disaggregate level of fresh produce in the analysis by using a theory-consistent demand systems approach as well as a comprehensive household dataset. The methodology is described in the next chapter.

Cabbages and mango

Beyond the main focus on fruits and vegetables consumption by revealed preference data, state preference data were also collected within the same sample households using the Contingent Valuation Method and Choice Experiment. The data were used to analyze consumers' willingness to pay for selected fruits and vegetables in terms of safety and quality attributes and analyzed for determinants of consumers' preference. To provide a technical background on the selected produce that are the subject of this study, this sub-section describes their farming and agronomic characteristics and the economics of their production and marketing. The fresh produce are cabbage and mango. Information sources for this review include literature

and secondary statistics. Cabbage and yellow mango of the variety “NamDokMai” were chosen because they are top ranked in local consumption patterns and well-known to Thai consumers. Thus, it was assumed that consumers possessed the basic knowledge and experience for both produce — an important pre-condition for the analysis employed in this study.

The production of opium in the upland areas of Northern Thailand has been suppressed by, among other measures, the replacement of poppy with cash crops such as temperate vegetables, fruit trees and flowers. Cabbage was one of the replacement crops. It grows well in the upland conditions and offers an attractive short run cash income to farmers (three crops can be grown in a year). Available data show a 15 percent increase in the volume of cabbage production from 2005 to 2009 (Table 2.2). The main production areas in Northern Thailand contribute 55 percent to the total national production. But the price of cabbage highly fluctuates depending on demand and season. This pattern is seen in Figure 2.4, which presents the monthly price of cabbage at the largest wholesale market in Bangkok.

Table 2.2 Planted and harvested areas, product quantity and cabbage yield from year 1998 to 2009

	Planted areas	**Harvested areas**	**Product quantity**	**Yield per Rai (kilogram)**	
	(Rai)	**(Rai)**	**(Ton)**	**/Plant**	**/Harvest**
1998	71,003	68,109	200,046	2,817	2,937
1999	78,179	76,282	242,405	3,101	3,178
2000	76,343	70,555	218,157	2,858	3,092
2001	61,543	49,258	171,258	2,783	3,477
2002	140,961	119,332	431,506	3,061	3,616
2003	93,144	81,783	259,478	2,786	3,173
2004	69,574	68,993	245,733	3,532	3,562
2005	57,897	56,181	188,402	3,254	3,353
2006	61,368	59,232	200,113	3,261	3,378
2007	63,178	60,869	207,381	3,282	3,407
2008	63,400	61,090	209,600	3,306	3,431
2009	65,041	62,591	216,690	3,332	3,462

Source: Office of Agricultural Economics

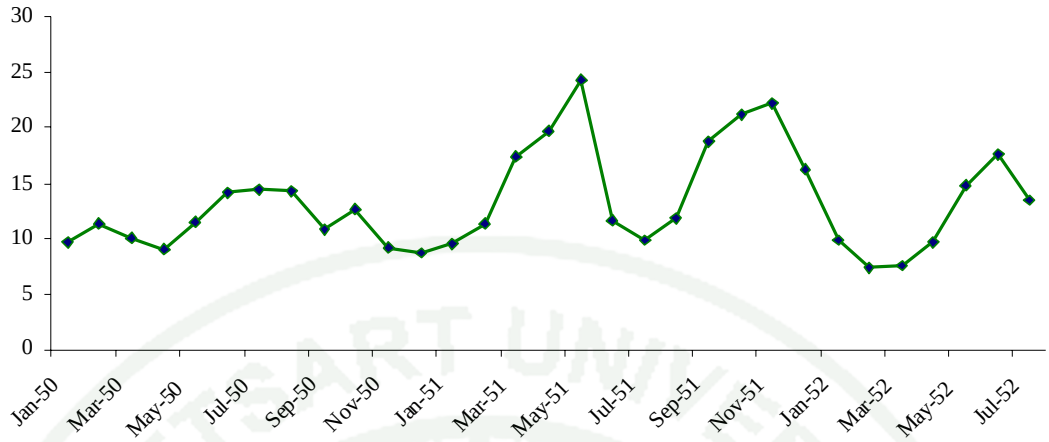


Figure 2.4 Retail price of conventional cabbage from January 2007 to July 2009. Source: www.taladthai.com, retrieve December, 2009

Three crops of cabbage can be grown in a year and the vegetable has a year-round market. Differences in cabbage growing seasons are related to production area, quality of product and selling price. Hruzova (2002) noted that cabbage from the first season (March to June) can be sold at a good price but the yield per rai and quality of product are low during this season. The second season (July to October) offers more favorable growing conditions resulting in high yields and therefore higher output and thus lower prices. Labor requirement is also higher. In the third season (November to February) price is quite high, but as in the first season, low outputs mean lower returns to producers. Seasonal fluctuations are more pronounced than short-term price variations (Hau *et al*., 2004). In order to improve the productivity and quality of cabbage especially in the off-season, chemicals are often used in the conventional production system (Junsongsang, 2004).

Mango is one of the most important economic fruits in Thailand showing great potential in local and overseas markets (Vichitrananda and Somsri, 2008; Subhadrabandhu and Wongwanich, 1996). A mango tree is the dominant fruit tree species in plantation areas (Figure 2.5). Mango can be grown in every part of Thailand; 65 percent of the cultivation area is in the central region and 26 percent in the northern regions. The volume of mango production increased by 37 percent from

2005 to 2009 (Table 2.3). The variety Nam Dok Mai is well-known to Thai consumers for its sweetness and fragrance. The variety has a yield potential of 1,027 kilogram per rai (6,418.75 kilograms per ha); this is higher than other local varieties (Table 2.4).

In general, the yield of a mango tree depends on its age and susceptibility to pests and diseases inducing chemical and pesticide use within the conventional production system (Jedele, 2002). In 2003, the Maximum Residue Limit for mango was 11.7 percent, followed by a reduction to 4.7 percent in 2005. These were set by the government "food safety program". Feedback from buyers in TOP supermarkets in Bangkok showed a potential market demand for NamDokMai with government labels that indicate low pesticide residue levels (Mingmori, 2006). From the supply side, a high potential demand is expected, especially for fruits with low pesticide and chemical residue levels (Jedele, 2002).

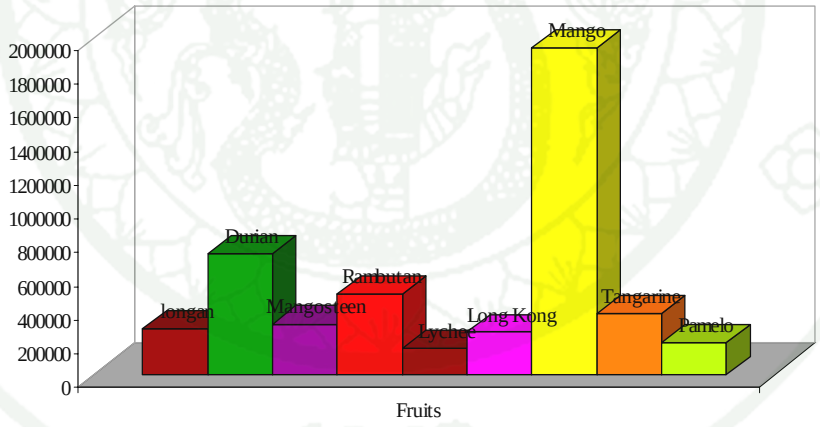


Figure 2.5 The harvested area (Rai) of the important fruit crops in Thailand in 2005
Source: http://www.oae.go.th. retrieve March, 2007.

Table 2.3 Planted and harvested areas, product quantity and mango yield from year 1998 to 2009.

	Planted areas (Rai)	Harvested areas (Rai)	Product quantity (Ton)	Yield Rai^{-1} (kilogram) /Plant	/Harvest
1998	2,223,951	1,420,582	1,087,776	489	766
1999	2,220,807	1,529,671	1,461,773	658	956
2000	2,235,804	1,683,160	1,623,141	726	964
2001	2,214,518	1,718,217	1,653,718	747	962
2002	1,552,364	1,307,692	1,775,531	1,144	1,358
2003	2,077,294	1,719,650	1,955,308	941	1,137
2004	1,825,663	1,771,906	1,975,016	1,082	1,115
2005	1,942,533	1,938,235	1,802,665	928	930
2006	2,215,541	1,762,423	2,093,759	945	1,188
2007	2,245,619	1,860,005	2,302,686	1,025	1,238
2008	2,306,559	1,906,960	2,374,165	1,029	1,245
2009	2,348,406	1,925,164	2,469,814	1,052	1,283

Source: Office of Agricultural Economics

Table 2.4 Planted area, harvested area and mango yield by variety in 2005

Variety	Planted Area (Rai)	Harvested Area (Rai)	Yield (kg./Rai)
Nang Kang Wan	60,369	51,292	805
NamDokMai	364,469	285,724	1,027
Oak Rong	149,279	132,971	918
Chok Anan	42,969	25,565	1,315

Source: Department of Agricultural Extension, Thailand

In light of the above discussion, cabbage and yellow mango are likely to become important sources of income for local producers. Product differentiation in terms of safety is a promising alternative for local supply actors to achieve and maintain competitiveness in local and export markets. The crucial element that is needed by the market particularly the suppliers is a deeper understanding of consumer's purchase decisions. This missing element can be provided by consumers' valuation. The lack of marketing information continues to be an obstacle for cabbage

and mango producers (Hruzova, 2002; Jedele, 2002). Previous studies of consumers' preference for safety and quality aspects obtained data mostly from purchasers in specialized retail outlets, which are not representative of larger population segments or urban areas. In sum, an understanding of consumer's valuation for these fresh produce can be a useful complement to information from previous studies and an important guide for food producers and policy makers.

CHAPTER III

METHODOLOGY

This chapter describes the analytical framework and empirical model for the study, and the tools and methodology for data collection. In the first section, the two elements of the analytical framework are separately presented in line with the two main objectives of the study. Likewise, the empirical models for food demand analysis and consumers' valuation are discussed separately. The same treatment is applied to the presentation of determinant factors. The survey design and sampling procedure and the structure of the questionnaire are explained in the second section.

Analytical Framework and Empirical Model

Completed demand analysis

The first objective is to study the household food consumption pattern and demand for fresh fruits and vegetables with specific quality attributes. Single demand equations may not satisfy all restrictions in the economic theory, especially for the budget constraint (Qaim *et al*., 1997). Therefore, appropriate demand system models and steps of analysis are chosen as depicted in Figure 3.1. A common treatment of food consumption patterns is to assume two-stage budgeting, which has found wide application in empirical studies (Menezes *et al*., 2008; Mergenthaler *et al*., 2009a; Jabarin, 2005; Shiptsova *et al*., 2004; Piumsombun, 2003; Fan *et al.*, 1995). At the core of two-stage budgeting is the assumption of weak separability; preferences for items within groups are assumed to be independent of items in another group (Deaton and Muellbauer, 1980a). Weak separability implies that the effects of price changes in one commodity group can be modeled via a combination of intra-group expenditure elasticities and changes in the allocation of expenditure across group (Edgerton, 1997). For practical reasons, a two-stage budgeting under a weak separable preference assumption is employed in this study. The estimation of demand system is divided into three parts, as described in the following sub-sections.

1. First budgeting stage analysis

For the first budgeting stage, households allocate their available budget among broad group (*g*); food away from home, food at home and non-food. In this stage, an extended Working-Leser Model is employed to derive group expenditure elasticities in the absence of price information, as in equation (3.1):

(3.1) $$w_{gh} = \alpha_g^* + \beta_g \ln X_h + \sum_{r=1}^{n} \delta_{gr} \eta_{rh}$$

where $\alpha_i = \alpha_i^* + \sum_{r=1}^{n} \delta_{ir} \eta_{rh}$. Index h denotes individual households and index r is the number of included household's characteristic variables. All variables employed in this analysis stage are presented in Table 3.1.

Table 3.1 Variables used in the estimation of first budgeting stage

Variables	Definition	Data types
w_{gh}	Budget share of broad group items. Calculated as a ratio of group expenditure on total expenditure.	Quantitative
X_h: Expenditure*	Annual per capita total household expenditure	Quantitative
η	Vector of household characteristics	
Size	Number of household members (persons)	Quantitative
Age	Age of household head (years)	Quantitative
Education	Education of household head (years)	Quantitative
Female labor	Female household head participation in labor force (1 = yes and 0 = no)	Qualitative
White collar	Occupation of household head is white collar jobs (1 = yes and 0 = no)	Qualitative
Workers	Occupation of household head is worker or entrepreneur (1 = yes and 0 = no)	Qualitative
Housewife	Occupation of household head is housewife (1 = yes and 0 = no)	Qualitative

Table 3.1 (Continued)

Variables	Definition	Data types
Child (> 5years)	Children in household above 5 years old (1 = yes and 0 = no)	Qualitative
Health awareness	Household respondent has awareness of health problems linked to food quality (1 = yes and 0 = no)	Qualitative

Note: * Total expenditure is used as a proxy of the permanent household income. It is generated by the inclusion all expenses for food and non-food items and own-productions during the recall period.

Source: Generated from household survey data

2. Aggregate demand analysis (second budgeting stage)

All food at home products captured in the survey are aggregated into 8 food commodity groups at the second budgeting stage, denoted by subscript *i*. The approximated Linear Almost Ideal Demand System (LAIDS) is applied to estimate within group expenditure and conditional own price elasticities. The approach proposed by Shonkwiler and Yen (1999) was employed to take the problems arising from censored data into account, which is frequently cited in literatures (Ecker, 2008; Yen and Lin, 2006; Shiptsova *et al.*, 2004; Pittman, 2004; Asatryan, 2003; Yen et. al., 2002; Su and Yen, 2000). The analysis starts with a probit decision model; first, define d_{ih} equal to 1 if household *h* consumes food item *i* and 0 otherwise, by estimating the following equation:

(3.2) $$d_{ih} = z_{ih}^{'}\alpha + v_{ih}$$

where $z_{ih}^{'}$ denotes a vector of socio-demographic variables. This equation is estimated using a maximum likelihood technique, with v_{ih} is an error term which is assumed to be normally distributed. $\phi(z_i^{'}\hat{\alpha})$, an univariate standard normal probability function, and $\Phi(z_i^{'}\hat{\alpha})$ denoting the associated cumulative distribution

function are formed using the estimated parameters from (3.2). The LAIDS models at the second step for aggregate demand systems are transformed, presenting by equation (3.3) to (3.10):

(3.3): share equation of fresh fruits

$$w_{(FF)h} = \Phi(z_i^{'}\ \hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n} \gamma_{ij} \log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n} \delta_{ir}\eta_{rh}] + \varphi\,\hat{\phi}(z_i^{'}\ \hat{\alpha}_i) + \xi_i$$

(3.4): share equation of fresh vegetables

$$w_{(FV)h} = \Phi(z_i^{'}\ \hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n} \gamma_{ij} \log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n} \delta_{ir}\eta_{rh}] + \varphi\,\hat{\phi}(z_i^{'}\ \hat{\alpha}_i) + \xi_i$$

(3.5): share equation of rice and glutinous rice

$$w_{(RG)h} = \Phi(z_i^{'}\ \hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n} \gamma_{ij} \log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n} \delta_{ir}\eta_{rh}] + \varphi\,\hat{\phi}(z_i^{'}\ \hat{\alpha}_i) + \xi_i$$

(3.6): share equation of meat

$$w_{(Meat)h} = \Phi(z_i^{'}\ \hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n} \gamma_{ij} \log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n} \delta_{ir}\eta_{rh}] + \varphi\,\hat{\phi}(z_i^{'}\ \hat{\alpha}_i) + \xi_i$$

(3.7): share equation of fish and seafood

$$w_{(FS)h} = \Phi(z_i^{'}\ \hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n} \gamma_{ij} \log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n} \delta_{ir}\eta_{rh}] + \varphi\,\hat{\phi}(z_i^{'}\ \hat{\alpha}_i) + \xi_i$$

(3.8): share equation of other fresh food

$$w_{(OFF)h} = \Phi(z_i^{'}\ \hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}] + \varphi\ \hat{\phi}(z_i^{'}\ \hat{\alpha}_i) + \xi_i$$

(3.9): share equation of preserved fruits and vegetables

$$w_{(PFV)h} = \Phi(z_i^{'}\ \hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}] + \varphi\ \hat{\phi}(z_i^{'}\ \hat{\alpha}_i) + \xi_i$$

(3.10): share equation of other preserved food

$$w_{(OPF)h} = \Phi(z_i^{'}\ \hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}] + \varphi\ \hat{\phi}(z_i^{'}\ \hat{\alpha}_i) + \xi_i$$

where $\alpha_i = \alpha_i^{*} + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}$. Index *h* denotes individual households and index *r* is the number of included household's characteristic variables. All variables employed in this analysis stage are presented in Table 3.2, and α_i , γ_{ij} , β_i δ_{ir} are parameters to be estimated

Table 3.2 Variables used in the estimation of aggregate demand system

Variables	Definition	Data types
w_{ih}	Budget share of aggregate food item *i.* Calculated as a ratio of its expenditure on food at home expenditure	Quantitative
x_h : FAH	Annual per capita food at home expenditure	Quantitative
p_{jh}	Price of commodity j	Quantitative
P_h^*	The selected price index	Quantitative
η	Vector of household characteristics	
Size	Number of household members (persons)	Quantitative
Age	Age of household head (years)	Quantitative
Education	Education of household head (years)	Quantitative
Female labor	Female household head participation in labor force (1 = yes and 0 = no)	Qualitative
White collar	Occupation of household head is white collar jobs (1 = yes and 0 = no)	Qualitative
Workers	Occupation of household head is worker or entrepreneur (1 = yes and 0 = no)	Qualitative
Housewife	Occupation of household head is housewife (1 = yes and 0 = no)	Qualitative
Distance1	Distance to the nearest traditional market (kilometer)	Quantitative
Disease	Household members being affected by long-term diseases (1 = yes and 0 = no)	Qualitative
Bangkok	Household sample is located in Bangkok (1 = yes and 0 = no)	Qualitative

Source: Generated from household survey data

3. Disaggregate demand analysis (second budgeting stage)

The third part is set to the disaggregate demand estimation also employing a two stage-budgeting under weak separability assumption and Shonkwiler and Yen approach as in the aggregate demand analysis. The new form is to integrate fresh fruits and vegetables (FFV) in the same commodity group and then to disaggregate by supply chain-related attributes. Four kinds of disaggregate demand sub-systems are considered in this study: "demand sub-system 1 (SDS1)" for place of purchase, "demand sub-system 2 (SDS2)" for safety and quality indications, "demand sub-system 3 (SDS3)" for convenience attribute, and "demand sub-system 4 (SDS4)" for source of production, presented in figure 3.1. In each disaggregate demand sub-system, FFV group is replaced by two sub-categories representing different supply chain-related attributes. Hence, each demand sub-system consists of eight commodity groups to be estimated at the second stage budgeting using an approximated Linear Almost Ideal Demand System (LAIDS) models.

By considering the disaggregate demand sub-system "place of purchase" (SDS1), available food at home budget is assumed to be allocated to FFV from traditional retail outlets (*Trad_FFV*), FFV from modern retail outlets (*Mod_FFV*) and other aggregated food items; rice & glutinous rice (RG), meat, fish & seafood (FS), other fresh food (OFF), preserved fruits & vegetables (PFV) and other preserved food (OPF). The LAIDS models are transformed with the results from probit decision model. The share equations in the disaggregate demand sub-system for place of purchase are demonstrated in equations (3.11) to (3.18):

(3.11): share equation of fresh fruits and vegetables from traditional retail outlets

$$w_{(Trad\_FFV)h} = \Phi(z_i^{'}\,\hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}] + \varphi\,\hat{\phi}(z_i^{'}\,\hat{\alpha}_i) + \xi_i$$

(3.12): share equation of fresh fruits and vegetables from modern retail outlets

$$w_{(Mod\_FFV)h} = \Phi(z_i^{'}\,\hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}] + \varphi\,\hat{\phi}(z_i^{'}\,\hat{\alpha}_i) + \xi_i$$

(3.13): share equation of rice and glutinous rice

$$w_{(RG)h} = \Phi(z_i^{'}\,\hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}] + \varphi\,\hat{\phi}(z_i^{'}\,\hat{\alpha}_i) + \xi_i$$

(3.14): share equation of meat

$$w_{(Meat)h} = \Phi(z_i^{'}\,\hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}] + \varphi\,\hat{\phi}(z_i^{'}\,\hat{\alpha}_i) + \xi_i$$

(3.15): share equation of fish and seafood

$$w_{(FS)h} = \Phi(z_i^{'}\,\hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}] + \varphi\,\hat{\phi}(z_i^{'}\,\hat{\alpha}_i) + \xi_i$$

(3.16): share equation of other fresh food

$$w_{(OFF)h} = \Phi(z_i^{'}\,\hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}] + \varphi\,\hat{\phi}(z_i^{'}\,\hat{\alpha}_i) + \xi_i$$

(3.17): share equation of preserved fruits and vegetables

$$w_{(PFV)h} = \Phi(z_i^{'}\,\hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}] + \varphi\,\hat{\phi}(z_i^{'}\,\hat{\alpha}_i) + \xi_i$$

(3.18): share equation of other preserved food

$$w_{(OPF)h} = \Phi(z_i^{'}\ \hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^{*}}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}] + \varphi\ \hat{\phi}(z_i^{'}\ \hat{\alpha}_i) + \xi_i$$

where $\alpha_i = \alpha_i^{*} + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}$. Index *h* denotes individual households and index *r* is the number of included household's characteristic variables. All variables employed in the estimation of disaggregate demand analysis are presented in Table 3.3, and α_i , γ_{ij} , β_i δ_{ir} are parameters to be estimated.

Table 3.3 Variables used in the estimation of disaggregate demand system

Variables	Definition	Data types
w_{ih}	Budget share of disaggregate fresh produce and aggregate food item i^{*}. It is calculated as a ratio of its expenditure on food at home expenditure	Quantitative
x_h : FAH	Annual per capita food at home expenditure	Quantitative
p_{jh}	Price of commodity *j*	Quantitative
P_h^{*}	The selected price index	Quantitative
η	Vector of household characteristics	
Size	Number of household members (persons)	Quantitative
Age	Age of household head (years)	Quantitative
Education	Education of household head (years)	Quantitative
Female labor	Female household head participation in labor force (1 = yes and 0 = no)	Qualitative
White collar	Occupation of household head is white collar jobs (1 = yes and 0 = no)	Qualitative
Workers	Occupation of household head is worker or entrepreneur (1 = yes and 0 = no)	Qualitative
Housewife	Occupation of household head is housewife (1 = yes and 0 = no)	Qualitative
Distance2	Distance to the nearest modern retail outlet (kilometer)	Quantitative

Table 3.3 (Continued)

Variables	Definition	Data types
Bangkok	Household sample is located in Bangkok (1 = yes and 0 = no)	Qualitative
Media**	Number of media used in sample household	
Attitude1***	Household respondent agrees that quality and safe fresh produce are assured in the modern retail outlets only (1 = yes and 0 = no)	Qualitative
Attitude 2****	Household respondent agree that they carefully wash fresh produce before cooking. (1 = yes and 0 = no)	Qualitative

Note: * In disaggregate demand sub-system "safety and quality indications", index *i* denote fresh fruits and vegetables with informal and formal indicators and other aggregate food groups. In disaggregate demand sub-system "convenience", index *i* denote conventional fresh fruits and vegetables and minimally processed fresh produce and other aggregate food groups. In disaggregate demand sub-system "source of production", index *i* denote domestic and imported fresh fruits and vegetables and other aggregate food groups. ** The media used from this household survey comprises radio, television, newspaper, internet and other sources. *** This variable is included in the sub-demand system "place of purchase". **** This variable is included in the sub-demand system "convenience attribute".

Source: Generated from household survey data

For the second stage budgeting of both aggregate and disaggregate demand analysis, commodity prices are considered. In the household survey, household head would give the information of food quantity and nominal expenditure which are drawn to calculate unit value of each aggregate food items. Deaton (1988) states that using unit value is subject to potential measurement bias as it does not account for different qualities of items purchased. To address this problem, several approaches are proposed (Cox and Wohlgenant, 1986; Deaton, 1988; Huang and Lin, 2000; Alfonzo and Peterson, 2006). The consistent approach proposed by Alfonzo and Peterson (2006) is chosen in our demand analysis because (i) it does not contain the error term, (ii) the approximation would be highly correlated with the true unobservable price, if it is correct, (iii) it allows estimating price-quantity relationships more accurately and

(iv) it can be computed for all observations. Thus, regression analysis of unit value towards household income, household characteristics and cluster dummies (11 districts[4]) reflecting the differences in prices between clusters were performed. The approximated price of each aggregate and disaggregate commodity follows as cluster dummy prediction. However, if this approach does not reveal statistical significance for the estimated model and predictor variable, the unit value will be used as a proxy of price information. Missing values because of zero consumption will be replaced by the district average weighted by household expenditure. Likewise, the prices of all food items will be examined for correlation structure in order to select the appropriate price index.

In the demand system equations, the error terms across equations are correlated by the fact that the dependent variables need to satisfy the budget constraint. Therefore, all system equations will be estimated with the Seemingly Unrelated Regression (SUR) developed by Zellner (1962). It provides estimations more efficiently by using estimated error variance-covariance matrix from OLS in the GLS estimation (Halcoussis, 2005; Sadoulet and Janvry, 1995). In the process of estimation at the second stage, symmetry and homogeneity conditions across equations are imposed, following Pittman (2004). The simultaneous system contains seven demand equations, as one (OPF share equation) has to be dropped from the system to preserve the adding-up restriction. The parameter estimates for the eighth equation are generated from those estimated parameters according to adding-up property.

The adding-up restrictions are $\sum \alpha_i^* = 1$, $\sum \beta_i = 0$, $\sum \gamma_{ij} = 0$ and $\sum_i \delta_{ir} = 0 \quad ; \quad \forall r$

Homogeneity is $\sum \gamma_{ij} = 0$,

Symmetry is $\gamma_{ij} = \gamma_{ji}$

[4] There are 12 districts in the sample. Chang Pueak district and Nongpakung district are merged as they have fewer observations but fairly homogenous geographic location.

Additionally, the error terms in the ultimate LAIDS model for both aggregate and disaggregate analyses differ from the original estimation as the selection mechanism interacts with the conditional mean, expressed as equation (3.19):

(3.19)

$$\xi_i = \varepsilon_i + \{[\Phi(z_i'\alpha_i) - \Phi(z_i'\hat{\alpha})][\alpha_i^* + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^T}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}]\} + \varphi[\,\phi(z_i'\alpha_i) - \hat{\phi}(z_i'\hat{\alpha}_i)]$$

with $E(\xi) = 0_i$

The error terms are heteroskedastic, consequently, the covariance matrix of second-step estimator is incorrect. Therefore, bootstrapping estimation is used for inferences about the estimated parameters (Alfonzo and Peterson, 2006; Su and Yen, 2000). All procedures are re-run for application in the other demand sub-systems. Finally, the demand elasticities of the entire food bundle and disaggregated items will be calculated; these are expected to be higher in the high-value food commodity groups.

All elasticity estimates are evaluated at the sample mean. Expenditure elasticity for both stages is calculated as follows (Green and Alston, 1990):

(3.20)
$$e_{g\,or\,i} = 1 + \left(\frac{\beta_{g\,or\,i}}{w_{g\,or\,i}}\right)$$

where *g* and *i* represent items at the first and second budgeting stage, respectively.

To obtain unconditional expenditure (income) elasticity of food item, the results from Carpentier and Guyomard (2001) and Edgerton (1997) is applied, presenting as equation (3.21):

(3.21)
$$E_i = e_{(g)i} \cdot e_{(g)}$$

where E_i is the unconditional expenditure (income) elasticity

$e_{(g)i}$ is the within-group expenditure elasticity (conditional expenditure elasticity)

$e_{(g)}$ is food at home expenditure elasticitiy from the first budgeting stage.

As no price elasticities are estimated at the first budgeting stage, unconditional own-price elasticities are not derived. The conditional uncompensated own-price elasticities are calculated as follows (Green and Alston, 1990):

(3.22) $$\varepsilon_{ii} = \frac{\gamma_{ii}}{w_i} - \beta_i - 1$$

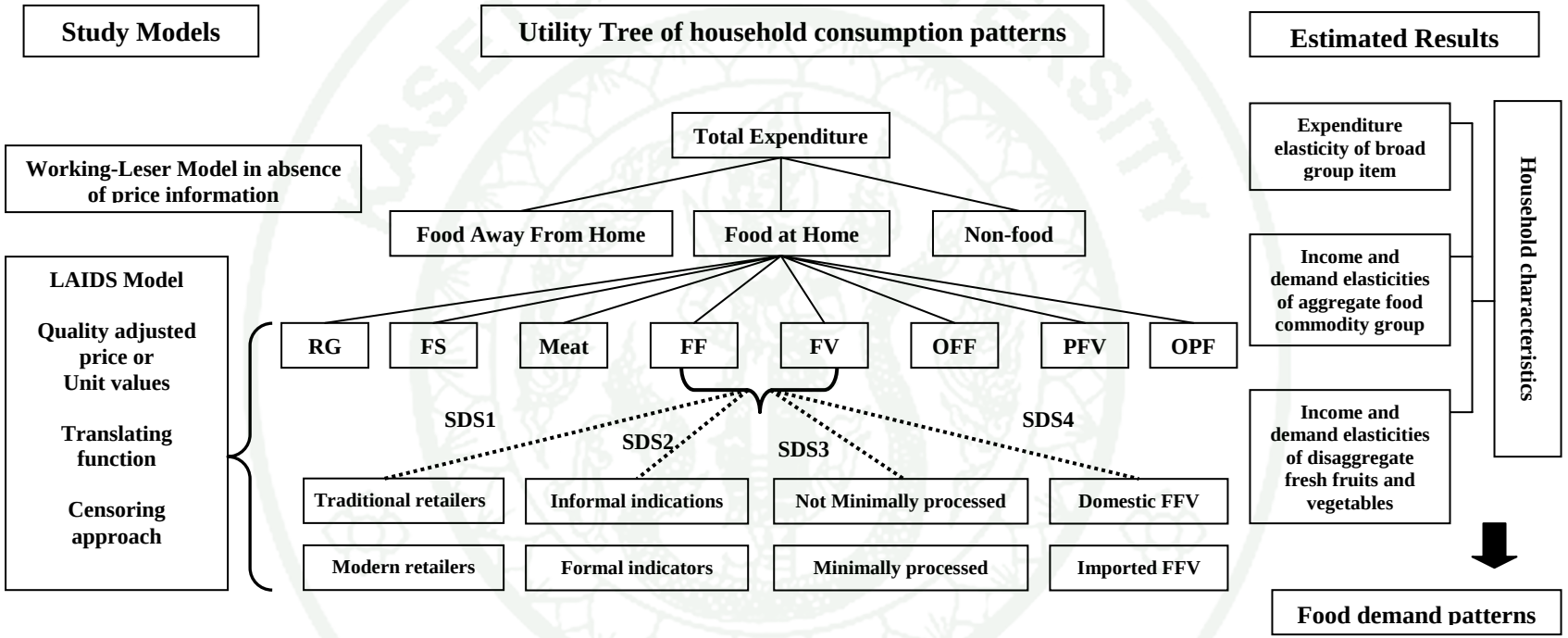


Figure 3.1 Analytical framework of demand system analysis

Note: RG: Rice and glutinous rice, FS: Fish & Seafood, FF: Fresh fruits, FV: Fresh vegetables, OFF: Other fresh food PFV: Preserved fruits & vegetables, OPF: Other preserved food, FFV: Fresh fruits & vegetables

SDS1: Place of purchase is categorized to traditional and modern retail outlets.

SDS2: Safety and quality indication is categorized to informal indications and formal indications.

SDS3: Convenience attribute is categorized to conventional and minimally processed fresh fruits and vegetables.

SDS4: Source of production is categorized to domestic and imported fresh fruits and vegetables.

Consumers' valuation and determinant factors

The second objective of this study is to elicit consumers' willingness to pay and identify the determinants of consumers' preference for specific quality attributes. Cabbage and NamDokMai mango were chosen to represent widely consumed fruits and vegetables for urban Thai households. It was assumed that consumers have basic knowledge of and experience with both fresh produce—an important pre-condition for the analysis employed in this study. Two state preference approaches are employed to achieve the second objective.

1. Contingent Valuation Method (CVM)

The double-bounded approach of CVM is preferred to elicit consumer's willingness to pay for pesticide-safe attribute. The approach is consistent with RUM theory. It reduces non-response and outliers, thus it is more efficient than the single-bounded approach (Kaye-Blake, 2006; Hanemann, 1991). The transformed first and second bid values are used in an interval censored model following Cameron (1988) as in equation (3.23):

(3.23) $$WTP = \beta X_i + \varepsilon_i$$

As Willingness to Pay (WTP) is not observed, we rely on the range of two sequential price bids which can be identified by survey observations. The log-likelihood function can be specified to estimate WTP as in equation (3.24), by multiplying the four different probabilities in the double bounded process for all individuals.

(3.24) $$\ln L = \sum_{i=1}^{n} \left\{ \begin{array}{l} I_1 \ln[F(\frac{B_L - X\beta}{\sigma})] + I_2 \ln[F(\frac{B_I - X\beta}{\sigma}) - F(\frac{B_L - X\beta}{\sigma})] + \\ I_3 \ln[F(\frac{B_U - X\beta}{\sigma}) - F(\frac{B_I - X\beta}{\sigma})] + I_4 \ln[1 - F(\frac{B_U - X\beta}{\sigma})] \end{array} \right\}$$

The first bid is denoted with B_I, and the second lower bid is B_L, while B_U is the second higher bid. Symbol I is a binary indicator of four possible outcomes. It is equal to 1 in case of appropriate range, otherwise is zero. Four possible groups are: (I_1) indicates that respondents answer "no" to both valuation question, so that $0 \le WTP < B_L$; (I_2) those responding "no" to the first bid and "yes" to the second bid, so that $B_L \le WTP < B_I$: (I_3) respondents reply "yes" to the first bid and "no" to the second bid, so that $B_I \le WTP < B_U$; and finally (I_4) respondents answer "yes" for both sequential price bid, so $B_U \le WTP < \alpha$. $F(\cdot)$ is the standard normal cumulative distribution function. The explanatory variables (X) included in the WTP model consist of control variables and household's characteristics as depicted in Table 3.4.

Table 3.4 Explanatory variables used in the estimation of WTP models

Variables	Definition	Data types
Expenditure	Annual per capita total household expenditure	Quantitative
Size	Number of household members (persons)	Quantitative
Age	Age of household head (years)	Quantitative
Education	Education of household head (years)	Quantitative
Gender	Household head is female (1 = yes and 0 = no)	Qualitative
White collar	Occupation of household head is white collar jobs (1 = yes and 0 = no)	Qualitative
Workers	Occupation of household head is worker or entrepreneur (1 = yes and 0 = no)	Qualitative
Housewife	Occupation of household head is housewife (1 = yes and 0 = no)	Qualitative
Media*	Number of media used in sample household	
Attitude 3	Fresh produce with higher prices have a better quality (1 = yes and 0 = no)	Qualitative
First bid	First price bid (% above market price)	Quantitative
Normal price	Price instrument (predicted price for conventional cabbage and NamDokMai mango: baht/kilogram)	Quantitative

Note: * The media used from this household survey comprises radio, television, newspaper, internet and other sources.

Source: Generated from household survey data

The first price bid (First bid) is entered into the model as a percentage compared to the average conventional market price of fresh produce[5] (Mergenthaler *et al*., 2009). If the coefficient of the first price bid shows a significant influence in the WTP model, a starting point bias is observed and the estimated mean WTP has to be reduced. For the unobserved quality preferences, the normally paid price (Normal price) is included in the WTP model as an instrumental variable to avoid an endogeneity problem caused by a correlation with the error term.

The parameters for calculating mean WTP are estimated by maximizing the log-likelihood function (equation 3.14). The estimated coefficient (β) can be directly interpreted as marginal effect on WTP. Mean WTP for pesticide safe fresh produce is evaluated at the sample mean, $(\hat{\beta}\bar{x})$. The analytical framework of pesticide safe fresh produce employing CVM is summarized in Figure 3.2.

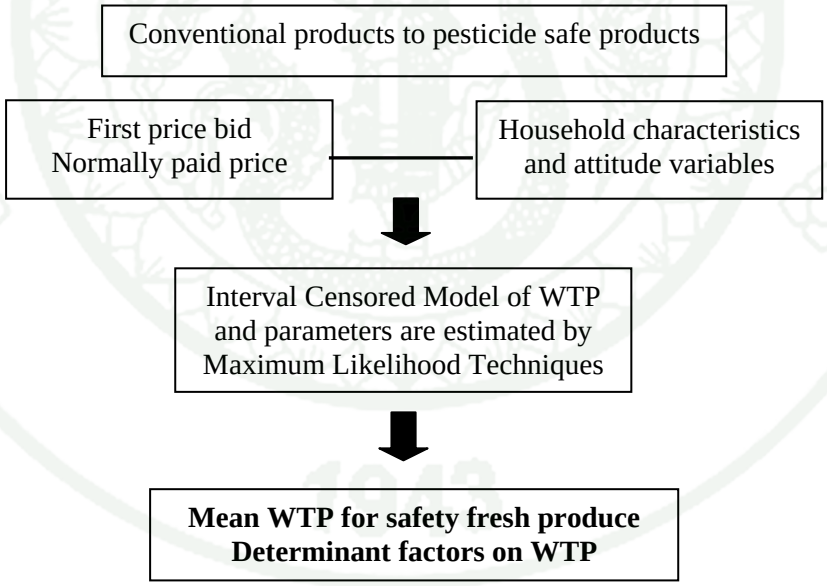


Figure 3.2 Analytical framework of pesticide safe fresh produce

[5] The calculation of first price bid, $bid = (\frac{P_1 - P_0}{P_0}) * 100$, where P_1 is first price bid and P_0 is conventional price which is observed from the survey

2. Choice Experiment (CE)

CVM concentrates on the valuation of a particular scenario or aggregate value of improvement. Therefore, it provides only a single value for an expected quality change (Bateman *et al*., 2002). Recently, there has been an extensive application by Choice Experiment (CE) in agricultural food economic literature (Roessler *et al*., 2008; Loureiro and Umberger, 2007; Carlsson *et al*., 2005; Wikstrom, 2003; Ara, 2003; Burton *et al*., 2001). CE provides a conceptual ground for implementing the multi-attribute framework and measuring the marginal value of change in the characteristic of products. To achieve the second objective, CE is also employed in this study, allowing the comparison of preference and marginal WTP for certain attribute levels. The analytical framework of multi-attribute levels is summarized in the figure 3.3.

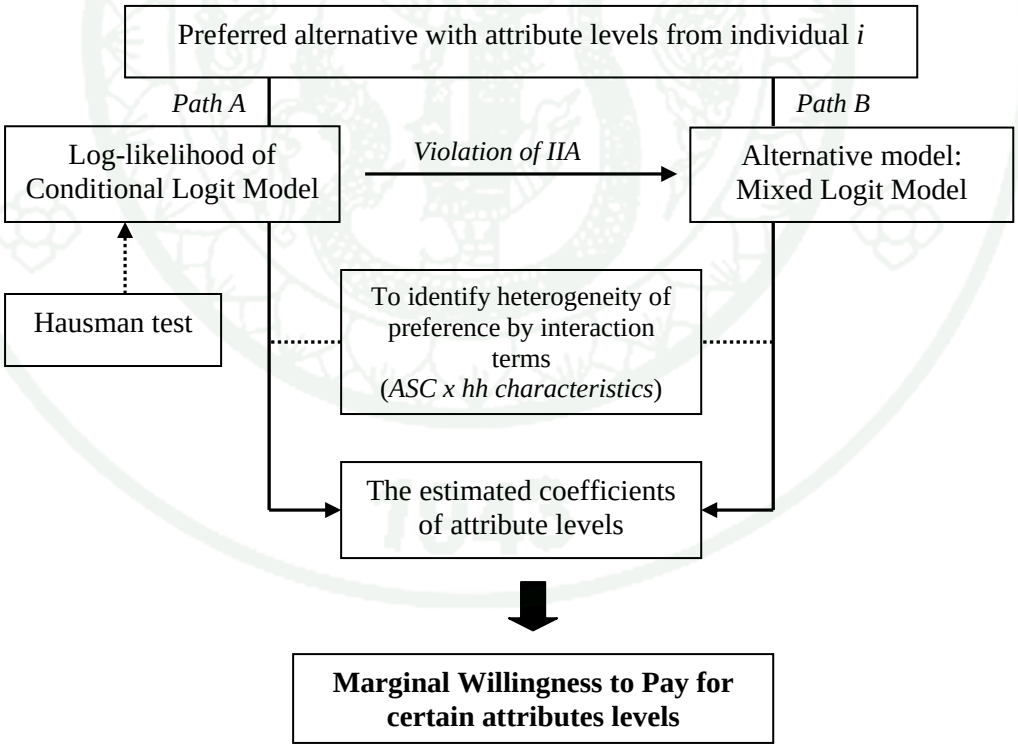


Figure 3.3 Analytical framework of multi-attributes for fresh produces

The choice experiment data are initially analyzed using the basic Conditional Logit Model (Path A), with respective log-likelihood function stated in equation (3.25):

$$\log L = \sum_{i=1}^{I}\sum_{j=1}^{J} y_{ij} \log\left[\frac{\exp(V_{ij})}{\sum_{k=1}^{J}\exp(V_{ik})}\right] \quad (3.25)$$

where y_{ij} is an indicator variable which take a value of one if individual *i* chose alternative *j* and otherwise zero. According to the framework of the random utility model ($U_{ij} = V_{ij} + \varepsilon_{ij}$), V_{ij} is a systematic component expressed as the linear function of attribute levels X_{ja} , illustrated in equation (3.26). ε_{ij} is the stochastic portion of the utility that are Independent and Identically Distributed (IID) extreme value across individuals, alternatives and choice situations.

$$V_{ij} = ASC + \beta_{ja} X_{ja} + \delta P_j \quad (3.26)$$

In the basic conditional logit model, a series of constant terms will be represented as “Alternative Specific Constant” (ASC). All attribute levels are entered the model using effect codes. The parameters in Conditional Logit model are estimated by maximum likelihood procedures. However, the problem arising from the Independent and Identically Distributed (IID) extreme value results in the Independence of Irrelevant Alternative (IIA) property, which can be checked by using the Hausman and McFaddent Test. If this assumption is violated, the conditional logit should not be used.

To relax IIA property, the “Mixed Logit Model” is employed as in Path B. Define a latent utility function of alternative *j* for individual *i*, consisting of a systematic and stochastic part as equation (3.27):

(3.27) $$U_{ij} = \beta_i X_{ja} + \varepsilon_{ij}$$

The coefficient vector β varies among the population with density $f(\beta)$. This means that the parameter for each attribute level is the sum of population mean $\tilde{\beta}$ and individual deviation η. Hence, the Mixed Logit model can be represented by the utility function as an error component specification, illustrated in equation (3.28):

(3.28) $$U_{ij} = ASC + \tilde{\beta}_i X_{ja} + \eta_i X_{ja} + \varepsilon_{ij}$$

The term $\eta_i X_{ja}$ is an error component that along with ε_{ij}, define the stochastic portion of the utility. The utility becomes correlated across alternatives, relaxing the IIA property. When β vary across individuals, it implies that each individual can have different weights for each destination attribute. In the choice experiment, the sequence of choices is the number of hypothetical choices that each individual makes in the survey. The unconditional choice probability, *P*, in the Mixed Logit Model is the logit formula integrated over all possible value of β with the density of β as weights, expressed as equation (3.29):

(3.29) $$P_i(j/J) = \int \tau_j(\beta)\ f(\beta)\ d(\beta)$$

This integral does not have a closed-form solution, so that it is approximated through simulated Maximum Likelihood procedure. (Christiadi and Cushing, 2007; Kaye-Blake, 2006; Colombo *et al.*, 2005)

All attribute levels are selected as the random parameters in the Mixed Logit model. The price term is fixed in order to improve the stability of the estimation, which makes the calculation of marginal willingness to pay easier. It also avoids the assumption of the distribution of price coefficient. For each attribute level, a mean effect on utility and a standard deviation in this effect exists. The degree of heterogeneity can be defined through the standard deviation of the parameters. The

parameter coefficients from the selected appropriate models are used to calculate the marginal willingness to pay for the discrete change in attribute levels. The positive amount of marginal rate of substitution for produce with an improved attribute can be expected, particularly from households with higher income and those with have higher educational level.

Data Collection

Sampling procedure

Households from two urban areas, Bangkok and Chiang Mai, were chosen to represent urban households in Thailand. A high level of disaggregation requires a relatively large sample size. Referring to a similar disaggregate demand analysis in Vietnam (Mergenthaler, 2008), a sample of 500 urban households were surveyed, 300 in Bangkok and 200 in Chiang Mai. A multi-stage sampling technique was employed in order to evenly distribute questionnaire coverage for remote areas and assure the representation of all major income household levels (Appendix Figure C1).

For the first stage, a stratified random sampling design was employed by separating the 50 districts of Bangkok into two groups of below and above average monthly household income (Socio-economic survey, National Statistics Office, Thailand 2004). This was followed by a random selection of three districts per stratum, which resulted in the selection of six districts in Bangkok. For Chiang Mai, the four city sub-districts and two districts comprised our household survey. The number of sample households in each district[6] (SHD_i) was calculated as a proportion of total households in each district (THD_i) and total household in Bangkok (TH^{bkk}) and Chiang Mai (TH^{cnx}), respectively. The sample households in each district are presented in Appendix Table C1 for Bangkok and Appendix Table C2 for Chiang Mai.

[6] The calculated sample households for each district in Bangkok can be done by $SHD_i = \frac{THD_i}{TH^{bkk}} * 300$, while in Chiang Mai $SHD_i = \frac{THD_i}{TH^{cnx}} * 200$ and *i* denote district.

Secondary units were selected by randomly choosing five residential roads in each district or sub-district. At this stage, a location map of all the estimated households along each road (*EHR*) was sketched. According to the location map, the estimates of total households for each road were summed up to provide the estimated total households in each district or sub-district (from 5 selected roads)[7] ($ETHD_i$). As such, the sample households along each road[8] (SHR_j) was calculated as a proportion of the estimated total households in each district ($ETHD_i$) and estimated sample households in that district (SHD_i). The results of the calculations for each road are illustrated in Appendix Table C3 for Bangkok and Appendix Table C4 for Chiang Mai.

Finally, to select a sample household, a systematic random sampling approach was made of the households along a road. Households were listed in random order and the count interval of house number was obtained by dividing the total estimated household on the road (EHR_j) by the number of sample households for each road (SHR_j). The count interval starts with house number 1 (also called 1st unit on each road) and moves on to the next sample household in the count interval. The result of the procedure, for example, Rama II Soi 24 in Jom Thong district, appears as Appendix Figure C2.

Design of the questionnaire

Following the analytical framework, the required survey information can be classified into 4 major sections. In the first section, a selected household was asked for detailed information on consumption expenditures on food and non-food items. The questionnaire format was open-ended to allow recording of the respondent's descriptions of consumption pattern particularly on items for food at home such as fresh fruits and vegetables, rice and glutinous rice, meat, fish & seafood, and other

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[7] $ETHD_i = \sum_{j=1}^{5} EHR_j$ While *j* is the selected road in district *i*.

[8] $SHR_j = \frac{EHR_j}{ETHD_i} * SHD_i$, With the summation of *SHR* should be equal *SHD* in each district.

fresh and preserved foods. Quality and processing attributes of fresh fruits and vegetables were considered with specific questions on location of purchased fresh produce, safety and quality indications, minimally processed attributes, and source of production including its price and quantities. The recall period was in some cases set to a particular event that was easy for a respondent to remember. For instance, household respondents were asked how much fresh food such as fruits and vegetables had been purchased during the previous week. For rarely purchased items like preserved foods, longer recall periods were applied. Consumption quantities were measured in kilogram. For liquid products, conversion to kilogram was done by multiplying density of liquid product with volumes purchased. Both expenditure and quantities were transformed into annual data.

The second section of the questionnaire addressed consumer's willingness to pay for specific quality attributes. Household heads were given detailed information concerning food safety and quality attribute for the selected fresh produce, cabbage and NamDokMai mango as well as label information. Contingent Valuation Method (CVM) and Choice Experiment (CE) were employed to assess consumers' preferences. The design of the questionnaires according to both approaches differed in terms of techniques. This is discussed below.

The double-bounded approach of CVM was applied to elicit Willingness to Pay (WTP) for pesticide-safe attribute of selected fresh produce. The structure of the premium bids were derived through consumer pre-surveys in the urban areas of Bangkok and Chiang Mai. The consumers were asked with open-ended questions to define their maximum willingness to pay for "pesticide-safe products" compared to actual market prices of cabbage and NamDokMai mango. The information from the pre-surveys was adjusted into five sets of bidding designs and worked into the household questionnaire (Table 3.5).

Table 3.5 The set of price bid for contingent valuation survey

Set	1st bid price	2nd lower bid price	2nd higher bid price
1	1.45	1.20	1.70
2	1.70	1.45	1.95
3	1.85	1.60	2.10
4	2.00	1.75	2.25
5	2.25	2.00	2.50

Source: Calculation from author's pre-survey data

These five sets of bidding designs were randomly applied for all 500 households. Enumerators had to introduce the information on the representative products and their specific attribute. Household respondents were asked how much they would currently pay for conventional products in order to make the price bid more capacious for respondents. The percentage of price bids was then translated into absolute values through the conventional price of products. The alternative format for each participant was presented by two bid levels: if the respondent answered "yes" at the first bid, they were asked a second higher bid price. If the answer is "no" at the first bid, they were asked a second lower price bid. Thus, there are four possible outcomes from the double-bounded approach, characterized by four different intervals.

In Choice Experiment, two steps of designing the experiment are needed. Firstly, the section of attributes and the assignment of levels has to be defined by consumers, by a focus group, face to face interviews or pre-survey and literature review (Bateman *et al.*, 2002). For this study, pre-surveys and focus group interviews were employed to identify and understand the concepts with regard to purchasing behavior for cabbage and NamDokMai mango, particularly on safety and quality aspects. Focus group interviews were organized in April 2007 in fresh markets, supermarkets and Doi khum shops in urban areas of Bangkok and Chiang Mai. Finally, three attributes for cabbage (price, chemical-residue and certificate) and four attributes for NamDokMai mango (price, appearance, chemical-residue and certificate) were selected (Table 3.6). The level of each attribute was finally approved

by pre-survey and consulted experts. The different price levels were defined from the pre-survey of 60 respondents in fresh markets and supermarkets which compared the current market prices.

Table 3.6 Attributes and levels in Choice Experiments

Cabbage		**Yellow Mango**	
Attribute	**Level**	**Attribute**	**Level**
Price (baht/kg)	20 35 50 70	Price (baht/kg)	35 55 75 95
Chemical Residue	Conventional Safety Organic	Chemical Residue	Conventional Safety Organic
Certificate	Non-certificate Have certificate	Appearance Certificate	Good Quite good Non-certificate Have certificate

Source: Focus group results and findings of previous studies

In the second step, a complete factorial design of 4 x 3 x 2 = 24 combinations and 4 x 2 x 3 x 2 = 48 combinations of cabbage and NamDokMai mango was calculated by 3 and 4 attributes for each level, respectively. Full factorial combinations are high considering product varieties, and would be difficult and complex for respondents to answer. Therefore, full profiles should be reduced to avoid doubtful information from respondents overwhelmed by complex questions, at the same time satisfy the standard criterion of a parsimonious number of parameters in any quantitative analysis (Batemann *et al*., 2002). An orthogonal design of analysis was recently applied allowing a statistically independent selection and estimation of main effects (Vanit-Anunchai, 2006). We therefore generated particular alternatives from the full factorial combination in order to set up the choice set for the choice experiment. After obtaining the fractional factorials of alternatives, we delineated the

choice set by two profiles for each choice set versus the status quo. In order to obtain status quo, it was assumed that consumers need to consume fruits and vegetables by conventional products. Status quo was defined as a conventional product of normal price and without certificate. Gustafsson (2000) indicated four properties of an efficient choice design: level balance, orthogonal, minimal overlap and utility balance. Level balance means that the level of each attribute should be of equal frequency.

The choice set should have a minimal overlap. Hence, the probability that a level of attribute repeats itself in each choice set should be as low as possible. After we pre-tested the choice set of fresh produces, we obtained 5 choice sets consisting of 2 alternatives versus status quo (Appendix Table C5) and 7 choice sets consisting of 14 alternatives versus status quo (Appendix Table C6) of cabbage and NamDokMai mango respectively. Each choice set of products was presented to respondents in a questionnaire handbook in the form of A4 booklets with colored printouts and containing the necessary descriptive and explanatory information. Enumerators had to explain the details of level of each attribute and ensure that respondents understood "what respondents were asked to do" (Bateman *et al*., 2002).

In the third section of questionnaire, statements concerning safety and quality aspects were given to household heads to understand their attitudes. Household heads were also asked to rank their three most important criteria for purchasing fresh fruits and vegetables. All in all, this section would generate more background information on consumer attitudes in relation to quality attributes.

The last section of the questionnaire was designed to collect household characteristics such as household size, marital status, years of education of household head, occupation, female household head participation in the labor force, number of media accessed, awareness of health problems linked to food quality, and others, which are expected to impact on consumer's behaviors. The questionnaire is presented in Appendix D.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter starts with a discussion of household characteristics, expenditure consumption patterns on aggregated food items, expenditure consumption patterns on fruits and vegetables from different supply chain-related attributes, and consumer attitudes toward safety and quality aspects. In the second section, the first sub-section discusses the results of analyses of the complete demand system for aggregated and disaggregated items, focusing on safety and quality attributes of fruits and vegetables. The second sub-section discusses the results of the elicitation of willingness to pay for selected fruits and vegetables; the outcomes from the Contingent Valuation Method with a double bounded approach and the Choice Experiment are presented.

Data Description

This section describes the socio-demographic and socio-economic characteristics of interviewed households. It is followed by a description of the food expenditure consumption patterns and a presentation of expenditure share of fruits and vegetables with different product or process attributes. In order to facilitate the basic analysis, all characteristics and expenditure share figures are disaggregated by location and expenditure quartile[9]. Educational levels of households are used to evaluate expenditure patterns between purchased fruits and vegetables from traditional and modern supply chain sectors. Respondent's attitude on safety and quality issues particularly on fruits and vegetables is presented in the last sub-section.

[9] Expenditure is used as a proxy for permanent household income. To generate the household income group, total per capita household expenditure was assigned to expenditure quartiles, contain 125 household each.

Household characteristics

Table 4.1 presents a description of household characteristics. Average annual per capita household expenditure of the entire sample households amounts to 110,934 baht, ranging from 40,214 baht in the lowest quartile to 236,221 baht in the highest quartile. Bangkok households have a moderately higher income than urban households in Chiang Mai. The majority of household heads in the survey were female, and most of them are the primary food purchaser. There are no strong differences between Bangkok and Chiang Mai households in socio-demographic characteristics such as household size, age and years of education of respondents. Average household size is 4.3 and it decreases with increasing expenditure. The average age of household heads is 49 years, varying only slightly between expenditure quartiles.

Expenditures increased with higher educational level and years of education. Moreover, a higher level of education tends to increase female labor participation in urban areas i.e. the women have employment outside the house. Share of female labor participation slightly exceeds 50 percent, with a fairly constant pattern across expenditure quartiles. The occupation of household head was divided into three groups. Most respondents were housewives mainly staying at home, which, however, decline with increasing household expenditures. The share of “housewife” does not differ in direction with the share of “female labor” and the likely reason is that there are as many employed women as housewives (who were household heads) in each quartile; the lowest proportion of female household head is being in the highest quartile. Unsurprisingly, the share of white collar jobs increases at higher expenditure quartiles.

The proportion of households with children under age 5 declines in higher quartiles whereas the proportion of household with children above age 5 is relatively stable among expenditure quartiles. The prevalence of long-term diseases among household members is quite high: in 41 percent of interviewed households respondents indicated that some member or members of the family were suffering from a long-term ailment[10]. In addition, 93.4 percent of the respondents know that some health problems are linked to food quality.

[10] Respondents/household members having chronic ailments such as diabetes, cancer, joint problems, and hypertension, etc.

Table 4.1 Household characteristics by location and expenditure quartile

Variable	Definition	Entire Sample	Location		Expenditure quartile			
			BKK	CNX	Q1	Q2	Q3	Q4
	Sample size	500	300	200	125	125	125	125
Expenditure	Annual per capita total household expenditure (baht)	110,934.50	117,940.90	100,424.90	40,214.19	66,175.81	101,126.80	236,221.20
Size	Household size (persons)	4.3	4.8	3.7	5.2	4.1	4.2	3.8
Age	Age (years)	49.2	49.1	49.3	50.5	51.9	49.5	44.8
Education	Education years of household heads	10.2	10.0	10.4	8.0	9.9	10.2	12.8
Gender	Gender of household head (%) Male	25.8	28.7	21.5	31	30	31	37
	Female	74.2	71.3	78.5	94	95	94	88
Female labor	Dummy for female participation in labor force (%)	53.4	46.0	64.5	52.8	56.8	52.8	51.2
		[267]	[138]	[129]	[66]	[71]	[66]	[64]
Health awareness	Dummy of awareness of health problems linked to food quality (%)	93.4	91.7	96.0	91.2	91.2	94.4	96.8
		[467]	[275]	[192]	[114]	[114]	[118]	[121]
Disease	Dummy for household members being affected by long-term diseases (%)	41	38.7	44.5	41.6	45.6	40.0	36.8
		[205]	[116]	[89]	[52]	[57]	[50]	[46]
White collar	Dummy for white collar jobs (%)	14.2	14.3	14.0	9.6	10.4	15.2	21.6
		[71]	[43]	[28]	[12]	[13]	[19]	[27]
Workers	Dummy for workers or entrepreneurs (%)	39.6	33.7	48.5	36.8	40.8	40.8	40.0
		[198]	[101]	[97]	[46]	[51]	[51]	[50]
Housewife	Dummy for housewives (%)	46.2	52	37.5	53.6	48.8	44.0	38.4
		[231]	[156]	[75]	[67]	[61]	[55]	[48]
Distance 1	Distance to a traditional market (km)	1.8	1.7	2.0	1.6	1.8	1.7	2.1
Distance 2	Distance to a modern retailer (km)	2.6	2.5	2.6	2.5	2.5	2.2	3.1
Child (<5yrs)	Dummy for children in household below 5 years old	15.4	17.3	12.5	21.6	15.2	13.6	11.2
		[77]	[52]	[25]	[27]	[19]	[17]	[14]
Child (>5yrs)	Dummy for children in household above 5 years old	31.6	31.7	31.5	35.2	27.2	33.6	30.4
		[158]	[95]	[63]	[44]	[34]	[42]	[38]

Note: Numbers in the parentheses are numbers of households.

Source: Calculated from field survey data.

Expenditure consumption patterns for aggregated food items

The consumption patterns of aggregate food items are reflected in terms of budget share, per capita expenditure and per capita quantity consumption (Table 4.2 and Table 4.3). The group of goods to which households allocate their available budget at the first stage of the two-stage budgeting process are food at home, food away from home and non-food. The average budget share of food at home is 0.23, declining towards higher expenditure quartiles. In contrast, the trend increases towards the richest quartile for the share of food away from home. This result is not surprising in light of observations that urban lifestyles tend to favor food that requires less time to prepare (Huang and Bouis, 1996).

At the second stage, food at home expenditure is allocated to particular items such as fresh fruits, fresh vegetables, rice and glutinous rice, meat, fish and seafood, other fresh food, preserved fruits and vegetables, and other preserved food. In this stage, the share of each aggregate food commodity is calculated as the ratio of expenditure on each item to total group expenditure. Households spent the most on fresh fruits (budget share is 0.20) followed by other preserved food (0.17) and other fresh food (0.17). The average budget shares of rice and vegetables slightly decline at higher quartiles. Those of the other food commodities are stable. Notably, households annually consumed 146.70 kilograms of fresh fruits per capita, with the richest quartile consuming twice more than the poorest quartile. The annual average per capita consumption of rice does not differ much between quartiles. In contrast, a notable increase in quantities consumed by expenditure quartiles is observed for meat, fish and seafood, other fresh food, preserved fruits and vegetables and other preserved food. As expected, the budget share of individual food items by expenditure quartile showed that high-income households tend to consume more high-value food items.

Table 4.2 Share of aggregated food items by location and expenditure quartile

Basic categories	Entire sample	Location		Expenditure Quartile			
		BKK	CNX	Q1	Q2	Q3	Q4
Annual per capita total household expenditure	110,934.50	117,940.90	100,424.90	40,214.19	66,175.81	101,126.80	236,221.20
First budgeting-stage							
Food at home	0.23	0.21	0.26	0.31	0.27	0.20	0.14
	[19,783.48]	[19,197.11]	[20,663.04]	[12,074.55]	[17,856.31]	[20,391.56]	[28,811.50]
Food away from home	0.15	0.14	0.16	0.13	0.15	0.16	0.16
	[16,679.44]	[17,642.96]	[15,234.17]	[5,366.50]	[9,841.59]	[16,059.17]	[35,450.51]
Non-food	0.62	0.64	0.59	0.56	0.58	0.64	0.70
	[74,471.56]	[81,100.81]	[64,527.69]	[22,773.14]	[38,477.91]	[64,676.02]	[171,959.2]
Second budgeting-stage							
Fresh fruits	0.20	0.20	0.20	0.19	0.20	0.20	0.21
	[4,009.39]	[3,943.36]	[4,108.45]	[2,260.58]	[3,730.21]	[4,090.12]	[5,956.66]
Fresh vegetables	0.11	0.10	0.12	0.12	0.12	0.11	0.09
	[2,158.73]	[1,970.27]	[2,441.41]	[1,460.91]	[2,157.35]	[2,292.42]	[2,724.24]
Rice and glutinous rice	0.10	0.11	0.08	0.12	0.10	0.09	0.07
	[1,531.38]	[1,688.83]	[1,295.21]	[1,330.52]	[1,535.69]	[1,561.37]	[1,697.96]
Meat	0.08	0.08	0.08	0.09	0.08	0.07	0.07
	[1,491.51]	[1,453.69]	[1,548.23]	[1,086.95]	[1,421.84]	[1,397.14]	[2,060.10]
Fish and seafood	0.13	0.14	0.12	0.13	0.12	0.14	0.12
	[2,807.03]	[2,885.51]	[2,689.30]	[1,647.48]	[2,427.85]	[3,095.49]	[4,057.29]
Other fresh food	0.17	0.16	0.19	0.15	0.18	0.16	0.19
	[3,419.26]	[3,062.50]	[3,954.40]	[1,826.21]	[3,131.20]	[3,237.73]	[5,481.91]
Preserved fruits and vegetables	0.05	0.04	0.05	0.03	0.04	0.06	0.06
	[1,004.19]	[922.06]	[1,127.39]	[410.67]	[620.30]	[1,152.33]	[1,833.47]
Other preserved food	0.17	0.17	0.17	0.17	0.16	0.17	0.18
	[3,361.99]	[3,270.88]	[3,498.66]	[2,051.23]	[2,831.88]	[3,564.97]	[4,999.87]

Note: Number in parentheses is average annual per capita expenditure (baht).

Source: Calculated from field survey data.

Table 4.3 Annual average per capita consumption (kilogram) of aggregate food items by location and expenditure quartile

Basic categories	Entire sample	Location		Expenditure Quartile			
		BKK	CNX	Q1	Q2	Q3	Q4
Fresh fruits	146.7	123.99	180.77	97.09	150.56	137.74	201.41
Fresh vegetables	74.13	59.47	96.13	53.42	79.68	77.54	85.89
Rice & glutinous rice	70.65	75.84	62.86	65.86	72.47	70.73	73.54
Meat	20.12	19.01	27.78	14.3	19.66	18.85	27.66
Fish & seafood	28.86	27.52	30.86	21.45	26.95	30.89	36.14
Other fresh food	76.05	67.37	89.06	44.32	72.92	74.18	112.77
Preserved F & V	26.12	22.17	32.04	10.82	19.73	28.48	45.43
Other preserved food	48.37	49.05	47.34	33.01	48.37	50.69	61.39

Source: Calculated from field survey data.

The expenditure consumption patterns for various fruit and vegetable items allow an in-depth analysis. With all household samples, rambutan (61.8 percent) was the most favored, followed by mangosteen (61.4 percent), tangerine (56.6 percent), apple (37.4 percent) and mango (32.4 percent). The vegetables commonly consumed are Chinese cabbage (61 percent), cabbage (58.2 percent), kale (54 percent) and bird pepper (51 percent). There are other kinds of fresh produce consumed by urban households. Fruits were further classified into two categories, namely, local and non-local fruits, examples of the latter being apple, avocado, cherry, kiwi, peach and strawberry. Table 4.4 presents the budget share, per capita expenditure and per capita quantity consumption for each group of fruits, by location and expenditure quartile. Unsurprisingly, the average share of the entire sample for local fruits consumption is 5 times higher than for non-local fruits; annual per capita consumption for local fruits is 133 kilograms, for non-local fruits it is 14 kilograms. An increasing share of non-local fruits can be observed at higher expenditure levels, with 24 kilograms per capita per year at the highest quartile. By location, the quantity consumption of non-local fruits is fairly homogeneous between the two cities although per capita expenditure value of this group is higher in Bangkok. The most plausible explanation is that some of the non-local fruits are grown in the hilly areas in northern Thailand, making these more accessible and cheaper to households in Chiang Mai.

Table 4.4 Budget share, annual expenditure per capita and annual average per capita consumption (kilogram) of local and non-local fruits by location and expenditure quartile

Fresh fruits	Entire	Location		Expenditure quartile			
	Sample	BKK	CNX	Q1	Q2	Q3	Q4
Local fruits							
Budget share	0.85	0.82	0.90	0.91	0.87	0.83	0.79
Expenditure	3233.86	3065.46	3486.45	2019.68	3206.28	3250.55	4458.91
Quantity	132.63	109.98	1666.61	91.10	137.76	124.64	177.03
Non-local fruits							
Budget share	0.15	0.18	0.10	0.09	0.13	0.17	0.21
Expenditure	775.54	877.90	622.00	240.90	523.92	839.57	1497.75
Quantity	14.04	14.01	14.1	5.99	12.8	13.11	24.28

Note: Non-local fruits are apple, avocado, cherry, kiwi, grape, peach pear, persimmon, strawberry Budget share for each group was calculated as a ratio of group expenditure on total fruit expenditure.

Source: Calculated from field survey data.

Fresh vegetables are divided into 7 major groups: leafy vegetables (i.e. cabbage, kale, and Chinese cabbage); fruit vegetables (i.e. tomato, cucumber, and bird pepper); root and bulb (i.e. carrot, onion, and ginger); inflorescence and stem (i.e. broccoli, cauliflower, and asparagus); suds and pod (i.e. long bean); mushrooms; and other local vegetables. Leafy vegetables have the highest share, with a value of 42 percent and a consumed quantity of 30 kilograms per capita per year. This reflects the wide variety of leafy vegetables sold throughout the year in both traditional and modern retail outlets. The second and third ranks are occupied by fruit vegetables and root & bulb, with a share of 25 and 14 percent, respectively (Table 4.5). The findings are in conjunction with a study of Schmidt and Isvilanonda (2002), which indicated that the most important local vegetable groups in Thailand were the leafy ones, followed by fruit vegetables.

Table 4.5 Budget share, annual expenditure per capita and annual average per capita consumption (kilogram) for kinds of vegetables by location and expenditure quartiles

Fresh vegetables	Entire	Location		Expenditure quartile			
	Sample	BKK	CNX	Q1	Q2	Q3	Q4
Leafy vegetables							
Budget share	0.42	0.44	0.39	0.43	0.41	0.42	0.42
Expenditure	797.08	831.49	745.47	549.15	758.00	839.67	1041.50
Quantity	29.99	25.60	36.57	22.62	34.06	30.45	32.82
Fruit vegetables							
Budget share	0.25	0.25	0.26	0.26	0.25	0.26	0.25
Expenditure	568.05	483.30	695.18	396.62	566.01	589.99	719.59
Quantity	22.33	17.62	29.41	16.68	23.51	21.82	27.33
Tuber and bulb							
Budget share	0.14	0.13	0.14	0.12	0.14	0.13	0.16
Expenditure	320.98	280.24	382.09	195.37	325.09	312.96	450.49
Quantity	11.24	7.55	16.79	6.82	11.31	10.79	16.06
Inflorescence and stem							
Budget share	0.08	0.09	0.08	0.09	0.08	0.08	0.09
Expenditure	171.20	165.07	180.41	132.13	130.76	183.57	238.36
Quantity	4.33	3.34	5.82	3.61	4.17	4.43	5.13
Suds and pod							
Budget share	0.05	0.05	0.05	0.06	0.05	0.05	0.03
Expenditure	84.83	69.52	107.79	78.50	103.91	84.02	72.88
Quantity	2.57	1.99	3.45	2.34	3.18	2.64	2.13
Mushroom							
Budget share	0.05	0.03	0.08	0.04	0.06	0.05	0.05
Expenditure	201.09	123.58	317.35	103.49	252.18	268.08	180.60
Quantity	2.04	1.22	3.28	1.22	2.43	2.60	1.91
Others							
Budget share	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Expenditure	15.49	17.08	13.12	5.64	21.39	14.13	20.81
Quantity	0.60	0.44	0.84	0.14	1.08	0.69	0.50

Note: Budget share for each group was calculated as a ratio of group expenditure on total vegetable expenditure.

Source: Calculated from field survey data.

Expenditure consumption patterns for fresh fruits and vegetables from different supply chain-related attributes by location and expenditure quartile

Safety and quality are credence attributes so that product identification needs to be preserved at every stage of the market chain. Consumers usually rely on direct indicators such as appearance, smell and color, or formal declarations and brand name but they should always be able to find the information on the safety of a product at the point of purchase. This subsection presents the derived measure of budget share, per capita expenditure, and per capita consumed quantity of fresh fruits and vegetables with different kinds of indications. Grunert (2005) stated that product information such as label, certificate, place of purchase and place of origin are increasingly used by consumers as decision reference to purchase fresh produce. In this regard, specific questions were included to assess household expenditure and quantity consumption patterns for fresh fruits and vegetables (FFV) characterized by product or process attributes. The attributes are place of purchase, safety and quality indications, convenience and source of production. The share of FFV from different supply chains[11] was calculated as a ratio of group expenditure to food at home expenditure.

Place of purchase is one of the main criteria to indicate consumers' confidence (Oates, 2006). The growing demand for safe and quality food has received attention from modern retail outlets such as supermarkets, the evidence being the growing shelf-space of high-value fresh produce (Wiboonpongse and Sriboonchitta, 2004). For the purpose of this study, two major types of retail outlets, namely, traditional retailers and modern retailers were considered. Traditional retailers in our context consist of wet markets, street shops and mobile vendors (those selling goods by driving around city neighborhoods and housing areas in pick-up trucks), whereas modern retailers are super- and hypermarkets, convenience stores and specialty (such as organic) shops like the DoiKham stores.

[11] Two focus alternative of each supply chain-related attributes were presented, while the share of other alternative or non- specific group were conflated with "other fresh food (OFF)".

Fresh produce are still mainly bought at traditional retail outlets, with budget shares of 0.16 for fruits and 0.09 for vegetables. Bangkok households have a higher share of purchased fruits and vegetables from modern retailers than those in Chiang Mai. Among expenditure quartiles, the shares of purchased fruits and vegetables from traditional retailers slightly decline toward higher quartiles. In contrast, modern retail outlets seem to be less important for fresh fruits and vegetables so far, particularly for higher income households. However, a two-fold budget share increase from the poorest to the richest expenditure quartile indicates that high income households purchase more fresh produce from supermarkets and specialty shops than low income households (Table 4.6).

Table 4.6 Budget shares of fresh fruits and vegetables from different place of purchase by location and expenditure quartile

Item	Supply chain related attribute	Entire Sample	Location		Expenditure Quartile			
			BKK	CNX	Q1	Q2	Q3	Q4
Fresh fruits	Traditional retailers							
	Budget share	0.16	0.16	0.17	0.17	0.18	0.16	0.15
	Expenditure	3197.23	3028.68	3450.05	1973.64	3293.98	3157.67	4363.63
	Quantity	122.16	100.24	155.04	86.91	135.38	110.13	156.23
	Modern retailers							
	Budget share	0.03	0.04	0.02	0.02	0.02	0.03	0.05
	Expenditure	699.33	810.03	533.27	237.67	344.17	771.79	1443.70
	Quantity	18.34	18.55	18.02	7.21	11.27	19.82	35.04
Fresh vegetables	Traditional retailers							
	Budget share	0.09	0.08	0.10	0.11	0.10	0.08	0.06
	Expenditure	1681.09	1445.57	2034.37	1306.68	1894.15	1699.35	1824.18
	Quantity	61.06	44.89	85.31	49.58	72.49	57.35	64.83
	Modern retailers							
	Budget share	0.02	0.02	0.01	0.01	0.01	0.02	0.03
	Expenditure	422.35	517.28	279.96	138.65	252.88	496.87	800.99
	Quantity	10.25	12.59	6.74	3.54	6.93	11.46	19.07

Note: The share of aggregate fresh fruits and fresh vegetables in food at home expenditure is 0.20 and 0.11, respectively.

Source: Calculated from field survey data.

In general, freshness and appearance are key criteria in purchasing fresh produce (Penau *et al*., 2006; Sakagamiet *et al*., 2006). However, direct observable indicators such as formal labels and brands are increasingly important for consumer's decision making. In Thailand, various brands and certification schemes exist in the market informing consumers of differences in production process (with brands) and of safety and quality levels (with a certification statement). For this sub-section, direct observable indicators were segmented into two groups: (i) informal indications such as appearance and freshness of products and (ii) formal indications including safety labels or brand names.

The expenditure share shows that direct observable informal indicators were the most important selection factor in the decision to purchase fresh produce. A formal indication has less importance. The quantity consumption for fresh vegetables with formal labels increases by a factor of more than two in the higher expenditure quartiles (Table 4.7). The results indicate that demand for fresh produce with formal indications can be expected to increase with rising household income. However, the missing share value for each fresh produce indicates that some households probably did not pay much attention to food safety and quality indications.

Table 4.7 Budget shares of fresh fruits and vegetables from different direct safety indications by location and expenditure quartile

Item	Supply chain related attribute	Entire Sample	Location		Expenditure Quartile			
			BKK	CNX	Q1	Q2	Q3	Q4
Fresh fruits	Informal indications							
	Budget share	0.15	0.16	0.14	0.15	0.15	0.15	0.15
	Expenditure	2995.76	3085.62	2860.97	1818.11	2741.96	3119.83	4303.16
	Quantity	111.08	99.96	127.76	77.45	114.90	106.13	145.84
	Formal indications							
	Budget share	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Expenditure	173.65	225.65	95.66	79.82	98.46	231.41	284.92
	Quantity	3.99	4.54	3.15	1.98	2.95	4.36	6.66

Table 4.7 (Continued)

Item	Supply chain related attribute	Entire Sample	Location		Expenditure Quartile			
			BKK	CNX	Q1	Q2	Q3	Q4
Fresh vegetables	Informal indications							
	Budget share	0.08	0.08	0.08	0.09	0.09	0.08	0.06
	Expenditure	1597.85	1489.58	1760.26	1128.60	1764.39	1560.44	1937.97
	Quantity	55.72	45.60	70.90	40.21	67.28	49.93	65.46
	Formal indications							
	Budget share	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	Expenditure	279.11	286.83	267.53	94.67	215.45	387.24	419.09
	Quantity	6.61	6.42	6.88	2.33	6.33	8.68	9.08

Note: The share of aggregate fresh fruits and fresh vegetables in food at home expenditure is 0.20 and 0.11, respectively.

Source: Calculated from field survey data.

Over the past decade, the variety of fresh produce being sold has greatly diversified in terms of special convenience attributes. Higher education levels, more disposable income, and changes in time value perception have led to an increasing desire for convenient fresh produce, especially in large cities or urban conglomerates (Sa-nguanpuag and Kanlayanarat, 2007; Florkowski, 2006; Kanlayanarat and McGlasson, 2003). In our context, “convenient fresh produce” refers to fruits and vegetables that are minimally processed by washing, peeling, cutting and packing.

Interestingly, the share of minimally processed fruits is 50 percent from specific group expenditure, while the share of minimally processed vegetable is lower than that of fresh fruits. The differences in the share of minimally processed fresh produce between expenditure quartiles are narrow (Table 4.8). This can be attributed to the fact that the volume and variety of fresh-cut produce have increased in both traditional and modern retail outlets in Thailand (Rattanapanone *et al*., 2000) with prices that are affordable to poorer households.

Table 4.8 Budget shares of fresh fruits and vegetables for convenience attribute by location and expenditure quartile

Item	Supply chain related attribute	Entire Sample	Location		Expenditure Quartile			
			BKK	CNX	Q1	Q2	Q3	Q4
Fresh fruits	Not minimally processes							
	Budget share	0.10	0.09	0.10	0.10	0.10	0.09	0.09
	Expenditure	1954.62	1809.03	2173.00	1130.04	1964.40	2089.34	2634.69
	Quantity	79.78	65.85	100.67	51.81	86.17	74.18	107.00
	Minimally processes							
	Budget share	0.10	0.10	0.09	0.08	0.10	0.10	0.11
	Expenditure	2032.17	2126.45	1890.76	1127.03	1751.09	1978.74	3271.82
	Quantity	65.87	57.96	77.74	45.07	63.66	62.25	92.52
Fresh vegetables	Not minimally processes							
	Budget share	0.05	0.04	0.06	0.05	0.06	0.04	0.04
	Expenditure	893.56	687.99	1201.91	648.47	1050.59	884.85	990.33
	Quantity	33.48	22.71	49.63	24.24	44.72	31.51	33.45
	Minimally processes							
	Budget share	0.06	0.06	0.05	0.06	0.06	0.06	0.05
	Expenditure	1212.09	1262.54	1136.41	759.39	1044.22	1334.09	1710.66
	Quantity	37.67	34.62	42.26	27.77	33.02	38.24	51.66

Note: The share of aggregate fresh fruits and fresh vegetables in food at home expenditure is 0.20 and 0.11, respectively.

Source: Calculated from field survey data.

The demand of Asian consumers for tropical and temperate fruits is expected to rise. Countries meet local demand by local production and importation. In Thailand, about 49 percent of imported fruits are from China. The fruits include apple, peach, grape and orange, and the vegetables include carrot, cabbage, broccoli and others (National Food Institute 2009). Product characteristics with different country of origin can induce different consumption behaviors as they could be perceived as exotic products. Mergenthaler *et al.* (2006) stated that region of production can influence the safety level of fresh produce in different ways. In addition, higher incomes allow consumers to purchase a greater variety of fresh products like off-season products or exotic fresh products.

Table 4.9 Budget shares of fresh fruits and vegetables from different source of production by location and expenditure quartiles

Item	Supply chain related attribute	Entire Sample	Location		Expenditure Quartile			
			BKK	CNX	Q1	Q2	Q3	Q4
Fresh fruits	Domestic							
	Budget share	0.16	0.15	0.19	0.16	0.18	0.16	0.16
	Expenditure	3273.30	2936.99	3777.76	1878.49	3340.64	3283.60	4590.46
	Quantity	129.36	101.34	171.38	84.39	139.31	121.72	172.00
	Import							
	Budget share	0.02	0.02	0.01	0.01	0.02	0.02	0.03
	Expenditure	446.18	543.82	299.73	137.06	256.17	456.05	935.45
	Quantity	8.00	8.22	7.66	3.57	7.20	5.51	15.72
Fresh vegetables	Domestic							
	Budget share	0.10	0.09	0.12	0.11	0.11	0.10	0.08
	Expenditure	2013.43	1728.12	2441.41	1292.27	2068.70	2127.94	2564.83
	Quantity	68.66	50.34	96.16	48.03	77.13	68.48	81.02
	Import							
	Budget share	0.001	0.001	0.00	0.00	0.001	0.001	0.0003
	Expenditure	11.84	19.73	0.00	1.65	14.69	22.14	8.88
	Quantity	0.27	0.45	0.00	0.02	0.37	0.49	0.19

Note: The share of aggregate fresh fruits and fresh vegetables in food at home expenditure is 0.20 and 0.11, respectively.

Source: Calculated from field survey data.

Most household respondents were able to identify the origin of purchase of fresh produce. Sample households still relied on fruits and vegetables from domestic production, with imported fruits having a rather small share of 2.0 percent. This could be related to the availability of a wide variety of local fresh produce throughout the year. Moreover, the Royal Project Foundation, “DoiKam”, produces and markets (with the DoiKam brand) temperate fresh fruits and vegetables from the regional production hubs in Northern Thailand (Nissen *et al*., 2006). However, the consumption quantity of imported fruits does increase between the poorest and the richest quartile, although not in a strong manner (Table 4.9).

Expenditure consumption patterns for fresh fruits and vegetables from different supply chain-related attributes by education of household head

Earlier studies have examined the influence of the educational level of household head on household expenditure and food consumption patterns (Mergenthaler *et al*., 2009; Bhadrakom, 2008). Higher educated consumers tend to be more open-minded in their food selection and quickly adopt new varieties of foods (Senauer *et al*., 1993). Additionally, highly educated consumers are expected to have more knowledge and higher awareness of food safety and quality aspects. This study assumes that household heads are the major food purchaser or have the major influence in household decision making regarding food purchase. In the preliminarily results, household head's the educational level was categorized into "undergraduate or below" and "graduate" (Table 4.10). Households with a higher educational level are expected to increasingly consume fresh fruits and vegetables with emerging supply chain-related attributes.

The budget share and consumed quantities of purchased fruits and vegetables from modern retail outlets show an upward trend associated with higher educational level of household heads. This is in line with the observation that modern retailers have penetrated the higher educated and younger consumer groups (Gorton *et al*., 2009). The increasing share of fresh produce with a formal label reflects the greater awareness of and concern for safety among better-educated consumers, particularly for fresh vegetables. The share of fresh produce that are minimally processed, particularly fresh fruits, has slightly increased with a higher educational level. This reflects the increasing opportunity cost of time. However, the share of imported fresh produce does not differ much between education groups. This could be explained by the variety of domestic fresh produce available year round and the fact that temperate fruits are produced in the northern region of Thailand, filling the demand for exotic products from other sources of origin.

Table 4.10 Budget shares, expenditure and quantity of disaggregate fresh fruits and vegetables by education of household head

Items from different supply chain related attributes		Entire sample	Educational level	
			Undergraduate level or below	Graduate level
Place of purchases				
Fruits from traditional retailers	Budget share	0.16	0.17	0.14
	Expenditure	3197.23	3341.16	2812.00
	Quantity	122.16	128.47	105.28
Fruits from modern retailers	Budget share	0.03	0.02	0.06
	Expenditure	699.33	491.68	1255.11
	Quantity	18.34	14.01	29.93
Vegetables from traditional retailers	Budget share	0.09	0.09	0.07
	Expenditure	1681.09	1848.51	1233.00
	Quantity	61.06	69.13	39.48
Vegetables from modern retailers	Budget share	0.02	0.01	0.03
	Expenditure	422.35	319.47	697.71
	Quantity	10.25	8.70	14.38
Safety and quality indications				
Fruits with informal indications	Budget share	0.15	0.15	0.15
	Expenditure	2995.76	3024.49	2918.89
	Quantity	111.08	115.16	100.16
Fruits with formal indications	Budget share	0.01	0.01	0.01
	Expenditure	173.65	113.25	335.32
	Quantity	3.99	2.86	7.02
Vegetables with informal indications	Budget share	0.08	0.08	0.07
	Expenditure	1597.85	1688.47	1355.30
	Quantity	55.72	62.50	37.58
Vegetables with formal indications	Budget share	0.01	0.01	0.02
	Expenditure	279.11	239.85	384.20
	Quantity	6.61	5.82	8.71

Table 4.10 (Continued)

Items from different supply chain related attributes		Entire sample	Educational level	
			Undergraduate level or below	Graduate level
Minimally processed attribute				
Fruits without minimally processes	Budget share	0.10	0.10	0.09
	Expenditure	1954.62	2009.27	1808.35
	Quantity	79.78	82.44	72.68
Fruits with minimally processes	Budget share	0.10	0.09	0.12
	Expenditure	2032.17	1875.47	2451.51
	Quantity	65.87	63.31	72.74
Vegetables without minimally processes	Budget share	0.05	0.05	0.04
	Expenditure	893.56	953.88	732.10
	Quantity	33.48	38.17	20.92
Vegetables with minimally processes	Budget share	0.06	0.06	0.06
	Expenditure	1212.09	1211.72	1213.09
	Quantity	37.67	39.18	33.64
Source of production				
Domestic fruits	Budget share	0.16	0.16	0.17
	Expenditure	3273.30	3239.47	3363.85
	Quantity	129.36	129.16	129.88
Imported fruits	Budget share	0.02	0.02	0.03
	Expenditure	446.18	341.03	727.62
	Quantity	8.00	6.74	11.38
Domestic vegetables	Budget share	0.10	0.10	0.09
	Expenditure	2013.43	2065.72	1873.48
	Quantity	68.66	74.72	52.47
Imported vegetables	Budget share	0.001	0.001	0.001
	Expenditure	11.84	11.54	12.65
	Quantity	0.27	0.26	0.30

Source: Calculated from field survey data.

Consumers' attitude toward safety and quality attributes.

In order to generate information on consumer attitude, household respondents were asked additional questions concerning safety and quality aspects (Table 4.11). Consistent with the findings of the National Statistics Office's (2005), most households agreed that consuming fruits and vegetables is useful for health. Therefore, we can assume that this relatively high share of sample households reflects the rising consumer interests in fruits and vegetables as healthy food. Consumers are now more confident to consume fresh produce from fresh market compared to five years ago. Nonetheless, about 41 percent of households agreed that quality and safety FFV are only achieved in supermarkets or specialty shops such as Doi Kham and Lemon Farm. Furthermore, most respondents agreed that control of production processes increases confidence in a product. This was further supported by a 94 percent agreement of sample households that government agencies should provide more budgets to improve the capacity of farmers and producers to implement strict quality control measures within the production system.

Table 4.11 Proportion of sample households with their attitude for fresh fruits and vegetables related to quality and safety attributes.

Statements	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Consuming fruits and vegetables is useful for health	74.6 [373]	24.4 [122]	-	-	-
Consumers are more confident to consume safety fruits and vegetables from fresh market, compared to five years ago.	7.6 [38]	37.8 [174]	30.4 [152]	22.8 [114]	4.2 [21]
Quality & safety fruits and vegetables are only in supermarkets and specific shops such as Doi Khum shop, lemon farm etc.	9.0 [45]	32.2 [161]	13.8 [69]	39.8 [199]	5.0 [25]
Higher price of fruits and vegetables have better quality and safety	9.4 [47]	33.0 [165]	15.2 [76]	36.2 [181]	5.8 [29]

Table 4.11 (Continued)

Statements	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Controlling production processes can create more confidence for cooking to consumers.	28.0 [140]	58.8 [294]	8.2 [41]	4.4 [22]	0.6 [3]
Thai government should spend budget to support farmers and producers for controlling strictly in production system.	61.4 [307]	32.4 [162]	4.4 [22]	1.4 [7]	0.2 [1]

Note: Numbers of sample households are presented in the parentheses.

Source: Calculated from field survey data.

Consumer preferences and their trust in different public and private food labels were assessed (Table 4.12). Various certificate logos exist and are usually printed on a specific product package. For this study, four common certification labels were drawn to assess respondents' confidence of FFV consisting of "safety food" (issued by Ministry of Public Health), "Q sign" (issued by the National Bureau of Agricultural Commodity and Food Standard), "Organic Thailand" (issued by the Department of Agriculture) and "ACT" (accredited by the International Federation of Organic Agriculture Movements or IFOAM). More than 70 percent of respondents trust government certificates more than private certifications, confirming the finding of Vanit-Aunuchai (2006).

Table 4.12 Proportion of sample households with their attitudes for fresh fruits and vegetables in relation to labels and brands

Descriptive	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I trust the "Safety Food" label.	21.0	54.8	16.0	7.0	0.4
	[105]	[274]	[80]	[35]	[2]
I trust the "Q" label.	19.0	55.4	16.4	7.4	0.4
	[95]	[277]	[82]	[37]	[2]
I trust the "Organic" label from public	16.6	54.2	18.8	7.6	1.0
sector.	[83]	[271]	[94]	[38]	[5]
I trust commercial "Organic" label from	9.4	44.8	28.0	14.0	1.8
private sector.	[47]	[224]	[140]	[70]	[9]
Package is used as a tool to create	7.8	46.2	22.0	21.4	2.6
confidence probably in the claim promised	[39]	[231]	[110]	[107]	[13]
fruits and vegetables					
I trust fresh fruits and vegetables which are	5.0	42.2	32.4	18.0	1.4
certified by private brands.	[25]	[211]	[162]	[90]	[7]
I trust fresh fruits and vegetables which are	46.8	42.0	7.4	2.6	0.6
certified by Royal project brand.	[234]	[210]	[37]	[13]	[3]

Note: Numbers of sample households are presented in the parentheses.

Source: Calculated from field survey data

Public sector labels were trusted more by consumers than commercial private sector labels. A particularly high consumer confidence on the quality and safety of fresh produce was found for the "DoiKham" brand of the Royal Project Foundation. The high percentage could be explained by consumers' knowledge of the strict product safety control in the supply chain system of Doi-Kham, including food product distribution to marketing agents and end consumers (Isvilanonda *et al*. 2006). In contrast, private brands and logos only gained the confidence of 47.2 percent of consumers.

Empirical Results

Completed demand analysis

1. First budgeting stage analysis

In the first budgeting stage, total household expenditure is allocated to three broad groups namely food at home, food away from home and non-food as shown in the utility tree of Figure 3.1. The Working-Leser Model (equation 3.1) is employed to derive expenditure elasticity when prices are missing as the results show in Table 4.13. Total per capita expenditure is statistically significant for the food at home equation. The derived food at home expenditure is inelastic, indicating that it is a normal good among urban households in Bangkok and Chiang Mai and confirming the results of a recent study (Bhadrakom, 2008). The negative sign of household size coefficient in food at home determines the negative directions between the number of household members and the expenditure share on food at home. The negative role of education on food at home consumption is statistically significant at 5 percent significance level, indicating that higher education of a household head tends toward less consumption of food at home. Expenditure is insignificant for food away from home, perhaps because of the variety of options to purchase it. In our case, the food away from home group consists of food served by street food shops, also affordable to poorer households, and up-scale restaurants patronized by the relatively richer segments of the population. However, the older the household head, the higher the expenditure share on food at home tends to be, whereas the share of food away from home declines. The impact of health awareness among urban households is that people become more cognizant of the health risks of food consumed away from home.

Table 4.13 Demand estimation for broad group expenditure

Variables	Food at home	Food Away From Home	Non-food
Annual per capita total	-0.1115***	0.0073	0.1042
expenditure (log)	[0.0070]	[0.0087]	
Size (log)	-0.0912***	-0.0015	0.0927
	[0.0092]	[0.0113]	
Female labor	-0.0059	-0.0089	0.0149
	[0.0093]	[0.0115]	
Education	-0.0021**	0.0007	0.0015
	[0.0010]	[0.0012]	
White collars	-0.0167	-0.0011	0.0178
	[0.0137]	[0.0168]	
Workers	-0.0228**	-0.0187	0.0415
	[0.0100]	[0.0123]	
Children (> 5 years)	-0.0074	-0.014	0.0214
	[0.0097]	[0.0119]	
Age	0.0005*	-0.0008**	0.0003
	[0.0003]	[0.0004]	
Bangkok	-0.0131	-0.0204*	0.0335
	[0.0092]	[0.0113]	
Health awareness	0.0171	-0.0816***	0.0645
	[0.0172]	[0.0211]	
Constant	1.6246***	0.2068**	-0.8314
	[0.0845]	[0.1039]	
Chi-square	**452.83**	**28.72**	
Mean budget share	**0.23**	**0.15**	**0.62**
Group expenditure elasticity	**0.52**	**1.05**	**1.17**

Note: *, **, *** Estimates are significant at the 10%, 5% and 1% level, respectively. Coefficient of non-food group is calculated from the adding-up restrictions. Numbers in parentheses are standard errors.

Source: Estimated based on household survey data.

2. Aggregate demand analysis (second budgeting stage)

The demand parameters for aggregate commodities within the food at home group are estimated at the second budgeting stage using the LAIDS model. However, the analysis started with the approximation process for market prices aggregate food items by the comprehensive approach proposed by Alfonzo and Peterson (2006), as depicted in Appendix Table A2. According to our household data, this approach did not reveal statistically significant results for cluster dummies. Hence, we decided to rely on unit quantities in order to keep the measurement error problem at reasonable levels. Missing values due to zero consumption were replaced by district average weighted by total household expenditures. The correlation structure of price among aggregate items has mix co- linearity (Appendix B), thus the Tronqvist price index was chosen to deflate food at home expenditure in the demand system stage two. The probit results needed for the Shonkwiler and Yen procedure (equation 3.2) for 4 food items[12] are presented in Appendix Table A3, while the parameters from the LAIDS models (equation 3.3-3.10) are presented in Table 4.14. All expenditure share equations for aggregate food items are significant at 5 percent level according to chi-square test.

The expenditure coefficients are significant for fruits, rice & glutinous rice, meat and fish & seafood. Most own-price coefficients are also statistically significant, at least at 10 percent significant level. Household size has a statistically negative impact on the share of fresh fruits, fresh vegetables, other fresh food and preserved fruits & vegetables. In contrast, household size exhibits a statistically positive impact on rice & glutinous rice and fish & seafood. The female labor force participation variable yields a statistically significant negative impact on the share of meat and a statistically significant positive impact on the shares of other fresh foods and preserved fruits & vegetables. The level of education positively influences demand for fruits, rice, meat, other fresh food and preserved fruits & vegetables. The findings are

[12] Some households reported very low frequencies of zero consumption for fresh fruits (1 household) and fresh vegetables (4 households), while non-zero consumption ws reported for other fresh food and other preserved food. Thus we could not estimate the selective estimators for those items.

in line with the assumption that better-educated household heads tend to consume healthier food products.

Table 4.14 Conditional aggregate demand system estimates for food categories

	FF	FV	RG	Meat	FS	OFF	PFV	OPF
FAH (log)	-0.0288**	0.0036	-0.0568***	0.0282***	0.0423***	-0.0021	0.0069	0.0067
	[0.0130]	[0.0058]	[0.0087]	[0.0068]	[0.0096]	[0.0112]	[0.0058]	
$Price^{FF}$ (log)	0.1022***	-0.0188***	-0.0210***	-0.0143*	-0.0197***	-0.0217**	0.0043	-0.0164
	[0.0149]	[0.0064]	[0.0059]	[0.0082]	[0.0068]	[0.0090]	[0.0044]	
$Price^{FV}$ (log)	-0.0188***	0.0398***	-0.0007	0.0062	-0.0141***	0.0022	0.0035	-0.0194
	[0.0064]	[0.0058]	[0.0043]	[0.0064]	[0.0053]	[0.0057]	[0.0028]	
$Price^{RG}$ (log)	-0.0197***	-0.0007	0.0649***	-0.0088	-0.0099**	-0.0037	0.001	-0.0228
	[0.0056]	[0.0040]	[0.0124]	[0.0066]	[0.0044]	[0.0062]	[0.0027]	
$Price^{meat}$ (log)	-0.0129*	0.0056	-0.0085	0.0139*	-0.0055	0.0071	0.0075**	-0.0074
	[0.0074]	[0.0058]	[0.0063]	[0.0083]	[0.0054]	[0.0064]	[0.0032]	
$Price^{fs}$ (log)	-0.0166***	-0.0119***	-0.0089**	-0.0052	0.0695***	-0.0024	-0.0067	-0.0102
	[0.0057]	[0.0044]	[0.0040]	[0.0050]	[0.0083]	[0.0068]	[0.0044]	
$Price^{off}$ (log)	-0.0217**	0.0022	-0.004	0.0079	-0.0028	0.0369*	0.0015	-0.0199
	[0.0090]	[0.0057]	[0.0066]	[0.0071]	[0.0080]	[0.0209]	[0.0082]	
$Price^{pfv}$ (log)	0.004	0.0032	0.0009	0.0076**	-0.0073	0.0014	0.0028	-0.0139
	[0.0040]	[0.0025]	[0.0026]	[0.0032]	[0.0047]	[0.0075]	[0.0022]	
$Price^{opf}$ (log)	-0.0164	-0.0194***	-0.0228***	-0.0074	-0.0102	-0.0199***	-0.0139**	0.1100
	[0.0123]	[0.0056]	[0.0052]	[0.0049]	[0.0071]	[0.0071]	[0.0063]	
Size (log)	-0.0690***	-0.0101*	0.0255*	-0.0006	0.0279**	-0.0224**	-0.0257**	0.0744
	[0.0123]	[0.0059]	[0.0136]	[0.0069]	[0.0132]	[0.0088]	[0.0103]	
Female labor	-0.0024	-0.004	0.0029	-0.0122**	-0.0015	0.0239**	0.0129*	-0.0195
	[0.0101]	[0.0059]	[0.0067]	[0.0058]	[0.0114]	[0.0100]	[0.0073]	
Education	0.0028***	-0.0008	0.0002	0.0005	-0.0019	0.0011	0.0003	-0.0023
	[0.0009]	[0.0006]	[0.0005]	[0.0007]	[0.0014]	[0.0009]	[0.0006]	
White collar	-0.0108	-0.0105	0.0023	-0.0084	0.0008	0.0446**	-0.0016	-0.0164
	[0.0152]	[0.0068]	[0.0081]	[0.0084]	[0.0175]	[0.0182]	[0.0097]	
Workers	-0.0012	-0.0012	-0.0064	-0.0031	0.0077	-0.0096	-0.0044	0.0180
	[0.0104]	[0.0057]	[0.0055]	[0.0061]	[0.0113]	[0.0086]	[0.0063]	
Diseases	0.0072	0.0142***	0.0059	-0.0024	-0.0031	-0.0036	-0.0054	-0.0128
	[0.0083]	[0.0046]	[0.0055]	[0.0062]	[0.0110]	[0.0086]	[0.0047]	
Distance 1	-0.0027	0.0027*	-0.0001	0.0031	0.0000	-0.0005	0.0000	-0.0025
	[0.0023]	[0.0015]	[0.0010]	[0.0023]	[0.0017]	[0.0014]	[0.0013]	
Age	0.0008**	0.0002	0.0007***	-0.0001	0.0003	0.0004	-0.0004**	-0.0017
	[0.0003]	[0.0002]	[0.0002]	[0.0002]	[0.0003]	[0.0003]	[0.0002]	

Table 4.14 (Continued)

	FF	FV	RG	Meat	FS	OFF	PFV	OPF
Bangkok	-0.0124	-0.0142***	0.0262***	0.0208***	0.0127	-0.0165*	-0.0078	-0.0088
	[0.0089]	[0.0052]	[0.0058]	[0.0074]	[0.0106]	[0.0095]	[0.0068]	
PDF	-	-	0.0399	-0.1425***	0.0054	-	-0.2782***	0.3755
	-	-	[0.0813]	[0.0383]	[0.0844]	-	[0.0964]	
Constant	0.5727***	0.1018*	0.6221***	-0.1987***	-0.3702***	0.1813	0.0786	0.0124
	[0.1365]	[0.0607]	[0.0989]	[0.0665]	[0.1039]	[0.1147]	[0.0727]	
Chi2	134.99	111.78	428.30	59.88	150.42	69.94	40.28	

Note: *, **, *** Estimates are significant at the 10%, 5% and 1% level, respectively. Coefficient of other preserved food group is calculated from the adding-up restrictions. Independent variables are multiplied by cumulative distribution functions ($\Phi(z_i' \hat{\alpha})$) as shown in equation 3.3. The model also included the probability density function (PDF : $\phi(z_i' \hat{\alpha})$). Numbers in parentheses are bootstrap standard errors.

Source: Estimated based on household survey data.

Geographic location dummies are statistically significant in expenditure share equation of vegetables, rice & glutinous rice, meat and preserved fruits & vegetables, but with different signs. This suggests that there are different preferences between households in Bangkok and Chiang Mai. Additionally, the significance level of probability density function for meat and preserved fruits & vegetables provides evidence that it is important to accommodate zero observations in these aggregate commodities.

The elasticities are calculated based on the formulas provided by Green and Alston (1990). Using the estimated coefficients on the logarithm of food at home expenditure, own-price and the average budget share, all resulting expenditure and own-price elasticities have the expected sign (Table 4.15). The unconditional expenditure elasticities for higher-value foods like fruits, vegetables, meats, fish and seafood are higher than the elasticities for rice and glutinous rice. These results suggest that urban households in Bangkok and Chiang Mai tend to spend more on nutritious food items with increasing incomes, pointing to a continuous dietary diversification. All own-price elasticites are negative, in accord with economic theory. As expected, absolute values are lowest for staple food and are significantly higher for more expensive food stuffs, especially meat and preserved fruits & vegetables.

As we relied on the use of unit value as a proxy of price information, the quality expenditure elasticity for each commodity is estimated to characterize the magnitude of effect of quality. Following Deaton (1988), unit values are equal to the sum of price and quality. The extent to which quality considerations of consumers determine demand can be assessed by regressing the logarithm of unit values on the logarithm of total expenditure, household characteristics and regional dummies (11 districts[13]) reflecting the differences between clusters in prices. The estimated percentage changes in unit values in response to percentage changes in total expenditures can be interpreted as quality expenditure elasticity. An insignificant quality effect is given for meat, other fresh food and preserved fruits & vegetables. However, quality expenditure elasticities are small in magnitude values for other commodities. This supports the assumption that aggregate food groups are fairly homogeneous in terms of quality. Therefore, unit values are relatively good proxies for product prices in our study.

Table 4.15 Demand elasticities for different food categories

Commodity	Mean Budget share	Within group expenditure elasticity	Unconditional expenditure elasticity	Uncompensated own-price elasticity	Quality elasticity*
Fruits	0.20	0.85	0.44	-0.46	0.16
Vegetables	0.11	1.03	0.54	-0.63	0.09
Rice & glutinous rice	0.10	0.41	0.21	-0.27	0.08
Meat	0.08	1.37	0.71	-0.84	-0.01
Fish & seafood	0.13	1.32	0.69	-0.51	0.20
Other fresh food	0.17	0.99	0.51	-0.78	0.04
Preserved F&V	0.05	1.14	0.60	-0.95	0.05
Other preserved food	0.17	1.04	0.54	-0.37	0.09

Note: * The estimate regression of unit value is presented in Appendix Table A2.

Source: Calculated from aggregate demand system estimates based on household survey data

[13] There are 12 districts in our sample. Chang Pueak district and Nongpakung district are merged as they have fewer observations but fairly homogenous geographic location.

3. Disaggregate Demand Analysis (second budgeting stage)

The previous analyses at the second budgeting stage were initially estimated for aggregate food items. In this sub-section, the focus is on fruit and vegetable consumption disaggregated by supply chain-related attributes. The new form is to integrate fresh fruits and vegetables (FFV) in the same commodity group. Then, FFV group is replaced by sub-categories representing different supply chain-related attributes. As outlined above, in our context four sub-demand systems are place of purchase, safety and quality assurances, convenience attribute and source of production. The demand parameters for disaggregated commodities for food at home group in each sub-demand system are estimated at the second stage, including other aggregate food items applying the same process of aggregate demand analysis. The required probit results for the Shonkwiler and Yen procedure are presented in Appendix Table A4. Table 4.16 depicts the disaggregate demand estimation for fresh fruits & vegetables (FFV) from different supply chain-related attributes. All expenditure share equations are significant at least at 10 percent significance level according to chi-square test.

The logarithm terms of per capita food at home expenditure are statistically significant for the case of place of purchase, not minimally processed FFV and domestic produce at least at 10 percent significant level. A negative sign indicates that if food at home expenditure rises by 10 percent, expenditure share of purchased FFV from traditional retailers and not minimally processed FFV tend to decrease by 0.6 and 0.4 percent, respectively. A positive sign indicates an increasing expenditure share on purchased FFV from modern retailers by 0.2 percent when food at home expenditure increases by 10 percent. Most own price coefficients are also statistically significant at least at 10 percent significance level. However, insignificant parameter estimates can be the result of less variation of food prices, particularly for products which are consumed by few households during the survey period. In that sense, missing price values are imputed by average weighted market price from each district.

Besides expenditure levels and prices, household composition variables were included to account for the influence of demographic factors. Household size has a statistically negative impact on the expenditure share of purchased FFV from traditional supply chain sectors, reflecting the decreasing FFV share of this sector as household size increases. It could be explained that in a larger household the share of young people and their influence on purchase decisions increase by rather preferring FFV with modern supply chain-related attributes. The estimated coefficients for educational level of household heads are positive and highly statistically significant for purchased FFV of modern retailers, FFV with formal labels and minimally processed FFV. The results are in line with the assumption that better-educated household heads tend to consume more FFV with additional safety and quality attributes. However, for the case of source of production, demand for domestic fresh produce is likely to increase with the higher educational level of household head.

Geographic location dummies are statistically significant in most cases except safety and quality indications, purchased FFV from traditional retailers and imported produce. However, location dummy variable shows a positive sign for all cases of FFV from emerging supply sectors, as we had expected. The result reflects the different levels in the development of modern retail sectors in Bangkok and Chiang Mai. Bangkok's food retail sector is much more advanced with respect to the density of modern retail outlets. The coefficient of household head's age has a significant positive impact on the share of FFV for almost all supply chain cases except modern retailers and formal certifications. Thus, the older household heads still purchase FFV from the traditional retailers and use appearance and freshness as important criteria. Likewise, demand by older household heads for minimally processed FFV and imported FFV are similar in the case of traditional retail outlets.

We further included dummy variables for different attitudes to food in the LAIDS estimation. As expected, the attitude dummy variable for consumers agreeing that quality and safety FFV are solely obtained in supermarkets and specialty stores has a significantly positive impact on the share of FFV from modern retail outlets. Household respondents who carefully clean fresh produce have a positive and significant impact on the share of fresh produce not minimally processed, thus a declining share in minimally processed FFV is also observed. This is probably the effect of including fresh produce from traditional retail outlets – perceived as not safe by some consumers -- into the sub-category of minimally processed FFV.

Table 4.16 Conditional disaggregate demand system estimates for fresh fruits and vegetables from different supply chain-related attributes

Variables	Place of purchase		Safety & quality indication		Convenience attribute		Source of production	
	Traditional retailers	Modern retailers	Informal indictors	Formal indicators	Non-MP	MP	Domestic	Import
FAH expenditure (log)	-0.0573***	0.0170**	-0.0067	0.0037	-0.0436***	0.0162	-0.0339**	0.0045
	[0.0160]	[0.0075]	[0.0107]	[0.0032]	[0.0123]	[0.0109]	[0.0157]	[0.0043]
Price-traditional FFV (log)	0.0720***	-0.0025	0.0883***	-0.0191**	0.0589***	-0.0039	0.0878***	-0.0074
	[0.0172]	[0.0155]	[0.0164]	[0.0096]	[0.0133]	[0.0106]	[0.0163]	[0.0069]
Price-High value FFV (log)	-0.001	-0.0040	-0.0042**	0.0014	-0.004	0.0321**	-0.0018	0.0131*
	[0.0058]	[0.0092]	[0.0021]	[0.0056]	[0.0109]	[0.0132]	[0.0017]	[0.0073]
Price-RG (log)	-0.0088	-0.0071	-0.0124**	-0.0026	-0.0075	-0.0051	-0.0091	-0.0062
	[0.0058]	[0.0095]	[0.0059]	[0.0071]	[0.0062]	[0.0055]	[0.0067]	[0.0076]
Price-Meat (log)	-0.0056	0.0094	-0.0038	0.0143	0.0109*	-0.0132**	0.0002	0.0006
	[0.0065]	[0.0091]	[0.0058]	[0.0107]	[0.0060]	[0.0063]	[0.0063]	[0.0063]
Price-FS (log)	-0.0226***	0.0003	-0.0311***	0.0031	-0.0125*	-0.0185***	-0.0340***	-0.0050
	[0.0072]	[0.0072]	[0.0079]	[0.0065]	[0.0069]	[0.0060]	[0.0070]	[0.0042]
Price-OFF (log)	-0.0101	0.0011	0.0064	0.0086	-0.0158	0.0011	-0.0135	0.0052
	[0.0100]	[0.0088]	[0.0140]	[0.0067]	[0.0102]	[0.0093]	[0.0147]	[0.0065]
Price-PFV (log)	-0.0037	0.0030	0.0000	-0.0015	-0.001	0.0031	-0.0003	0.0016
	[0.0048]	[0.0050]	[0.0044]	[0.0023]	[0.0048]	[0.0043]	[0.0044]	[0.0034]
Price-OPF (log)	-0.0202	-0.0002	-0.0432***	-0.0043	-0.0290***	0.0044	-0.0294**	-0.0019
	[0.0124]	[0.0109]	[0.0108]	[0.0043]	[0.0097]	[0.0105]	[0.0137]	[0.0051]
Size (log)	-0.0775***	-0.0030	-0.0297***	0.001	-0.0605***	-0.0165	-0.0788***	0.0020
	[0.0161]	[0.0085]	[0.0106]	[0.0034]	[0.0122]	[0.0117]	[0.0148]	[0.0048]
Education years	-0.0023*	0.0057***	0.0001	0.0038*	-0.0006	0.0025**	0.0023**	0.0016
	[0.0014]	[0.0022]	[0.0012]	[0.0020]	[0.0013]	[0.0012]	[0.0011]	[0.0021]
Female labor	-0.0103	0.0040	-	-	-	-	0.0039	0.0248
	[0.0136]	[0.0230]	-	-	-	-	[0.0119]	[0.0278]

Table 4.16 (Continued)

Variables	Place of purchase		Safety & quality indication		Convenience attribute		Source of production	
	Traditional retailers	Modern retailers	Informal indictors	Formal indicators	Non- MP	MP	Domestic	Import
Bangkok	-0.0366***	0.0065	-0.0040	0.0261	-0.0418***	0.0315***	-0.0713***	0.0125
	[0.0133]	[0.0275]	[0.0133]	[0.0315]	[0.0118]	[0.0109]	[0.0115]	[0.0182]
Age	0.0008**	0.0002	0.0011**	-0.0003	0.0005	0.0006*	0.0009***	0.0019***
	[0.0004]	[0.0007]	[0.0004]	[0.0006]	[0.0004]	[0.0004]	[0.0003]	[0.0006]
Distance 2	-0.0037	0.0083	-0.0021	0.0032	-	-	0.0009	-0.0002
	[0.0027]	[0.0054]	[0.0022]	[0.0068]	-	-	[0.0019]	[0.0028]
Number of media	0.0033	-0.0140*	-	-	-	-	-	-
	[0.0047]	[0.0077]	-	-	-	-	-	-
Attitude 1 and 2	-0.0230**	0.0851***	-	-	0.0232*	-0.0285**	-	-
	[0.0111]	[0.0248]	-	-	[0.0126]	[0.0111]	-	-
White collar	-0.0099	-0.0415	0.0161	-0.0563	-0.0172	-0.0032	-0.0485**	-0.0253
	[0.0211]	[0.0368]	[0.0172]	[0.0481]	[0.0175]	[0.0170]	[0.0193]	[0.0374]
Workers	0.0108	-0.0159	0.0188	-0.0600*	0.0021	-0.0011	-0.019	-0.0252
	[0.0160]	[0.0345]	[0.0138]	[0.0335]	[0.0141]	[0.0140]	[0.0126]	[0.0235]
Probability function	-0.2047**	-0.0381	-0.0327	0.0483	-0.1705**	-0.1243**	-0.1051	-0.1099
	[0.0904]	[0.0950]	[0.0552]	[0.0743]	[0.0786]	[0.0624]	[0.0765]	[0.0722]
Constant	0.9992***	-0.1304***	0.3613***	-0.0435	0.7038***	0.0011	0.7584***	-0.0191
	[0.1656]	[0.0489]	[0.1026]	[0.0272]	[0.1356]	[0.1126]	[0.1695]	[0.0350]
Chi2	135.09	110.80	101.33	50.87	109.89	67.97	167.66	69.20

Note: *, **, *** Estimates are significant at the 10%, 5% and 1% level, respectively. Numbers in parentheses are bootstrap standard errors. MP denotes minimally processes. Attitude in sub-demand for place of purchase is attitude 1, while attitude 2 was included in sub-demand for convenience attributes. (See all variable definitions in Table 3.1)

Source: Estimated based on household survey data.

The disaggregate demand elasticities with respect to continuous variables are presented in Table 4.17. All point estimates of conditional expenditure elasticities indicate a 1.0 percent increase in food at home expenditures, implying there will be a huge increase in demand for FFV from emerging modern supply sectors. The estimated unconditional expenditure (income) elasticities for each disaggregated item are calculated by corresponding conditional expenditure elasticity of disaggregate FFV multiplied by food at home expenditure elasticity at the first budgeting stage (0.52). All income elasticities are smaller than one, indicating that they are normal goods. The demand responsiveness in respect to income among the different supply chain-related attributes are in the expected range. Income elasticities for FFV from emerging supply sectors are higher than those from traditional ones, suggesting a substantial improvement in safety and quality of fruit & vegetable consumption as household income increases.

Table 4.17 Disaggregate demand elasticity for fresh fruits and vegetables from different supply chain-related attributes

Supply chains related attributes	Mean Budget share	Within group expenditure elasticity	Unconditional expenditure elasticity	Uncompensated own-price elasticity	Within group education elasticity
Place of purchase					
Traditional retailers	0.25	0.77	0.40	-0.65	-0.09
Modern retailers	0.05	1.35	0.70	-1.10	1.19
Safety & Quality					
Informal indicators	0.23	0.97	0.51	-0.61	0.01
Formal indicators	0.02	1.18	0.61	-0.94	1.83
Convenience attribute					
Not minimally processed	0.14	0.70	0.36	-0.55	-0.04
Minimally processed	0.16	1.10	0.57	-0.81	0.16
Source of production					
Domestic	0.26	0.87	0.45	-0.63	0.09
Import	0.02	1.23	0.64	-0.35	0.82

Source: Estimated based on household survey data.

The conditional own-price elasticity of FFV from modern retail outlets is greater than one and almost elastic for FFV with safety labels and minimally processed FFV. Between traditional and non-traditional FFV, consumers react more sensitively to price changes for purchased FFV from modern retailers, minimally processed FFV and FFV with formal indication. Nonetheless, the absolute value of price responsiveness for imported FFV (as well as domestic ones) is quite low compared to other high-value attributes. It could be explained by the penetration of Chinese fresh products into the domestic market, which has lowered the prices of fresh produce. Free trade agreements and market liberalization have had broad impacts on consumers' behavior.

The level of educational attainment of household respondents influences demand for FFV from emerging supply chain sectors. The education elaticities are calculated for each attribute using the estimated coefficients and mean budget shares, yielding some very interesting insights. The education elasticities indicate that education significantly influences demand for FFV from modern retail outlets, FFV with formal indications and minimally processed FFV. Education has an influence on the lifestyle of consumers and thus would induce a change in consumers' preferences. This result is much in line with the conclusion that the improving education standard in Thailand has impacted on the awareness of food safety and quality as in more highly developed countries (Kanlayanarat and McGlamon, 2003).

The estimated disaggregate demand elasticities based on significant effects of continuous variables are further used to calculate demand growth factors in order to project the quantity demand of FFV over the next ten years from the time of this study. Special product attributes are considered in making the demand projection, namely, purchased FFV from modern retail outlets, minimally processed FFV, FFV with formal indications, domestic and imported fresh produces. In our context, the growth in urban consumption of FFV from different supply chain-related attributes is driven by income, education years of household head and own-price, demonstrated as follows:

(4.1) $$G_i = [\varepsilon_I * (\hat{G}_{inc} - POP)] + (\varepsilon_{edu} * \hat{G}_{edu}) + (\varepsilon_p * \hat{G}_{price}) + POP, \; i = 1, 2, \ldots 5$$

where $\hat{G}_i$ denotes growth of fresh fruits and vegetables demand from different supply sectors (i = 1, 2,….,5)

$\varepsilon_I, \varepsilon_{edu}$ and ε_p are demand elasticities with respect to income, education and own-price, respectively.

$\hat{G}_{inc}$ $\hat{G}_{edu}$ and $\hat{G}_{price}$ are growth of real income, education years and price

POP is growth of population growth.

The growth of Gross Domestic Product (GDP) is used as a proxy of growth rate for real income, while the change in price is based on the annual price dataset for major types of fruits & vegetables sold in the biggest wholesale market in Bangkok, “Talad Thai”. In order to estimate the differences in consumption patterns by different economic situations, we set the growth rate into 3 scenarios with changes in income and price. Scenario A presents a normal situation, assuming that GDP will grow by 8 percent and price will increase by 6 percent. Scenario B is economic recession with only a 4 percent growth in GDP and a 9 percent increase in price. Scenario C is a rather high economic growth with a 12 percent growth in GDP and 12 percent rise in price. To eliminate the impact of population growth on the increase of GDP, we include this variable into the growth demand factor model. The forecast of population trend from National Economic and Social Development Board year 2007 shows an expansion of 0.82 percent during the year of projection (Kongrith, 2009). Based on policy of the Office of Education of the Council for Education Attainment of Thai Population, an increase of years in education by 2.9 percent will be expected.[14] According to our household survey data, the average years of educational attainment would increase from 10.2 in 2007 to an average level of around 12.8 in 2017. A growth rate of FFV demand from different supply chain-related attributes is presented in Table 4.18. It will be used for the next estimation to project the FFV demand trend.

[14] The expected years of schooling for Thai population as a whole are 10 and 13 years in 2011 and 2026, respectively. The average year of educational attainment of Thai population in 2005 is 8.52 years. (Office of Education Council: www.onec.go.th). Retrieved September, 2009.

The demand growth factors are used to calculate the purchased quantity for FFV from different supply related attributes over the next ten years from different scenarios–*ceteris paribus*-. The purchased quantities of FFV from modern retail outlets is expected to slightly increase from 29 kilograms to 65 kilograms in a normal economic growth, to 50 kilograms in a recession, and 102 kilograms per capita per year in a high economic growth scenario. In the case of FFV with formal indicators, the demand is likely to increase three-fold to reach 37 kilograms per capita per year in a high economic growth situation. The projected quantity demand for minimally processed FFV shows a declining demand from 104 to 69 kilograms per capita per year in an economic recession. However, it slightly increases to 108 and 115 kilograms per capita per year in normal growth and high-growth economy, respectively. This phenomenon is also observed for FFV of domestic origin. This could be related to the projected demand for those products, which is driven more by own-prices especially when the economy is in recession or slow-growth. Overall, the projected quantity demand for FFV from emerging supply chain-related attributes is likely to increase when household income increases and the educational level of household head or purchase decision maker is higher. Therefore, the trend may resemble that for specific quality FFV demands; both will grow in the medium or long-run period in the urban areas of Thailand.

Table 4.18 Growth assumptions used to project high-value fresh fruits and vegetables

Items	Scenarios		
	A	**B**	**C**
Growth Factors			
Population growth	0.0082	0.0082	0.0082
Income growth	0.08	0.04	0.12
Own-price	0.06	0.09	0.12
Education year	0.023	0.023	0.023
Growth of FV demand per annum			
FFV from modern retailers*	0.09	0.06	0.14
FFV with formal indications*	0.09	0.07	0.15
Minimally processed FFV	0.004	-0.043	0.01
Domestic FFV	0.005	-0.032	0.026
Imported FFV	0.052	0.016	0.083

Note: Growth factor of own-price is not applied for these two categories according to insignificance level of own-price variable in sub-demand system estimation (Table 4.16).

Table 4.19 The projection of fresh fruits and vegetables (kilogram per capita per annual) under different growth assumptions by supply chains-related attributes

Year	FFV from Modern retailers			FFV with formal indications			Minimally processed FFV			Domestic FFV			Imported FFV		
Scenario	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
2007	28.6	28.6	28.6	10.6	10.6	10.6	103.6	103.6	103.6	198.0	198.0	198.0	8.3	8.3	8.3
2008	31.0	30.2	32.5	11.6	11.3	12.2	104.0	99.1	104.6	199.0	191.7	203.1	8.7	8.4	9.0
2009	33.7	32.0	36.9	12.7	12.1	14.0	104.4	94.9	105.7	199.9	185.5	208.3	9.2	8.5	9.7
2010	36.6	33.8	41.9	13.9	13.0	16.0	104.9	90.8	106.7	200.9	179.5	213.6	9.6	8.7	10.5
2011	39.7	35.8	47.6	15.2	13.9	18.4	105.3	86.9	107.8	201.8	173.8	219.1	10.1	8.8	11.4
2012	43.2	37.9	54.1	16.6	14.8	21.1	105.7	83.2	108.9	202.8	168.2	224.7	10.7	8.9	12.3
2013	46.9	40.1	61.4	18.2	15.9	24.2	106.2	79.6	110.0	203.8	162.8	230.4	11.2	9.1	13.4
2014	50.9	42.4	69.8	19.9	17.0	27.7	106.6	76.2	111.1	204.7	157.6	236.3	11.8	9.2	14.5
2015	55.2	44.8	79.3	21.8	18.2	31.8	107.1	72.9	112.3	205.7	152.5	242.3	12.4	9.4	15.7
2016	60.0	47.4	90.1	23.8	19.4	36.5	107.5	69.8	113.4	206.7	147.6	248.5	13.1	9.5	17.0
2017	65.1	50.2	102.3	26.1	20.8	41.9	108.0	66.8	114.5	207.7	142.9	254.9	13.7	9.7	18.4

Note: Scenario A, B and C are determined with a normal growth, recession economic and growing economic, respectively.

Source: Estimated based on the elasticities values and assumption growth rates.

Consumers' valuation and determinant factors

1. Contingent Valuation Method (CVM)

CVM concentrates the valuation under a particular scenario or single attribute changes. In this study, the "pesticide safe[32]" attribute is considered to be an improved quality of cabbage and NamDokMai mango. As explained earlier, household head and/or household primary food purchaser was confronted with two-rounds of yes/no questions presented in sequence, with a series of price bid levels. The outcomes are expressed into four intervals (Table 4.20).

Table 4.20 Percentage of four response groups as obtained by two sequential bids

Category	Cabbage		NamDokMai mango	
	Household	Percentage	Household	Percentage
Yes/Yes	258	51.6	174	34.8
Yes/No	136	27.2	88	17.6
No/Yes	47	9.4	108	21.6
No/No	59	11.8	130	26.0

Source: Based on household survey data

The lower-bound and upper-bound values of WTP were generated for each household to prepare the input data for interval-censored model. Here some values are presented by the natural lower bound of zero WTP or infinity value at the upper bound for the last interval. To obtain information on interval data distribution, we separated histograms for lower-bound and upper-bound values from WTP data for cabbage and NamDokMai mango (Figure 4.1 and Figure 4.2). The histograms show an almost normal distribution of WTP values for both products, following the interval regression model assumption.

[32] Fruits and vegetables are produced by a reduction in pesticide use through the practice of integrated pest management (IPM). The level of pesticide residues therefore is below the Maximum Residue Limit (MRL) meaning products are safe enough for consumption. (Vanit-Anunchai and Schmidt, 2004)

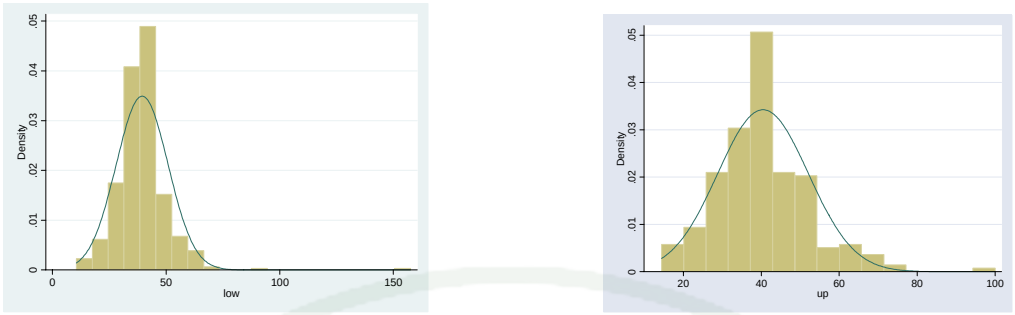

Figure 4.1 Distribution of lower and upper values willingness to pay for cabbage

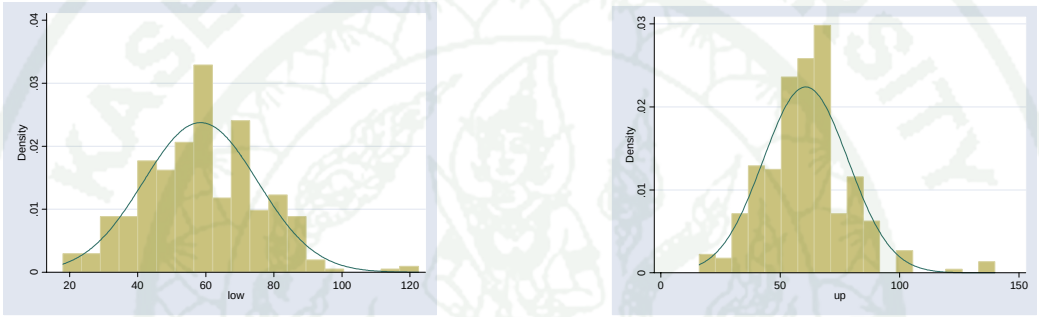

Figure 4.2 Distribution of lower and upper values willingness to pay for NamDokMai mango

The determinants of consumers' preference

The unknown parameters in the WTP model are estimated by maximizing a log-likelihood function of the four possible probability outcomes of the empirical model presenting in equation 3.24. The estimated coefficient can be directly interpreted as marginal effects of the explanatory variables on WTP. Selected household characteristics and appropriate controlling variables are included in the estimated model to analyze their impact on WTP besides the interval censored data. Both models are statistically significant by the Chi-square test. It suggests the model's capability to explain WTP variation of pesticide safe attribute (Table 4.21). Total per capita household expenditure is statistically significant at least at 10 percent significant level for both fresh products. Each additional thousand baht of expenditure increases WTP by 0.0154 and 0.0383 baht per kilogram for pesticide safe cabbage and NamDokMai mango, respectively. The household size and female household

heads have a significantly positive effect on WTP for pesticide safe products. A general impact of the mass media is captured by the number of media (such as television, radio, internet and newspapers) used by households to assess the information on food safety and quality and health issues. It is positively related to the size of premium that consumers are willing to pay for pesticide-safe cabbage and NamDokMai mango. Consumers who agreed to the statement that higher prices relate to higher quality of products (attitude 3) have a higher WTP for safe vegetable.

Table 4.21 The estimation results of WTP model and mean WTP

Variables	Cabbage	Standard error	Mango	Standard error
Expenditure[a]	0.0154*	0.0090	0.0383***	0.0119
White collar	6.4073**	2.6439	2.7647	3.3685
Housewife	5.2678***	1.8930	5.8281**	2.3862
Size (log)	5.4335***	1.7013	5.2795**	2.1748
Age	0.1330**	0.0597	-	-
Gender	4.5957**	1.9221	7.5695***	2.5338
Media	1.3798**	0.6300	1.8907**	0.7987
Attitude 3	3.0929*	1.7739	-	-
First Bid	0.1015***	0.0317	0.0661*	0.0394
Normal price	2.4504***	0.8161	1.4836***	0.2428
Constant	-39.0329**	17.0262	-19.5925**	9.5409
Log likelihood	-663.29		-691.15	
Chi2	61.30		75.42	
Mean WTP	**47.3**		**62.0**	
Mean WTP (less starting point bias)	**38.7**		**56.0**	

Note: Estimated based on household survey data. *, **, *** Estimates are significant at the 10%, 5% and 1% level, respectively. [a] Expenditure is included in the WTP model in the unit of thousand baht.

Source: Estimated based on household survey data.

To account for a possible starting point bias in the CVM analysis, the first price bid is included in the interval-regression model. It is statistically significant in both models, indicating a starting point bias. Additionally, to take unobserved quality preferences into account, normally paid cabbage and NamDokMai mango price are also included in the WTP model as an instrument variable[33] to avoid an endogeneity problem caused by a correlation with the error term. The results show that these variables are statistically significant for both fresh products, indicating heterogeneous price difference from quality indicators and location for cabbage and NamDokMai mango, respectively.

Mean Willingness to Pay

Based on the estimated parameters from both WTP models, mean WTP are calculated as given in equation 2.55 for pesticide safe products. The mean WTP of pesticide safe cabbage and NamDokMai mango are 47.3 and 62.3 baht per kilogram, respectively. By controlling the starting point bias, mean WTP is reduced to 38.7 and 56 baht per kilogram for these pesticide safe products. The correlation between WTP of cabbage and NamDokMai mango is positive with 0.51, and highly significant. The positive relationship confirms that consumers having concerns about pesticide residues in cabbage also have a positive WTP for pesticide-safe NamDokMai mango. However, the percentage of mean WTP compared to average current market price is 91 and 66 percent for cabbage and NamDokMai mango, respectively. WTP of pesticide safe cabbage is higher compared to pesticide-safe NamDokMai mango, indicating that consumers are more concerned with accumulated pesticide in vegetables than in fruits. Thai consumers sometimes prefer to eat raw cabbage leaves as part of the main course, while for NamDokMai mango the peel is removed before consumption. In that sense, a higher consumers' concern may exist for cabbage.

[33] The calculation of conventional price instrument; $P_0 = \beta_0 + \beta_1 dummy \quad \rightarrow \quad P(IV) = \hat{\beta}_0 + \hat{\beta}_1 dummy$. Safety and quality assurance dummies are used to predict the price for cabbage, while location dummies are used to predict prices for NamDokMai mango.

Additionally, we segmented the WTP data according to location, educational level of household head and purchased criteria (Table 4.22). By location, the estimated WTP are separately calculated for Bangkok and Chiang Mai. The estimated results show the same range for safe cabbage, but a slightly higher WTP for NamDokMai mango among consumers in Bangkok. As to educational level, we classified household head education into 2 subgroups, namely, undergraduate and bachelor degree or higher. As hypothesized, the average WTP for both safety products increases with increasing level of education. Lastly, household heads were asked open-ended questions concerning criteria for their purchase decisions. “Safety from pesticide and synthetic chemicals” has been used as a criterion by 216 households in our sample. The average WTP for safe cabbage notably differs between “use” and “non-use”, but is in a similar range for safe NamDokMai mango. As mentioned above, different ways of preparing cabbage and NamDokMai mango could be a reason. Moreover, other criteria may exist that influence the purchase decision of NamDokMai mango such as product appearance.

Table 4.22 Comparison of mean WTP among different segmentations

Segmentation	Number of households	Mean Willingness to pay (baht/kilogram)	
		Cabbage	NamDokMai Mango
Whole sample	500	38.7	56.0
Province			
Bangkok	300	37.4	60.0
Chiang Mai	200	36.8	52.4
Educational level			
Undergraduate	364	38.7	55.2
Bachelor degree or above	136	46.5	60.0
Safety criteria for purchased decision			
Use	216	41.5	55.8
Non-use	284	35.6	55.3

Note: All willingness to pay is already reduced the starting point bias.

Source: Estimated based on household survey data

2. Choice Experiment

Results of the Contingent Valuation Method highlight urban households' perception to prevent potential risks of pesticide residue exposure in fresh fruits and vegetables. In reality, product differentiation is achieved by several attributes to attract the interest of consumers. Knowledge of preferences of a certain product attribute would be of additional information for local producers. The aim of this sub-section is to compare consumer preferences and marginal willingness to pay (MWTP) for selected attributes of cabbage and NamDokMai mango by applying the Choice Experiment (CE) approach. Selected important attributes of cabbage are chemical residue, certificate and price; for NamDokMai mango, appearance of products was an additional attribute.

Estimated models

Household heads were confronted with 5 and 7 choice sets of cabbage and NamDokMai mango, containing three alternatives in each choice set in the experiment survey. They were asked to choose the most preferred alternative with a combination of attribute levels. However, some household heads chose only status quo for all choice sets. Burton *et al*. (2001) warned that including such choices in the analyses would lead to biased estimation, a form of protest vote. Therefore, seven households were excluded in the estimation of cabbage, while one was excluded in the estimation of NamDokMai mango. In total, a final dataset of 7,395 observations (493 households) and 10,479 observations (499 households) were used in the estimations.

The estimation of choice data started with a basic Conditional Logit model (equation 3.25) implicitly assuming that preference structure is homogeneous for respondents. Moreover, choice is conformed to the Independence from Irrelevant Alternatives Assumption (IIA) and all errors show similar small scale parameters. This basic model depends on the differences among alternative characteristics, with the results shown in Table 4.23 for two selected fresh products. The entire model and

most coefficients are highly significant and exhibiting the expected signs. The pseudo R^2 of 0.2865 and 0.2448 for cabbage and mango as well as Chi-square statistics indicate a reasonably good fit of the models.

Table 4.23 Conditinal Logit Model estimation for cabbage and NamDokMai mango

Variable	Cabbage		NamDoKMai Mango	
	Coefficient	**SE**	**Coefficient**	**SE**
Price	-0.0566***	[0.0034]	-0.0409***	[0.0023]
Alternative Specific Constant	0.7858***	[0.2249]	-0.9537***	[0.1190]
Safety	1.0925***	[0.0723]	0.1701***	[0.0519]
Organic	0.7914***	[0.0726]	0.007	[0.0406]
Certificate	0.4451***	[0.0304]	0.2716***	[0.0236]
Appearance	-	-	0.5769***	[0.0272]
Log likelihood at convergence	-1932.28		-2898.06	
LR chi2	1551.6		1878.78	
Number of observations	7,395 (493 households)		10,479 (499 households)	
Pseudo R^2	0.2865		0.2448	

Note: SE is the standard error.

Source: Calculated from field survey data.

The Independence of Irrelevant Alternative (IIA) property was considered by applying an approach developed by Hausman and MaFadden (1984). If the IIA assumption holds, the ratio of choice probabilities of first and second alternatives does not depend on the inclusion or exclusion of status quo. The results indicate that omitting one alternative has an influence on the probability that respondents choose other ones. We can reject the null hypothesis that the coefficient difference is not systematic, interpreted as the violation of IIA property. In that case, more complex choice model options are required to acknowledge this assumption, i.e. Nested Logit model and Mixed Logit model (Random Parameters Logit model). A Nested Logit model loses the IIA assumption by allowing a correlation of unobserved factors, whereas a Mixed Logit model is similar to a Conditional Logit model moreover allowing parameter estimation to vary across individuals. The Mixed Logit model

fully releases the IIA assumption. Therefore, it can be used to modify the heterogeneity preferences among consumers.

As a consequence, we adopted the Mixed Logit model (equation 3.29) for this study. All attributes, except cost, were estimated as random parameters. All parameters were specified to be independently normal distributed with 50 random draws. Results of the Mixed Logit model specifications with two different models i.e. the “basic model without interaction terms” and “model with interaction terms” are presented in Table 4.24 for cabbage and NamDokMai mango, respectively. Based on the determinants of consumers’ preference revealed by CVM analysis, two major household’ characteristic were chosen: household income and years of education of household head. These interacted with the Alternative Specific Constant (ASC) as they cannot be entered in the model autonomously. All coefficient signs of both models (with and without interaction terms) for cabbage and NamDokMai mango are intuitively plausible. The negative sign of ASC indicates that consumers in general do not prefer status quo for cabbage and NamDokMai mango.

Additionally, the conventional level is used as a baseline by keeping the price term fixed. The estimated parameters indicate how much an individual’s utility increases or decreases with an attribute rise of one unit. The negative sign of prices for both products imply that a price increase would reduce the probability of choosing improved quality in the choice set questions. The positive signs of attribute levels indicate a preference of urban households for improved quality attributes, except for organic yellow mango estimation. The estimated standard deviations of coefficients for all attribute levels are statistically significant, indicating the heterogeneity preferences among households over attribute levels. Likewise, a household with a higher income would more likely choose improved quality levels instead of status quo, as indicated by the negative signs of interaction terms in both fresh products. These findings can be supported by the results of CVM. The educational level of household head shows a positive sign to choose the status quo. However, this variable is not statistically significant for both cabbage and NamDokMai mango models.

Table 4.24 Mixed Logit Model estimation for cabbage and NamDokMai mango

Variable	Basic Models		With interaction terms	
	Cabbage	**Mango**	**Cabbage**	**Mango**
Mean Effects				
Price	-0.1201***	-0.0726***	-0.1197***	-0.0729***
	[0.0071]	[0.0041]	[0.0071]	[0.0041]
Alternative Specific Constant	-0.8454**	-2.8487***	-0.9140**	-2.4933***
	[0.3312]	[0.2952]	[0.4506]	[0.4158]
Safety	1.4543***	0.3166***	1.4332***	0.3115***
	[0.1054]	[0.0748]	[0.1060]	[0.0744]
Organic	1.1434***	-0.022	1.1347***	-0.0215
	[0.1140]	[0.0566]	[0.1125]	[0.0562]
Certificate	0.8520***	0.4210***	0.8440***	0.4159***
	[0.0604]	[0.0431]	[0.0599]	[0.0431]
Appearance	-	0.8787***	-	0.8749***
	-	[0.0609]	-	[0.0610]
ASC * Household income	-	-	-0.0000***	-0.0000***
	-	-	[0.0000]	[0.0000]
ASC* Education years	-	-	0.0511	0.0426
	-	-	[0.0315]	[0.0367]
Standard Deviation Effects				
Alternative Specific Constant	2.1765***	3.1188***	2.1841***	3.1582***
	[0.2655]	[0.2421]	[0.2692]	[0.2575]
Safety	-0.4747***	-0.4701***	-0.4311***	-0.4662***
	[0.1417]	[0.1070]	[0.1553]	[0.1112]
Organic	1.5292***	0.3096***	1.5007***	0.2844**
	[0.1295]	[0.1076]	[0.1332]	[0.1200]
Certificate	0.6211***	0.5607***	0.5979***	0.5420***
	[0.0756]	[0.0551]	[0.0771]	[0.0536]
Appearance	-	0.9540***	-	0.9266***
	-	[0.0662]	-	[0.0657]
Log likelihood at convergence	-1669.64	-2351.5824	-1665.37	-2341.83
LR chi2(5)	525.27	1092.96	510.36	1054.69

Note: ASC denotes Alternative Specific Constant. Numbers in parentheses are standard errors.

Source: Calculated from field survey data.

In comparing the two models, the log likelihood of convergence among the models with interaction terms do not significantly differ compared to the basic model. Both produce results that are similar in terms of magnitude, sign and significant levels of coefficient. In this context, the basic Mixed Logit model was employed for the estimation of part-worth.

Estimates of part-worth

The part-worth value reflects the relative importance for consumers to trade-off their willingness to pay on each of the non-monetary attributes. In a simple linear model of indirect utility function, the implicit price or part-worth-*ceteris paribus*- is calculated as a negative ratio of attribute level coefficient to the estimated price coefficient. Each of these ratios expresses Marginal Willingness to Pay (MWTP) for a discrete change in an attribute level. Moreover, implicit price of the base level is a negative sum of implicit prices of the other levels (Roessler *et al*., 2008). Based on the estimated results from basic Mixed Logit model in Table 4.24, marginal WTP is computed in comparison to base level as depicted in Table 4.25.

Table 4.25 Implicit prices of each attribute level for cabbage and NamDokMai mango

Attribute	Level	Cabbage	NamDokMai mango
Chemical Residue	Safety	12.11	4.36
	Organic	9.52	-0.30*
Certificate	Certificate	7.09	5.80
Appearance	Good		12.10

Note: The implicit price of each attribute level is calculated, as status quo of each attribute level as a base reference. * The coefficient of organic level is not significant for the estimation models of NamDokMai mango (Table 4.24).

Source: Estimated based on household survey data.

As to additional WTP for attribute level, consumers would be willing to pay 12 baht per kilogram more for safe cabbage than the conventional product. From the magnitude value of attribute levels, urban households in Bangkok and Chiang Mai place a high priority on safe cabbage. Meanwhile, the marginal willingness to pay for safe mango is low, contrary to our expectation. One possible reason is consumers pay more concern to the appearance attribute. Appearance, especially of fruits like ripe mango, would likely trump other attributes.

However, the evaluated marginal willingness to pay from the NamDokMai mango model estimation can be still used to learn about consumers' preferences by considering their relative magnitudes. The good appearance attribute level is the most important criterion for purchasing NamDokMai mango, with a marginal willingness to pay value of about 12 baht per kilogram. Furthermore, the lowest marginal willingness to pay for organic attribute can be observed in both fresh products. The likely explanation is that demand for organic products is still confined to a niche group of consumers such as purchasers in green food shops. Thus this attribute may not have been reflected with high willingness to pay in the sample households. Certificate indications which are used to inform consumers about safety and quality attributes show a significant positive marginal WTP for both fresh produces, with values of 12-14 baht per kilogram, with "no certification" as a reference.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In light of the transformation happening in the food sector, an understanding of consumer food demand, elasticities, and consumers' valuation and their underlying determinants are important prerequisite to designing food and agriculture policies. It would enable the food sector as a whole to respond effectively to changes in consumer behavior and meet targeted demand. Policy and strategies would benefit from more precise projections of future trends. Previous studies on food demand in Thailand took only a partial look at certain foods or food groups, such as rice, fish and seafood. For fresh horticultural produce, recent demand analyses have been carried out in the aggregate way, which does not show the necessary degree of details. Additionally, descriptive statistics, single-equation econometric models or the limited application of restrictive Engel formulations, which these studies employed, are not fully consistent with economic theory. Safety and quality of fresh produce have been studied only through consumers' willingness to pay for certain attributes or through the assessment of consumers' attitudes. Most of the data were collected by purchasers at specialized retail outlets. As such, the results of the studies can not be considered as representative of the wider urban population. This study fills these research gaps by estimating demand elasticities for the entire food bundle and disaggregating demand elasticities for fresh fruits and vegetables from different supply chain-related attributes. In addition, consumers' willingness to pay for certain safety and quality attributes was estimated and the underlying determinants of consumers' preferences were identified and described.

All estimations are based on data obtained through a comprehensive survey of households in urban areas in Bangkok and Chiang Mai, Thailand. In the absence of recent census data, a multi-stage sampling design was applied to obtain a representative sample of 500 households, 300 in Bangkok and 200 in Chiang Mai.

The field survey was conducted from April to July 2007, by interviewing the primary household food purchasers and household heads. Household respondents were asked information on the following: on consumption expenditures of all food and non-food items; location of stores or retail outlets where the goods were purchased; purchase of minimally processed fresh products; safety and quality indications; origin of products (i.e. where they were produced); prices and purchased quantities; and certain characteristics of the household. Furthermore, Contingent Valuation and Choice experiment questions were presented to the respondents, by asking them to put a value on a product with the specific attribute and to choose the most preferred option, respectively.

The approximated linear form of the Almost Ideal Demand System (LAIDS) with two-stage budgeting was employed to estimate the demand elasticities of a basket of food items at home food under weakly separable preference assumption. To account for the problem of censored data, the Shonkwiler and Yen approach was applied. Demand elasticity results have plausible orders of magnitude. The derived food at home expenditure elasticity is inelastic among urban households. The expenditure elasticities for aggregate food items mask some important heterogeneity existing among different group. The demand for high-value food such as fruits, vegetables and meat in urban Thailand rises more with increasing incomes than the demand for staples. Households are more price responsiveness with respect to high value foodstuffs.

The study further analyzed the demand patterns for fresh fruits and vegetables, with a special focus on different supply chain-related attributes. The same procedure of estimation as in the aggregate demand analysis was applied. The supply chain-related attributes which were specifically considered are: place of purchase, safety and quality indications, minimally processed attribute, and source of production. Consumers' decision to purchase fresh produce from modern retail outlets are mainly influenced by household income and educational level of household head. Moreover, consumers' confidence on quality products that are sold only in supermarkets or specialty stores also impact on purchased fresh produce from modern retailers.

Interestingly, a significant impact on decisions to purchase fresh produce with formal labels is linked to the educational level of the household head, whereas own-price significantly influences the consumption pattern for minimally processed fresh produce. Household heads with higher education and households in Bangkok are more likely to purchase fresh fruits and vegetables that are already washed, cut, peeled and packed i.e. minimally processed. For imported fresh produce, price is evidently the major factor in consumers' decisions. Lower income households opt to consume domestic fresh produce in higher quantities. Overall, the estimated demand elasticities for each emerging supply chain of fresh produce follow the expected signs. Demand for products from modern retailers, product with formal indications, and minimally processed fresh produce have a relatively high income, own-price and education elasticity, compared to traditional ones. Thus, a rapid economic development and higher education levels will likely spur a trend in domestic demand for fresh fruits and vegetables toward a greater emphasis on product safety, quality and convenience.

A comparison of our estimates of aggregate and disaggregate food item demand elasticities with those of other food demand analyses are discussed (Appendix Table A5). Our estimated demand elasticities are in the same range for broad groups of commodities, but differ significantly from those described in other studies of aggregate items of food at home. For instance, Isvilanonda and Kongrith (2008) conclude that rice is an inferior good; in our study, rice has small but positive income and expenditure elasticity. In Sutthipongpan (2005), income elasticities for aggregate fish and seafood among urban households in Bangkok and the Northern Region ranged between 0.26 and 0.35, and around 0.12 for meat; our estimates for both food groups are above 0.4. As to own-price demand elasticity, the result is only found in a recent study of Isvilanonda and Kongrith (2008), but not for high-value food items. Moreover, most previous studies did not apply theoretically consistent demand systems. The interdependence of various commodities depending on relative prices, available household budget, and preferences for them were neglected and censored data problems were not addressed. In light of these comparisons, our findings are more robust and reliable. Likewise, findings of our household survey for

a basket of foods in Bangkok and Chiang Mai provide strong evidence of the reliability of our results, particularly for household food consumption patterns in urban areas.

There are very few studies of demand estimation from different supply chain-related attributes but results of a recent study in Vietnam (Mergenthaler *et al*. 2009a) were compared with the results of this study. Our income elasticities for disaggregate FFV show a smaller difference than the Vietnamese results, particularly with FFV from modern retail outlets. This can be explained by the difference in demand responses between "low-income and middle-income countries"; a low income country has a high responsiveness to income change (Seale *et al*. 2003). On the other hand, high income urban households may still purchase FFV from traditional market as they are now have more confidence on these traditional outlets than they had five years ago. Moreover, FFV with specific quality attributes like fresh-cut fruits and pesticide-safe vegetables are more easily found in Thai domestic markets, a situation that is induced by middle class households that can afford such products.

This study also estimated consumers' willingness to pay for certain quality and safety attributes. The "pesticide-safe" attribute was included in the analysis because of the increasing awareness among Thai consumers of negative health impacts associated with pesticide residues. For this attribute, the Contingent Valuation Method was employed. Mean WTP for pesticide-safe products was almost 100 percent for cabbage and more than 50 percent for NamDokMai mango compared to current average market prices. A preference for pesticide-safe products by higher income households is obvious. Other household characteristics have an influence on consumers' preferences, including household size and age and gender of the household head. Additionally, the estimated mean WTP of different educational levels indicates that higher education is associated with a WTP for a premium price on safe products. On average, households in Bangkok have a higher WTP than those in Chiang Mai. Likewise, a higher willingness to pay can be observed for households that use safety criteria in purchasing fresh fruits and vegetables.

The study also estimated consumers' WTP by employing Choice Experiment. Several attributes were considered in this assessment. The trade-off between attribute levels is observed from their marginal rate of substitution. Urban households give the highest priority on pesticide-safe attributes for cabbage and good appearance on NamDokMai mango. Consumers have a premium willingness to pay for both fresh produce if these were certified. However, the demand for organic fresh products seems to exist only in the niche group of consumers as indicated by the lowest magnitude value of marginal willingness to pay. The CE approach assumes that the value of the whole product is equal to the sum of part-worth (Gonzalez *et al*., 2008). Hence, the calculated marginal willingness to pay for certified pesticide-safe cabbage results in a value of 19 baht per kilogram. Urban households are willing to pay 22 baht more per kilogram for pesticide safe NamDokMai that has a certification and good appearance. The percentage premium over current average market price shows results that are very similar to that of the Contingent Valuation Method. Hence, the findings show the robustness of the estimation in consumers' preferences.

The comparison between our WTP estimates with previous studies broadens our general understanding of food safety valuation beyond the situation in Thailand. Several studies have shown that mean WTP for pesticide risk is lower in developed than in developing countries. Authors have pointed out that food regulations in developing countries are often less stringent than in developed countries, which tend to encourage higher rates of pesticide application and thus high concentration of chemical residues and contamination levels (Mergenthaler et at., 2009b; Krishna and Qaim, 2008). In general, only a small number of studies on willingness to pay for safer fruits and vegetables have been conducted in developing countries. In Taiwan, price increments between 46 and 75 percent were found for leafy vegetables with low pesticide residue (Tsu-Tan *et al*., 1999). While mean WTP for residue-free vegetable in India was more than 50 percent above current market prices (Kishna and Qaim, 2008). Mergenthaler *et al*. (2009) showed that the percentage above current market price for safe Pak-Choi in Vietnam was around 60 percent. Vanit-Anunchai and Schmidt (2004) estimated mean WTP for environmentally friendly Chinese cabbage of almost 100 percent in Thailand. The findings of this study for pesticide safe

cabbage closely correlate with Vanit-Ananchai and Schmidt. Results by Mingmori (2006) indicated a potential domestic market for safety improved yellow mango. However, we are not aware of any study that estimated local consumers' WTP for pesticide safe yellow mango in Thailand.

Recommendations and Directions for Future Research

The findings from demand analysis and consumers' valuation hold important implications for supply actors and policy makers. The first part of the demand analysis demonstrates the change in urban household food consumption patterns from staple foods towards high-value and functional foods like fruits, vegetables and meats. This significant change presents an opportunity for supply side actors to increase domestic production of the food items with an increasing demand.

The significant difference between unconditional expenditure elasticity of fresh produce from traditional and emerging supply chain-related attributes suggests that food sector as a whole should adapt to such a change in consumers' preferences. This has direct implication, first on retailers. Particularly those operating in the traditional markets, their new-found strength is that urban Thai consumers have more confidence in traditional markets now than they had five years ago; for this reason they still mainly purchase fresh horticultural produce at wet markets. In this regard, traditional retail outlets could build on this favorable situation to create customer trust and raise their competitiveness by developing safety and quality standards and upgrading fresh produce. Under standard sanitary conditions of traditional markets, the market share of minimally processed fruits and vegetables could be increased. Modern retail outlets, on the other hand, should maintain their reputation and improve product lines with premium standards to reach consumers in the higher class segments. Additionally, reduction in price by efficiency gains will lead to a disproportionate increase in demand for fresh produce from modern retailers and for minimally processed products.

Secondly, the findings have important implications for the upstream stages of the supply chain, particularly the farmers. The larger unconditional expenditure elasticities for safe and quality fresh produce indicate that a rapid growth in income will increase demand for this food group; this should induce an increase in production. Consequently, development strategies for fresh produce should include product differentiation in terms of safety attributes. This could improve incomes of local producers if they can meet the targeted demand. Moreover, farmers could try to directly access the end consumer markets such as making direct sales of fresh produce in the local market. To enable local producers to have a better access to the modern retail sector, the Royal Project Foundation could provide technical assistance and advice to farmers on improved production, farm business management and marketing.

Finally, the findings of this study can provide useful guides to policies that aim to improve the efficiency of the supply chains. Economic growth and development, and policies that foster income growth and better education as well programmes that strengthen the competitiveness of the agribusiness sector will contribute to better nutrition, higher food quality and further dietary diversification. Infrastructure improvement and technological know-how subsidy could help supply side actors, especially small scale farmers to reduce cost of production and marketing process. Public intervention is needed to ensure effective communication with consumers by establishing reliable and credible certification and labeling systems. Additional investments on studies on supply and demand sides would provide key information and knowledge to design efficient policies on food system transformation.

This study is an initial step for disaggregate demand analysis based on Thai household survey data. It can serve as a guideline for demand analysis of other agricultural food products and other quality attributes. Our experience with the delineated methodological framework and the results of this study suggests three improvements, two on methodology and one on research emphasis. The first would be on model estimation and analysis of consumer demand. Although the linear form of Almost Ideal Demand System is suitable for our dataset, other rank demand systems

such as Quadratic Demand System are an option; these can capture more varieties of the Engel curve. Other quality attributes of fresh produce can be included in the Choice Experiment to enable an interpretation of product differentiation. The second recommendation relates to sample size and study areas. A bigger household sample size is required for disaggregate demand analysis in order to develop more significant model implications. The inclusion of other urban areas can account for the variations in market price of food products, allowing an integration of a comprehensive model for quality adjustment. Thirdly, further research on fruit and vegetable consumption behavior with other quality aspects and rural household segments are necessary to increase the understanding of the dynamics of the market and the characteristics of specific markets

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REFERENCES

Agribusiness Research Unit. 1997. **"Strategic Commodity: A Case of Rice".** A Research Paper submitted to Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, Bangkok.

Aksoy, M.A. 2005. The evolution of agricultural trade flows. In M.A. Aksoy and J. Beghin. (ed.). **Global Agricultural Trade and Developing Countries.** Washington DC: World Bank, 17-35.

Alfonzo, L. and H. Peterson. 2006. "Estimating food demand in Paraguay from Household survey data." **Agricultural Economics** 34: 243-257.

Ali, M., T.Q. Nguyen, and V.N. Ngo. 2006. **An analysis of food demand patterns in Hanoi: predicting the structural and qualitative changes.** Technical Bulletin No. 35. AVRDC publication number 06-671. Shanhua, Taiwan: AVRDC – The World Vegetable Center.

Amemiya, T. 1974. "Multivariate regression and simultaneous equation models when dependent variables are truncated normal." **Econometrica** 42(6): 999-1012.

Ara, S. 2003. **Consumer Willingness to Pay for Multiple Attributes of Organic Rice: A Case Study in the Philippines.** The 25th International Conference of Agricultural Economists, Durban, South Africa.

Asatryan, A.A. 2003. **Data Mining of Market Information to Assess At-home Pork Demand.** Doctor of Philosophy Dissertation in Agricultural Economics, Texas A&M University.

Banks, J., R. Blundell, and A. Lewbel. 1997. "Quadratic Engel Curves and Consumer Demand." **The Review of Economics and Statistics** 79 (4): 527-539.

Barnett, W.A. and S. Apostolos. 2008. **Consumer preferences and demand systems.** MPRA Paper 8413. Munich University Library, Munich.

Barten, A. P. 1964. **Family Composition Prices and Expenditure Patterns in Econometric Analysis for National Economic Planning: 16th Symposium of the Colston Society.** ed. By P. Hart, G. Mills, and J. K. Whitaker. London: Butterworth.

Bateman, I. J. and R. T. Carson *et al.* 2002. **Economic Valuation with Stated Preference Techniques.** Academic Publishers.

Ben-Akiva, M. and S. Lerman. 1985. **Discrete Choice Analysis: Theory and Application to Travel Demand.** MIT Press, Cambridge, MA.

Bhadrakom, C. 2008. **Economic Analysis of Food at Home and Food Away from Home Consumption of Thai Households in 2004.** Master of Science Thesis, Department of Agricultural and Resource Economics, Kasetsart University.

Birthal, P.S., P.K. Joshi, and A. Gulati. 2005. **Vertical coordination in high-value commodities: implications for smallholders.** MTID Discussion Paper No. 85, Washington DC: International Food Policy Research Institute.

Blanciforti, L. and R. Green. 1983. "An Almost Ideal Demand System Incorporating Habits: An Analysis of Expenditures on Food and Aggregate Commodity Groups." **Review of Economics & Statistics** 65(3): 511.

Bopape L. and R. Myers. 2007. **Analysis of Household Demand for Food in South Africa: Model Selection, Expenditure Endogeneity, and the Influence of Socio-Demographic Effects.** Selected paper prepared for presentation at the African Econometrics Society Annual Conference, Cape Town, South Africa, July 4-6, 2007.

Boselie, D., S. Henson and D. Weathersppon. 2003. "Supermarket Procurement Practices in Developing Countries: Redefining the Roles of the Public and Private Sectors." **American Journal of Agricultural Economics** 85(5): 1155-1161.

Brosig, S. 2000. **A Model of Household Type Specific Food Demand Behavior in Hungary.** Discussion paper no. 30. Institute of Agricultural Development in Central and Eastern Europe.

Burton, M., D. Rigby, T. Young and S. James. 2001 "Consumer Attitudes to Genetically Modified Organisms in Food in the UK. **European Review of Agricultural Economics** 28(4): 479-498.

Buse, A. and W. H. Chan. 2000. "Invariance, price indices and estimation in almost ideal demand systems." **Empirical Economics**. 25: 519-539.

Calvin, L., F. Gale, D. Hu and B. Lohmar. 2006. "Food Safety Improvements Underway in China." **Amber Waves.** 16–21.

Cameron, T. A. 1988. "A new paradigm for valuing non-market goods using referendum data: maximum likelihood estimation by censored logistic regression." **Journal of Environmental Economics and Management**. 15: 355-379.

Cameron, T. A., G. L. Poe *et al.* 2002. "Alternative non-market value-elicitaion methods: are the underlying preferences the same?" **Journal of Environmental Economics and Management**. 44: 391-425.

Carlssn F., P. Frykblom and C. J. Lagerkvist. 2004. **Consumer Willingness to Pay for Farm Animal Welfare Transportation of Farm Animals to Slaughter versus the Use of Mobile Abattoirs.** Working Papers in Economics No. 149 Department of Economics, Gothenburg University.

Carpentier, A. and H. Guyomard. 2001. "Unconditional elasticities in two-stage demand systems: an approximate solution." **American Journal of Agricultural Economics** 83(1): 222-229.

CGIAR. 2004. **Revised Summary Report on Developing CGIAR System Priorities for Research.** Science Council working paper. Washington DC: CGIAR

Chalfant, J.A. 1987. "A Global Flexible, Almost Ideal Demand System." **Journal of Business and Economic Statistic** 5: 233-242.

Champ, P.A. and K. J. Boyle *et al.* 2003. **The Economics of Non-Market Goods and Resources: A Primer on Nonmarket Valuation**. Kluwer Academic Publishers.

Chaobankor, S. 2002. **Economic Value of Chemical-free Attribute in Vegetables: The Choice Modelling Approach.** Master of Science Thesis, Faculty of Economics, Thammasart University. (In Thai)

Chern, W.S., K. Ishibashi, K. Taniguchi and Y. Tokoyama. 2003. **Analysis of Food Consumption Behavior by Japanese Households.** FAO Economic and Social Development Paper. 152.

Christiadi and B. Cushing. 2007. **Conditional Logit, IIA, and Alternative for Estimating Models of Interstate Migration.** 46th Annual Meeting of the Southern Regional Science Association. Charleston, SC.

Colombo, S., N. Hanley and J. Calatrava-Requena. 2005. "Designing Policy for Reducing the Off farm Effects of Soil Erosion Using Choice Experiments." **Journal of Agricultural Economics** 56(1): 81-95.

Cox, T. L. and M. K. Wohlgenant. 1986. "Prices and Quality Effects in Cross-Sectional Demand Analysis." **American Agricultural Economics Association**. 908-919.

Daroonpate, A. *et al.* 2005. **Domestic Fruit Consumption and Fruit Export of Thailand.** Department of Agricultural and Resource Economics, Kasetsart University. (In Thai)

Deaton, A. 1988. "Quality, quantity, and spatial variation of price." **American Economic Review**. 78: 418-429.

Deaton, A. and J. Muellbauer. 1980a. **Economics and Consumer Behavior.** Cambridge: Cambridge University Press.

_____. 1980b. "An Almost Ideal Demand System." **American Economics Review**. Vol. 30 No.3 pp. 312-326.

Decoster, A. and F. Vermeulen. 1998. **Evaluation of Empirical Performance of Two-Stage Budgeing AIDS, QUAIDS and ROTTERDAM Models Based on Weak Separability,** Center for Economic Studies, Katholieke Universiteit Leuven. Discussion Paper Series DPS 98.08.

Dong, D., B.W. Gould, and H.M. Kaiser. 2004. "Food demand in Mexico: An application of the Amemiya-Tobin approach to the estimation of a censored food system." **American Journal of Agricultural Economics.** 86(4): 1094-1107.

Eaton C. and A. W. Sheperd. 2001. **Contract farming: partnerships for growth.** Agricultural Service Bulletin 145, Rome: Food and Agriculture Organization of the United Nations.

Ecker, O. 2008. **Economics of Micronutrient Malnutrition: The Demand for Nutrients in Sub-Saharan Africa.** Doctor of Philosophy Dissertation in Agricultural Sciences, Faculty of Agricultural Sciences, University of Hohenheim, Stuttgart.

Edgerton, D. L. 1997. "Weak Separability and the Estimation of Elasticities in Multistage Demand Systems." **American Journal Agricultural Economics**. 79: 62-79.

Fan, S., J. Wailes, E. and L. Cramer. 1995. "Household Demand in Rural China: A Two-Stage LES-AIDS Model." **American Journal Agricultural Economics**. 77: 54-62.

FAO and WHO. 2004. **Fruits and Vegetables for Health: Report of a Joint** FAO/WHO Workshop. Kobe, Japan.

FAO. 2006. **The State of Food and Agriculture in Asia and the Pacific.** RAP PUBLICATION 2006/03

Florkowski, W. J. 2006. "Fruit and Vegetable Quality, the Value of Time and Marketing." **Acta Hort**. 712.

Gale, F. and K. Huang. 2007. **Demand for Food Quantity and Quality in China.** Economic Research Report Number 32, USDA.

Gorton, M., J. Sauer and P. Supatpongkul. 2009. **Investigating Thai Shopping Behavior: Wet-Markets, Supermarkets and the 'Big Middle'**. the International Association of Agricultural Economists Conference. Beijing, China.

Gould, B. W., T. L. Cox and F. Perali. 1990. "The Demand for Fluid Milk Products in the U.S.: A Demand Systems Approach." **Western Journal of Agricultural Economics** 15(1): 1-12.

Gould, B.W. and H.J. Villarreal. 2006. "An assessment of the current structure of food demand in urban China." **Agricultural Economics** 34: 1-16.

Green, R. and J.M. Alston. 1990. "Elasticities in AIDS models." **American Journal Agricultural Economics**. 72: 442-445.

Greene, W.H. 2003. **Econometric Analysis.** 5th ed. New Jersy: Prentice-Hall, Inc.

Gregory, N.G. 2000. Consumer concerns about food. **Outlook on Agriculture** 29(4): 251-257.

Grunert, K. G. 2005. "Food quality and safety: consumer perception and demand." **European Review of Agricultural Economics** 32(3): 369-391.

Gulati, A. and N. Minot. 2005. **Growth in high-value agriculture in Asia and the emergence of vertical links with farmers.** Paper presented at the workshop "Linking Small-Scale Producers to Markets: Old and New Challenges" The World Bank.

Haab, T. C. and K. E. McConnell. 2003. **Valuing Environmental and Natural Resources. The Econometrics of Non-Market Valuation.** Edward Elger.

Halcoussis, D. 2005. **Understanding Econometrics**, South-Western, part of the Thomson Corporation.

Hamemam, M. W., J. Loomis, and Kanninen. 1991. "Statistic Efficiency of Double Bounded Dichotomous Choice Contingent Valuation." **American Journal of Agricultural Economics.** 73: 1255-1263.

Hardeweg, B. and H. Waibel. 2006. **A Spatial Model of Vegetable Production in Thailand: Results and Policy Implications.** Tropentag**.** October 11-13, 2006. Bonn.

Hau, A. M. and M. V. Oppen *et al.* 2004. **The Efficiency of the Vegetable Market in Northern Thailand.** Conference on International Agricultural Research for Development, Deutscher Tropentag 2004, Berlin, October 5-4, 2004.

Hausman, J. and D. McFadden. 1984. Specification Test for the Multinomial Logit Model. **Econometrica** 52: 1219-1240.

Heckman, J. J. 1976. "The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models." **Annals of Economic and Social Measurement** 5(4): 475-492.

Heien, D. and C. R. Wessells. 1990. "Demand Systems Estimation with Microdata: A Cencored Regression Approach." **Journal of Business & Economic Statistics.** Vol. 8 No. 3.

Henson, S. and T. Reardon. 2005. "Private agri-food standards: implications for food policy and the agri-food system." **Food Policy** 30(3): 241-253.

Hruzova, V. 2002. **The Thai Cabbage Market- Analysis of Price and Market Efficiency.** Master Thesis, Hohenhiem University, Germany.

Huang, J. and C. C. David. 1993. "Demand for Cereal Grains in Asia: The Effect of Urbanization." **Agricultural Economics** 8: 107-124.

Huang, K. S. and B. H. Lin. 2000. **Estimation of food demand and nutrient elasticities from household survey data.** Technical Bulletin No. 1887, Food and Rural Division, Economic Research Service, U.S. Department of Agriculture, Washington Dc.

International Trade Center. 2001. **World markets for organic fruit and vegetables: opportunities for developing countries in the production and export of organic horticultural products** (Online). www.fao.org, December, 2009.

Isvilanonda, S. and J. Patrawart *et al.*. 2006. **A Study on Marketing System of the Royal Project Products. (Translate from Thai original).** Center of Applied Economics Research, Faculty of Economics, Kasetsart University. (In Thai)

Isvilanonda, S. and W. Kongrith. 2008. "Thai Household's Rice Consumption and Its Demand Elasticity." **ASEAN Economic Bulletin.** 25 (3): 271-82.

Jabarin, A. 2005. "Estimation of meat demand system in Jordan: an almost ideal demand system." **International Journal of Consumer Studies** 29: 232-238.

Jealviriyapan, P. 2001. **Agribusiness Management towards Strengthening Agricultural Development and Trade: Agribusiness Research on Marketing and Trade, Fruit Marketing System in Thailand.** Multiple Cropping Center, Chiang Mai University, National Chung Hsing University and The Ministry of Agriculture and Cooperatives, retrieved March, 2008.

Jedele, S. 2002**. The Importance of the World Market for Mangos for Developing Countries with Special Consideration of Thailand.** Diploma Thesis, Department of International Economics, University of Hohenheim, Germany.

Jitsanguan, T., A. Noomhorm and B. Sootsukon. 2004. **Trend and Situation on Agricultural Organic Business in Thailand.** Asian Institute of Technology. (In Thai)

Johnson, G. I., K. Weinberger and M. Wu. 2008**. The Vegetable Industry in Tropical Asia: Thailand.** An Overview of Production and Trade, The World Vegetable Center.

Junsongsang, W. 2004. **Cabbage with poison. (Translate from Thai original)** Sarakadee Magazine, 20 (237): 73-87 (online). www.sarakadee.com, December, 2009. (In Thai)

Kaewsuk N. 2004. **A Study on Household Expenditure Behavior of Fresh Vegetables Consumption.** Master of Science Thesis, Department of Agricultural and Resource Economics, Kasetsart University. (In Thai)

Kanlayanarat, S. and B. McGlasson. 2003. "A Chain of Quality: Linking Quality Aspects in the Chain to Meet Consumer Demand." **Acta Hort**. 604.

Kaye-Blake, W. H. 2006. **Demand for Genetically Modified Food: Theory and Empirical Findings.** Doctor of Philosophy Dissertation in Economics. Lincoln University.

Kedir, A. and S. Girma. 2007. "Quadratic Engel Curves with Measurement Error: Evidence from a Budget Survey." **Oxford Bulletin of Economics and Statistics**. 69

Knowles, T., R. Moody and M.G. McEachern. 2007. "European food scares and their impact on EU food policy." **British Food Journal** 109(1): 43-67.

Kongrith, W. 2009. **The Thai Rice Economy: Could Thailand Maintain Its Future Exportable Surplus?** Doctor of Philosophy Thesis in Agricultural Economics, Department of Agricultural and Resource Economics, Kasetsart University.

Kosulwat, V. 2002. "The nutrition and health transition in Thailand." **Public Health Nutrition**: 5(1A): 183-189.

Kramol, P. and K. Thong-ngam *et al.* 2006. "Challenges in Developing Pesticide-free and Organic Vegetable Markets and Farming Systems for Smallholder Farmers in North Thailand. Proc. It is on Supply Chains in Transitional Econ." **Acta Hort**. 699, ISHS 2006. P. J. Batt.

Krishna, V. V. and M. Qaim. 2008. "Consumer Attitudes toward GM Food and Pesticide Residues in India." **Review of Agricultural Economics.** 30(2): 233-251.

Le, C. Q. 2008. "An Empirical Study of Food Demand in Vietnam." **ASEAN Economic Bulletin** 25(3): 283-292.

Lee, L.-F. and M.M. Pitt. 1986. "Microeconometric demand systems with binding non-negativity constraints: The dual approach." **Econometrica**. 54(5): 1237-1242.

Leser, C.E. 1963. "Forms of Engel Function." **Economics** 22: 43-62.

Lewbel, A. 1996. "Aggregation without separability: A generalized composite commodity theorem." **American Economic Review**. 86(3): 524-543.

Liao, W.-C., T.-R. Lee. *et al*. 2001. **Agribusiness Management towards Strengthening Agricultrual Development and Trade.** Agribusiness Research on Marketing and Trade: The Comparison of Vegetable Marketing Systems of Urban Cities in Taiwan and Thailand. Thailand, Multiple Cropping Center, Chiang Mai University and National Chung Hsing University and The Ministry of Agriculture and Cooperatives.

Lin, W., A. Somwaru, F.Tuan, J. Huang and J. Bai. 2006. "Consumers' Willingness to Pay for Biotech Foods in China: A Contingent Valuation Approach." **AgBioForum**. 9(3): 166-179.

Liu, K. E. and W. S. Chern. 2001. **Effects of Model Specification and Demographic Variables on Food Consumption: Microdata Evidence from Jiangsu, China.** The Area of Focus: Area II Changing Consumer. Paper presentation for 11th Annual World Food and Agribusiness Forum, World Food and Agribusiness Symposium of the international Food and Agribusiness Management Association to be held in Sydney, Australia, June 27-28, 2001.

Loureiro, M. L. and W. J. Umberger. 2007. "A choice experiment model for beef: What US consumer responses tell us about relative preferences for food safety, country-of-origin labeling and traceability." **Food Policy**. 32(4): 496-514.

Louviere, J. J. 2001. Choice experiments: an overview of concepts and issues. In J. Bennett & R. Blamey (Eds.), **The choice modeling approach to environmental valuation** (pp.13-36). Cheltenham, UK: Edward Elgar Publishing Ltd.

Louviere, J., D. Hensher and J. Swait. 2000. **Stated Choice Methods: Analysis and Applications.** Cambridge University Press, Cambridge.

Lusk, J. L. 2003. "Effects of Cheap Talk on Consumer Willingness-to-Pay for Golden Rice." **American Journal of Agricultural Economics** 85(4): 840.

MaFadden, D. 2001. "Economic Choices." **The American Economic Review** 91 (3): 351-378.

McFadden, D. 1974. **Conditional logit.** In P. Zarembka (Ed.), Frontiers in econometrics. New York: Academic Press.

Menezes, T. A., C. R. Azzoni and F. G. Silveira. 2008. "Demand elasticities for food products in Brazil: a two-stage budgeting system." **Applied Economics**. 40: 2557-2572.

Mergenthaler, M. 2008. **The Food System Transformation in Vietnam: Challenges for the Horticultural Sector posed by Exports and by Changing Consumer Preferences.** Doctor of Philosophy Dissertation in Agricultural Sciences, Faculty of Agricultural Sciences, University of Hohenheim, Stuttgart.

Mergenthaler, M., K. Weinberger and M. Qaim. 2009a. "The food system transformation in developing countries: A disaggregate demand analysis for fruits and vegetables in Vietnam." **Food Policy** 34: 426-436.

_____. 2009b. "Consumer Valuation of Food Quality and Food Safety Attributes in Vietnam." **Review of Agricultural Economics** 31(2): 266-283.

Mergenthaler, M., M. Qaim *et al*. 2006. "The Demand for Unpolluted Agricultural Products in the Great Cities of Vietnam." **Science & Technology Journal of Agricultural & Rural Development** 11: 4-7. (In Vietnamese version).

Meyerhoefer, C.D., C.K. Ranney and D.E. Sahn. 2003. **Consistent estimation of longitudinal censored demand systems: An application to transition country data.** Ithaca: Working Paper 2003-33. Cornell University.

Meyerhoefer, C.D., C.K. Ranney and D.E. Sahn. 2005. "Consistent estimation of censored demand systems using panel data." **American Journal of Agricultural Economics**. 87(3): 660-672.

Michelini, C. 1999. "The estimation of rank 3 demand system with demographic demand shifters from quasi-unit record data of household consumption." **Economics Letters.** 65 (1999): 17-24.

Mingmori, K. 2006. **Consumer's Behavior and Factors Affecting Buying Decision of Chemical Safe of Namdokmai Mangoes in Bangkok Metropolitan.** Master of Science (Agricultural Economics), Department of Agricultural and Resource Economics, Kasetsart University, Bangkok, Thailand

Mogas, J., P. Riera. And J. Bennett. 2005. "A Comparison of Contingent Valuation and Choice Modelling with Second-Order Interactions." **Journal of Forest Economics** 12: 5-30.

Moschini, G. 1995. "Units of Measurement and the Stone Index in Demand System Estimation." **American Journal Agricultural Economics**. 17: 63-68.

Muellbauer, J. 1977. "Testing the Barten Model of Household Composition Effects and the Cost of Children." **Economic Journal**. 87: 460-487.

Narrod, C. and D. Roy *et al.* 2007. **The Role of Public-Private Partnerships and Collective Action in Ensuring Smallholder Participation in High Value Fruit and Vegetable Supply Chains.** Research Workshop on Collective Action and Market Access for Smallholders October 2-5, 2006 Cali, Colombia. CAPRi Working Paper No. 70 • OCTOBER 2007.

National Food Institute. 2009. **Report of Thai food industry (April 2009).** Food Intelligence Center/ http://fic.nfi.or.th (In Thai)

National Statistic Office. 2005. **The population health care behavior survey 2005 (Food consumption behavior).** Ministry of Information and Communication Technology Thailand (In Thai).

Nicholson, W. 2004. **Microeconomic theory: basic principles and extension**. 9th ed. Australia: South-Western/Thomson learning.

Oates, C. 2006. **"Quality and safety of fruits and vegetables in Thailand**: **Annex 9."** Proceedings of the FAO/AFMA workshop on quality and safety in the traditional horticultural marketing chains of Asia. pp. 97-104.

Park, J. and O. Capps Jr. 2002. "Impacts of Advertising, Attitudes, Lifestyles, and Health on the Demand for U.S. Pork: A Micro-Level Analysis." **Journal of Agricultural and Applied Economics** 33: 1-15.

Patmasiriwat, D. and T. Poldee. 1990. **Consumption of Rice, Vegetables, Fruits, and Meat of Thai Households.** Paper presented in the Annual Conference of the Economic Society of Thailand, Bangkok, 9–10 November 1990.

Patweekonga, S. 2004. **Consumer Behavior toward Pesticide-Free Vegetables in Bangkok, Thailand.** Proc. Of the 1st KMITL International Conference on Integration of Science & Technology for Sustainable Development, Bangkok, Thailand. 25-26 August 2004. 2: 87-89.

Penau, S., E. Hoehn, H.-R. Roth, F. Escher and J. Nuessli. 2006. "Importance and consumer perception of freshness of apples." **Food Quality and Preference**. 17: 9–19.

Perali, F. and J.-P. Chavas. 2000. "Estimation of censored demand equations from large cross-section data." **American Journal of Agricultural Economics**. 82(4): 1022-1037.

Pindyck, R. S. and D. L. Rubinfeld. 2009. **Microeconomics.** New York: Pearson Prentice Hall.

Pingali, P. 2007. "Westernization of Asian diets and the transformation of food systems: Implications for research and policy." **Food Policy** 32(3): 281-298.

Pittman, F. G. 2004. **Drivers of Demand, Interrelationships, and Nutritional Impacts Within the Nonalcoholic Beverage Complex.** Doctor of Philosophy Dissertation in Agricultural Economics, Texas A&M University.

Piumsombun, S. 2003. "Analysis of Demand for Fish Consumed at Home in Thailand." **Department of Fisheries (DOF), Thailand.** 56: No. 2 March-April 2003.

Pollak, R. A. and T. J. Wales. 1980. "Comparison of the Quadratic Expenditure System and Translog Demand Systems with Alternative Specifications of Demographic Effects." **Econometrica.** 48: 595-612.

_____. 1981. Demographic Variables in Demand Analysis. **Econometrica**. 49: 1533-1551.

Posri, W., B. Shankar and S. Chadbunchachai. 2007. "Consumer Attitudes Towards and Willingness to Pay for Pesticide Residue Limit Compliant Safe Vegetables in Northeast Thailand." **Journal of International Food & Agribusiness Marketing** 19 (1).

Prais, S. J. and H. S. Houthakker. 1955. **The Analysis of Family Budgets.** Cambridge: Cambridge University Press.

Purithewate N. 2004. **An Analysis of Household Expenditure on Fruit Consumption in Bangkok Metropolitan.** Master of Science Thesis, Agricultural and Resource Economics, Kasetsart University. (In Thai)

Putthawong, P. and J. Tejawaree *et al.* 2008. **The Study of Impact of the Early Harvest Program Trade Agreement of Fruits Products between Thailand and China (Translate from Thai original).** Social Research Institute, Chiang Mai University, Thailand. (In Thai)

Qaim, M. and A. D. Janvry. 2003. "Genetically Modified Crops, Corporate Pricing Strategies, and Farmers' Adoption: The Case of BT Cotton in Argentina." **American Journal Agricultural Economics** 85(4): 814-828.

_____., J. V. Braun and H. T. Seeth. 1997. **Food Consumption in Russia: Econometric Analyses with Household Data.** Discussion Paper, Series: The Russian Food Economy in Transition.

Ragaert, P. and W. Verbeke *et al.* 2004. "Consumer perception and choice of minimally processed vegetables and packaged fruits." **Food Quality and Preference** 15(3): 259-270.

Rattanapanone, N., C. Chongsawat and C. Soungsuda. 2000. "Fresh-cut Fruits in Thailand." **HORTSCINCE** 35(4).

Reardon, T. and C. P. Timmer *et al.* 2003. "The Rise of Supermarket in Africa, Asia, and Latin America." **American Journal of Agricultural Economics**. 85: 1140-1146.

Regmi, A. and J. Dyck. 2001. **Effect of Urbanization on Global Food Demand: Changing Structure of Global Food Consumption and Trade.** Market and Trade Economics Division, Economic Research Service, U.S. Department of

Reilly, A. 2004. **Defining the responsibilities and tasks of different stakeholders within the framework of a national strategy for food control.** Second FAO/WHO Global Forums of Food Safety Regulators. Bangkok, Thailand.

Rigby, D. and M. Burton. 2003. **Capturing Preference Heterogeneity in State Choice Model: a random parameter logit model of the demand for GM food.** Manchester, UK: School of Economics, Manchester University.

Roessler, R. and A. G. Drucker *et al.* 2008. "Using choice experiments to assess smallholder farmers' preferences for pig breeding traits in different production systems in North-West Vietnam." **Ecological Economics** 66(1): 184-192.

Roitner-Schobesberger, B. and I. Darnhofer *et al.* 2008. "Consumer perceptions of organic foods in Bangkok, Thailand." **Food Policy** 33(2): 112-121

Sadashivappa, P. and M. Qaim. 2009. **Effects of Bt Cotton in India During the First Five Years of Adoption.** International Association of Agricultural Economists' 2009 Conference. Beijing, China.

Sadoulet, E. and A. d. Janvry. 1995. **Quantitative Development Policy Analysis,** The Johns Hopkins Press, Baltimore, London.

Sakagami, M., M. Sato and K. Ueta. 2006. "Measuring consumer preferences regarding organic labelling and the JAS label in particular. New Zealand" **Journal of Agricultural Research** 49: 247–254.

Sanglestsawai, S. 2006. **Assessing Consumer Preferences for Doikham Safe Vegetables in Bangkok: A Choice Modeling Approach.** Master of Science Thesis, Department of Agricultural and Resource Economics, Kasetsart University. (In Thai)

Sa-nguanpuag, K., S. Kanlayanarat and K. Tanprasert. 2007. "Trends of Fresh Cut Produce in Thai Retail Markets for Identification of Packaging for Shredded Green Papaya." **Acta Hort**. 746

Schmidt, E. and S. Isvilanonda. 2002. "Food consumption expenditure structure in Thailand 1998: the case of vegetables." **ISHS Acta Horticulture**. 655: 99-106.

Schroder, M. J. A. 2003. **Food Quality and Consumer Value: Delivering Food that Satisfies.** New York: Springer-Verlag Berlin Heidelberg.

Seale, J., A. Regmi and J. Bernstein. 2003. **International Evidence on Food Consumption Patterns.** Volume, DOI: www.ers.usda.gov. Retrieved November, 2009.

Sectoral Economic Program (SEP). 1992a. **Food situation outlook in Asia: a case study of Thailand.** Thailand Development Research Institute (TDRI), Bangkok, Thailand.

_____. 1992b. **Vegetables and Fruits in Thailand: Supply and Demand.** Thai-EC Northeast Fruit and Vegetable Project, Thailand Development Research Institute (TDRI), Bangkok, Thailand.

Senauer, B., E. Asp and J. Kinsey. 1993. **Food Trends and the Changing Consumer.** Eagan Press.

Shiptsova, R., L. Goodwin, H., Jr., and B. Holcomb, R. 2004. "Household Expenditure Patterns for Carbohydrate Sources in Russia." **Journal of Agricultural and Resource Economics** 29(2): 296-307.

Shonkwiler, J.S. and S.T. Yen. 1999. "Two-step estimation of a censored system of equations." **American Journal of Agricultural Economics**. 81(4): 972-982.

Straub, M. 2002. **Supply and demand of fruits, vegetables and pulses: A market study in Thailand**. Master Thesis, Hohenheim University, Germany.

Su, S. B. and S. T. Yen. 2000. "A censored system of cigarette and alcohol consumption." **Applied Economics**. 32: 729-737.

Subhadrabandhu, S. and O. Wongwanich. 1996. "Status of the Fruit and Vegetable Industry inThailand." **Kasetsart Journal (Soc. Sci.)**, 17, 170-180.

Sutthipongpan, A. 2005. **An Analysis of Household Behavior on Meat Consumption in Thailand.** Master of Science Thesis, Department of Agricultural and Resource Economics, Kasetsart University. (In Thai)

Tey, Y.S. and M. N. Shamsudin *et al.* 2008. "A Complete Demand System of Food in Malaysia." **Journal of Agricultural Economics** 5(3): 17-29.

Thong-ngam, K., P. Kramol, N. Teerakul, J. Puangmanee and N. Chowsilpa. 2002. **Consumers' Consumption Behavior and Interest in Participatory Development in Pesticide-Free Vegetable Production in Chiang Mai Province.** Chiang Mai. (in Thai): Multiple Cropping Center.

Tokrisna, R. 2006. **Thai changing retail food sector: consequences for consumers, producers and trade** (Online)**.** Economic Profile Paper, Pacific Economic Cooperation Council, Pacific Food System Outlook 2005-2006 "A Revolution in Food Retailing". http://www.pecc.org/food/papers/2005-2006/Thailand/tncpec-ruangrai-paper.pdf, December, 2009.

Train, K.E. 1998. "Recreation Demand Models with Taste Differences Across People." **Land Economics.** 74(2): 230-235.

_____. 2003. **Discrete Choice Methods with Simulation.** Cambridge, UK: Cambridge University Press.

Tranter, R. B. and R. M. Bennett *et al.* 2009. "Consumers' willingness-to-pay for organic conversion-grade food: Evidence from five EU countries." **Food Policy** 34(3): 287-294.

Trienekens, J. and P. Zuurbier. 2008. "Quality and Safety Standards in the Food Industry, Developments and Challenges" **International Journal of Production Economics** 113(1): 107-122.

Tsu-Tan, F. and L. Jin-Tan *et al.* 1999. "Consumer Willingness to Pay for Low-Pesticide Fresh Produce in Taiwan." **Journal of Agricultural Economics.** 50(2): 220-233.

Unnevehr, L. J. 2000. "Food safety issues and fresh food product exports from LDCs." **Agricultural Economics** 23(3): 231-240.

_____. 2003. **Food Safety in Food Security and Food Trade: Overview,** International Food Policy Research Institute.

USDA. 2004. **Thailand Retail Food Sector.** GAIN Report No. TH4143.

_____. 2005. **New Direction of Global Food Market.** GAIN Report No. 794.

_____. 2006. **Thailand Organic Products**. GAIN Report No. TH6007.

_____. 2007. **Thailand Exporter Guide Report.** GAIN Report No.TH7152.

Vanit-Anunchai, C. 2006. **Possibilities and Constraints of Marketing Environmentally Friendly Produced Vegetables in Thailand.** Doctor rerum politicarum dissertation in Economic Sciences, Faculty of Economics. Leibniz University Hannover.

Vanit-Anunchai, C. and E. Schmidt. 2004. "Consumer willingness to pay for environmentally friendly produced vegetables in Thailand." **Acta Horticulture**. 655: 107-113.

Varanyanond, W. 2000. **Food Security in Asia and the Pacific: Thailand.** Asian Productivity Organization: APO. pp. 294-304.

Vichitrananda, S. and Somsri, S. 2008. "Tropical Fruit Production in Thailand." **Acta Horticulture. (ISHS)**, 787, 33-46.

Vinning, G. and C. Tshering. 2005. **Recent Trends and Future Prospects of Fruit and Vegetable Marketing in Asia and the Pacific --An Overview.** The Seminar of Improvement of Agricultural Marketing Systems for Enhancing International Competitiveness. Islamabad, Asian Productivity Organization.

Wales, T.J. and A.D. Woodland. 1983. "Estimation of consumer demand systems with binding non-negativity constraints." **Journal of Econometrics** 21(3): 263-285.

Weinberger, K. and T. A. Lumpkin. 2006. **High value agricultural products in Asia and the Pacific for small-holder farmers: Trends, opportunities and research priorities.** How can the Poor Benefit from the Growing Markets for High Value Agricultural Products. CIAT, Cali, Colombia.

Wiboonpongse, A. and S. Sriboonchitta. 2004. **Securing small producer participation in restructured national and regional agri-food systems in Thailand.** Research Report, IIED Regoverning Markets Program, Chiang Mai University, Thailand.

Wikstrom, D. 2003. **Willingness to pay for Sustainable Coffee. A Choice Experiment Approach.** Master Thesis, Department of Business Administration and Social Science, LuLea University of Technology.

Working, H. 1943. "Statistical Laws of Family Expenditure". **Journal of the American Statistical Association**. 38: 43-56.

Yen, S. T. and C. Fang. 2004. "Household food demand in urban China: a censored system approach". **Journal of Comparative Economics** 32: 564-585.

Yen, S.T. and B. H. Lin. 2006. "A sample selection approach to censored demand systems". **American Journal of Agricultural Economics**. 88(3): 742-749.

Yen, S.T., K. Kan, and S. J. Su. 2002. "Household demand for fats and oils: Two-step estimation of a censored demand system." **Applied Economics**. 34 (14): 1799-1806.

Zellner, A. 1962. "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias." **Journal of the American Statistical Association** 57: 348-68.

APPENDICES

Appendix A

Available data and Estimated Result Tables

Appendix Table A1 Land use in Thailand (Unit: Rai)

Year	Whole Kingdom	Areas of agricultural holding by land use								
		Total	Residence	Paddy Rice	Field Crop	Fruit Plantations	Vegetables/ Flowers	Pasture/Pen	Unused Land	Others
1986	320,696,888	130,898,940	3,109,040	74,223,803	32,724,161	14,323,982	538,850	833,285	3,596,032	1,549,787
1987	320,696,888	131,202,622	3,140,279	72,169,171	33,457,581	15,999,491	753,458	837,416	3,546,687	1,298,539
1988	320,696,888	131,772,759	3,226,960	70,827,661	33,240,928	17,755,015	750,826	768,461	3,845,151	1,357,757
1989	320,696,888	131,831,185	3,285,163	70,189,879	33,137,811	18,660,145	708,729	750,235	3,814,397	1,284,826
1990	320,696,888	132,124,409	3,361,565	69,436,107	33,415,198	19,428,795	805,851	740,435	3,679,803	1,256,655
1991	320,696,888	133,076,188	3,454,464	69,253,120	33,510,922	20,255,876	858,180	742,268	3,560,781	1,440,577
1992	320,696,888	132,051,209	3,461,547	68,835,616	32,795,010	20,849,471	881,726	749,713	3,319,692	1,158,434
1993	320,696,888	131,270,893	3,476,337	68,336,567	32,228,127	20,998,898	931,164	743,604	3,238,848	1,317,348
1994	320,696,888	131,833,288	3,494,454	68,320,651	32,130,516	21,638,423	937,789	751,710	3,236,149	1,323,596
1995	320,696,888	132,478,570	3,518,683	68,292,753	32,011,185	22,318,991	957,934	760,940	3,221,465	1,396,619
1996	320,696,888	131,819,506	3,516,309	67,547,556	31,119,785	23,131,363	959,523	741,965	3,151,272	1,651,733
1997	320,696,888	131,107,608	3,505,524	66,695,947	30,101,204	24,132,029	961,182	718,642	3,036,300	1,956,780
1998	320,696,888	130,393,525	3,491,908	65,914,065	29,051,965	25,079,407	961,792	693,143	2,950,814	2,250,431
1999	320,696,888	131,341,384	3,578,872	65,686,993	2,876,500	26,075,492	1,025,811	802,414	2,864,219	2,521,083
2000	320,696,888	131,195,913	3,598,823	65,412,560	28,535,387	26,350,915	1,091,015	846,891	2,796,521	2,563,801
2001	320,696,888	131,059,974	3,628,223	65,220,587	28,241,647	26,584,191	1,152,867	885,625	2,744,835	2,601,999
2002	320,696,888	130,892,013	3,652,699	65,124,470	28,035,295	26,636,756	1,188,320	889,008	2,718,630	2,646,835
2003	320,696,888	130,682,025	3,643,462	64,892,333	27,944,482	26,762,771	1,208,932	919,046	2,627,126	2,683,873

Appendix Table A1 (Continued)

Year	Whole Kingdom	Areas of agricultural holding by land use								
		Total	Residence	Paddy Rice	Field Crop	Fruit Plantations	Vegetables/ Flowers	Pasture/Pen	Unused Land	Others
2004	320,696,888	130,480,284	3,627,302	64,658,948	27,788,606	26,848,043	1,224,015	1,012,798	2,602,411	2,718,161
2005	320,696,888	130,275,993	3,610,930	63,861,066	27,400,423	27,787,972	1,229,808	1,103,271	2,532,003	2,750,521
2006	320,696,888	130,290,717	3,609,998	63,551,124	27,249,969	28,626,646	1,236,938	1,132,083	2,290,823	2,593,136
2007	320,696,888	130,353,309	3,678,021	63,877,461	26,619,118	29,061,372	1,215,856	1,121,073	2,204,503	2,575,905

Source: Office of Agricultural Economics. www.oae.go.th , Retrieved December, 2009

Appendix Table A2 The estimated regression of unit value

Variable	Logarithm of unit value of							
	FF	**FV**	**RG**	**Meat**	**FS**	**OFF**	**PFV**	**OPF**
Total expenditure (log)	0.1618***	0.0875***	0.0758***	-0.0107	0.2046***	0.0401	0.0475	0.0932***
	[0.0257]	[0.0322]	[0.0187]	[0.0192]	[0.0484]	[0.0256]	[0.0654]	[0.0358]
Din Daeng district	0.2229***	0.1459	0.0061	0.1157*	0.3680***	0.2419***	0.1080	-0.0428
	[0.0678]	[0.1099]	[0.0861]	[0.0644]	[0.1277]	[0.0882]	[0.2171]	[0.1233]
Dusit district	0.2031**	0.1916	0.1750**	0.1024	0.4411***	0.2429**	0.5063**	0.0273
	[0.0826]	[0.1203]	[0.0846]	[0.0690]	[0.1408]	[0.0966]	[0.2378]	[0.1350]
Jom Thong district	0.3329***	0.3051***	0.1628**	0.0679	0.4807***	0.2467***	0.3060	0.0857
	[0.0716]	[0.1081]	[0.0826]	[0.0626]	[0.1285]	[0.0868]	[0.2117]	[0.1213]
Khlong Toei district	0.4867***	0.2530**	0.1086	0.0938	0.4303***	0.3091***	0.2787	0.0251
	[0.0778]	[0.1106]	[0.0834]	[0.0624]	[0.1260]	[0.0883]	[0.2191]	[0.1234]
Wangthonglang district	0.2479***	0.3162***	0.1640*	0.0439	0.3548***	0.1642*	0.3180	0.0025
	[0.0675]	[0.1112]	[0.0844]	[0.0643]	[0.1280]	[0.0893]	[0.2216]	[0.1247]
Yannawa district	0.2819***	0.2089*	0.1911**	0.1512**	0.5259***	0.2477***	0.3138	0.0070
	[0.0697]	[0.1136]	[0.0803]	[0.0650]	[0.1107]	[0.0912]	[0.2254]	[0.1275]
Kawila sub-district	0.0345	-0.0086	0.1142	-0.0538	0.2519**	0.2417***	0.4305*	0.0728
	[0.0655]	[0.1108]	[0.0839]	[0.0634]	[0.1210]	[0.0888]	[0.2182]	[0.1240]
Meng-Rai sub-district	0.0073	-0.0522	0.2047**	-0.0461	0.2274*	0.0779	0.1757	0.0659
	[0.0663]	[0.1134]	[0.0922]	[0.0645]	[0.1298]	[0.0907]	[0.2248]	[0.1268]
Nakorn-Ping sub-district	0.0111	-0.0297	0.0348	0.0147	0.3827***	0.1939**	-0.1075	0.0496
	[0.0671]	[0.1120]	[0.0819]	[0.0634]	[0.1096]	[0.0899]	[0.2244]	[0.1257]

Appendix Table A2 (Continued)

Variable	Logarithm of unit value of							
	FF	**FV**	**RG**	**Meat**	**FS**	**OFF**	**PFV**	**OPF**
Sri-Vichai sub-district	-0.0104	0.0189	0.0951	-0.0059	0.2466*	0.1262	0.4346*	-0.0252
	[0.0662]	[0.1156]	[0.0879]	[0.0666]	[0.1385]	[0.0929]	[0.2277]	[0.1298]
Size (log)	0.1077***	0.0002	0.0238	-0.0056	0.1492**	-0.0315	-0.0918	-0.0006
	[0.0313]	[0.0397]	[0.0254]	[0.0240]	[0.0598]	[0.0318]	[0.0812]	[0.0444]
Female labor	-0.0503*	0.0145	-0.0075	0.0185	0.0012	-0.0570*	-0.1467*	-0.1185***
	[0.0289]	[0.0400]	[0.0259]	[0.0237]	[0.0580]	[0.0320]	[0.0812]	[0.0448]
Education year	0.0005	0.0093**	0.0030	0.0010	0.0050	0.0010	-0.0023	0.0092*
	[0.0033]	[0.0043]	[0.0025]	[0.0026]	[0.0064]	[0.0035]	[0.0088]	[0.0049]
Age	0.0009	0.0013	0.0007	0.0016*	0.0034*	-0.0014	0.0000	0.0020
	[0.0009]	[0.0014]	[0.0009]	[0.0008]	[0.0020]	[0.0011]	[0.0028]	[0.0015]
Constant	1.1017***	2.1234***	1.9874***	4.3255***	1.3311**	3.3003***	3.5635***	2.9871***
	[0.2995]	[0.3938]	[0.2287]	[0.2311]	[0.5668]	[0.3131]	[0.8009]	[0.4375]
R-square	0.3384	0.1340	0.1051	0.0750	0.1283	0.0694	0.0550	0.0553
Observation	499	496	469	452	422	500	457	500

Note: *, **, *** Estimates are significant at the 10%, 5% and 1% level, respectively. Numbers in parentheses are robust standard errors for FF, RG, FS and standard error for the other commodities. The estimated percentage change in total expenditure can be interpreted as quality expenditure elasticity.

Source: Estimated based on household survey data.

Appendix Table A3 Probit estimation of the decision to purchase aggregate food item of food at home

	RG	Meat	FS	PFV
Total expenditure (log)	0.1942	-0.3189**	-0.0029	0.0802
	[0.1368]	[0.1274]	[0.1157]	[0.154]
Price-FF (log)	-0.0053	0.5867**	0.1499	-0.0146
	[0.2844]	[0.2741]	[0.2205]	[0.3024]
Price-FV (log)	-0.0505	-0.2168	-0.5615***	-0.1521
	[0.2324]	[0.2289]	[0.1896]	[0.1728]
Price-RG (log)	0.9153**	-0.0434	0.1532	0.0081
	[0.3710]	[0.3105]	[0.2463]	[0.2692]
Price-Meat (log)	-0.4438	-0.1479	-0.052	-0.1924
	[0.2999]	[0.2598]	[0.2272]	[0.2598]
Price-FS (log)	-0.1007	0.0021	-0.0259	0.1554
	[0.1707]	[0.1273]	[0.1144]	[0.1429]
Price-OFF (log)	-0.1857	-0.1715	-0.3763*	-0.2264
	[0.2828]	[0.2088]	[0.1999]	[0.2067]
Price-PFV (log)	-0.2179	-0.2403**	-0.0156	0.0356
	[0.1834]	[0.1192]	[0.0913]	[0.0786]
Price-OPF (log)	-0.0829	0.0174	0.144	0.2653
	[0.2491]	[0.1988]	[0.1808]	[0.2138]
Size (log)	1.3049***	0.8284***	0.6858***	0.4749***
	[0.2125]	[0.1740]	[0.1546]	[0.1618]
Female labor	-0.3386	0.0129	0.0173	-0.2923*
	[0.2059]	[0.1771]	[0.1476]	[0.1710]
Education	-0.0204	-0.0232	-0.0537***	0.007
	[0.0185]	[0.0200]	[0.0155]	[0.0162]
Bangkok	-0.1373	-0.6073***	0.1268	-0.0737
	[0.2320]	[0.2186]	[0.1740]	[0.2037]
Constant	0.2397	5.8430***	2.9372*	0.3348
	[2.3488]	[1.9769]	[1.6618]	[1.9822]
Wald chi2	69.53	73.6	49.96	22.48
N	31	48	78	43

Note: *, **, *** Estimates are significant at the 10%, 5% and 1% level, respectively. N denotes the number of households that reported zero consumption. Numbers in parentheses are robust standard errors.

Source: Estimated based on household survey data.

Appendix Table A4 Probit estimation of the decision to purchase disaggregate fresh fruits and vegetables item of food at home

Variable	Place of purchase		Safety and Quality indications		Convenience attribute		Source of production	
	Traditional retailers	Modern retailers	Informal indicators	Formal indicators	No minimally processed	Minimally processed	Domestic	Import
Total Expenditure (log)	-0.2832	0.3440**	0.4996**	0.0256	0.0061	-0.2450**	-0.0685	0.4647**
	[0.1871]	[0.1599]	[0.2521]	[0.2323]	[0.1171]	[0.1217]	[0.2306]	[0.1837]
Price-traditional FFV (log)	0.5115	-0.0826	1.0386***	0.2958	0.5324**	-0.3661	1.0875**	0.4341**
	[0.3817]	[0.1917]	[0.2798]	[0.2198]	[0.2192]	[0.2509]	[0.4455]	[0.2197]
Price-high value FFV (log)	0.3165	0.1191	-0.6565***	0.0512	0.2866*	0.6359**	-0.2041	-0.3098*
	[0.1966]	[0.1599]	[0.2259]	[0.2351]	[0.1605]	[0.2525]	[0.2478]	[0.1717]
Price-RG (log)	-0.103	0.2340	0.0115	0.1786	-0.6001**	0.5449*	0.4056	0.2560
	[0.4275]	[0.2171]	[0.2799]	[0.2439]	[0.2828]	[0.3094]	[0.3625]	[0.2450]
Price-Meat (log)	-0.2128	-0.1019	0.0391	-0.2547	-0.1996	0.0857	0.3737	0.1133
	[0.2771]	[0.2060]	[0.3332]	[0.2161]	[0.2663]	[0.3726]	[0.3631]	[0.2111]
Price-FS (log)	-0.4473**	-0.0891	-0.2050	0.3591***	0.0473	0.2164	-0.5486**	0.0684
	[0.2017]	[0.1197]	[0.1705]	[0.1362]	[0.1490]	[0.1693]	[0.2147]	[0.1190]
Price-OFF (log)	-0.07	0.2581	1.1310***	0.3904**	-0.0159	0.0238	1.4184***	0.0235
	[0.2637]	[0.1837]	[0.3226]	[0.1727]	[0.2124]	[0.2186]	[0.4670]	[0.1815]
Price-PFV (log)	0.001	0.0593	0.1530*	0.1745**	0.0019	0.0686	-0.0843	0.0510
	[0.0967]	[0.0725]	[0.0818]	[0.0876]	[0.1025]	[0.0840]	[0.1626]	[0.0740]
Price-OPF (log)	-0.0428	0.0210	-0.2641	0.0577	-0.1099	0.0571	0.4340**	0.1418
	[0.2001]	[0.1352]	[0.1668]	[0.1334]	[0.1862]	[0.2391]	[0.2112]	[0.1349]
Size (log)	-0.1935	0.0844	-0.2596	0.0316	0.0535	-0.0383	-0.2446	0.4779***
	[0.1968]	[0.1300]	[0.1909]	[0.1427]	[0.1650]	[0.1766]	[0.1745]	[0.1407]
Female labor	-0.3279	0.2658**	-0.1747	-0.0048	-0.1199	-0.1774	0.2838	-0.2208
	[0.2260]	[0.1290]	[0.1869]	[0.1491]	[0.1846]	[0.2118]	[0.2769]	[0.1446]
Education year	-0.0542**	0.0530***	-0.0323	0.0215	-0.0436**	0.0259	0.0727***	0.0093
	[0.0261]	[0.0141]	[0.0244]	[0.0160]	[0.0208]	[0.0220]	[0.0280]	[0.0153]
White collar	0.6732	-0.3823**	0.6395*	-0.6498***	0.1111	-0.2072	-0.7417*	-0.1510
	[0.4252]	[0.1934]	[0.3378]	[0.2401]	[0.2828]	[0.3151]	[0.3887]	[0.2218]

Appendix Table A4 (Continued)

Variable	Place of purchase		Safety and Quality indications		Convenience attribute		Source of production	
	Traditional retailers	Modern retailers	Informal indicators	Formal indicators	No minimally processed	Minimally processed	Domestic	Import
Workers	0.5751**	-0.5976***	0.0066	-0.3250**	-0.0057	-0.2319	-0.2527	-0.1473
	[0.2594]	[0.1416]	[0.1956]	[0.1606]	[0.1978]	[0.2267]	[0.3343]	[0.1571]
Distance 1	-0.0665**	0.0085	-0.0520	0.0140	-0.0524	-0.0019	-0.0652**	0.0415
	[0.0300]	[0.0258]	[0.0345]	[0.0232]	[0.0336]	[0.0407]	[0.0319]	[0.0256]
Awareness	-0.0776	-0.1625	0.7007**	0.4892	-0.0238	0.7855***	-0.4358	0.5615*
	[0.4802]	[0.2588]	[0.2790]	[0.3518]	[0.3458]	[0.2803]	[0.4273]	[0.3236]
Bangkok	-0.5631**	0.3265**	0.5319**	-0.1136	-0.0729	-0.4443*	n	0.0436
	[0.2853]	[0.1459]	[0.2072]	[0.1640]	[0.1770]	[0.2615]		[0.1558]
Diseases	0.0161	0.2955**	0.3044	0.1543	0.1326	0.1402	-0.2891	-0.0452
	[0.2199]	[0.1255]	[0.2045]	[0.1389]	[0.1736]	[0.1965]	[0.2349]	[0.1359]
Constant	7.3162***	-6.3327***	-8.3655***	-6.3684***	2.1986	-0.6061	-6.7695***	-9.9384***
	[2.5603]	[1.7863]	[3.1538]	[2.2262]	[2.0779]	[2.4518]	[2.5637]	[1.8901]
Log likelihood	-72.76	-285.94	-108.89	-223.08	-141.05	-99.09	-64.11	-242.60
Chi-square	50.56	71.37	68.05	44.71	36.26	60.44	51.38	57.51
N	22	318	47	401	47	32	20	382

Note: Note: *, **, *** Estimates are significant at the 10%, 5% and 1% level, respectively. N denotes the number of households that reported zero consumption. Numbers in parentheses are robust standard errors. n: Variable is not included due to perfect co linearity with the dependent variable

Source: Estimated based on household survey data.

Appendix Table A5 The comparison of demand elasticities with the other studies

Commodity	Own estimated results		Results from previous studies		
	Unconditional expenditure elasticity	Own-price elasticity	Expenditure elasticity	Own-price elasticity	Authors/Year
Food at home	0.52	-	0.45[a]	-	Bhadrakom, 2008
			0.50[b]		
Food away from home	1.05	-	0.91[c]	-	
			1.17[d]		
Fruits	0.44	-0.46	0.85[e]	-	Daroonpate *et al*., 2005
vegetables	0.54	-0.63	0.18[f]	-	Schmidt and Isvilanonda, 2002
Rice	0.21	-0.27	-0.17	-0.26	Isvilanonda and Kongrith, 2008
Meat	0.71	-0.84	0.11-0.12	-	Sutthipongpan, 2005
Fish & Seafood	0.69	-0.51	0.26-0.35	-	
Fruits & Vegetables					
Modern retail outlets	0.70	-1.10	2.50	-1.50	
Safety and Quality indications	0.61	-0.94	1.16	-1.12	Mergenthaler *et al*., 2009
Minimally processed	0.57	-0.81	-	-	(Vietnamese household consumers)
Imported fresh produces	0.64	-0.35	2.59	-1.17	

Note: a and b are expenditure elasticity for food prepare at home for households in Bangkok and North region, respectively. c and d are expenditure elasticity for food away from home for households in Bangkok and North region, respectively. e and f is the elasticity of group expenditure with respect to total food expenditure.

Appendix B

Correlation structure of commodity prices

Price correlation structure of aggregate food items

	ln_p1	ln_p2	ln_p3	ln_p4	ln_p5	ln_p6	ln_p7	ln_p8
ln_p1	1.0000							
ln_p2	0.3448	1.0000						
ln_p3	0.1847	0.1375	1.0000					
ln_p4	0.1377	0.1523	0.1945	1.0000				
ln_p5	0.2329	0.1505	0.2400	0.2650	1.0000			
ln_p6	0.1619	0.0236	0.0850	0.0500	0.1088	1.0000		
ln_p7	0.0729	0.1017	0.0710	0.0933	0.1517	0.0434	1.0000	
ln_p8	0.0899	0.1587	0.1561	-0.0095	0.1562	0.1248	0.0216	1.0000

Price correlation structure of disaggregate and aggregate food items in sub-demand system for place of purchase

	ln_p1	ln_p2	ln_p3	ln_p4	ln_p5	ln_p6	ln_p7	ln_p8
ln_p1	1.0000							
ln_p2	0.2537	1.0000						
ln_p3	0.1570	0.2895	1.0000					
ln_p4	0.1455	0.2447	0.1945	1.0000				
ln_p5	0.1934	0.3323	0.2400	0.2650	1.0000			
ln_p6	0.0652	0.0855	0.0877	0.0632	0.1074	1.0000		
ln_p7	0.1117	0.1101	0.0710	0.0933	0.1517	0.0353	1.0000	
ln_p8	0.0705	0.1880	0.1561	-0.0095	0.1562	0.0783	0.0216	1.0000

Price correlation structure of disaggregate and aggregate food items in sub-demand system for safety and quality indications

	ln_p1	ln_p2	ln_p3	ln_p4	ln_p5	ln_p6	ln_p7	ln_p8
ln_p1	1.0000							
ln_p2	0.3896	1.0000						
ln_p3	0.2205	0.3010	1.0000					
ln_p4	0.1193	0.2640	0.1945	1.0000				
ln_p5	0.2705	0.3589	0.2400	0.2650	1.0000			
ln_p6	0.2555	0.1748	0.1089	0.0991	0.1418	1.0000		
ln_p7	0.1424	0.1048	0.0710	0.0933	0.1517	0.0171	1.0000	
ln_p8	0.1329	0.1626	0.1561	-0.0095	0.1562	0.0988	0.0216	1.0000

Price correlation structure of disaggregate and aggregate food items in sub-demand system for convenience attribute

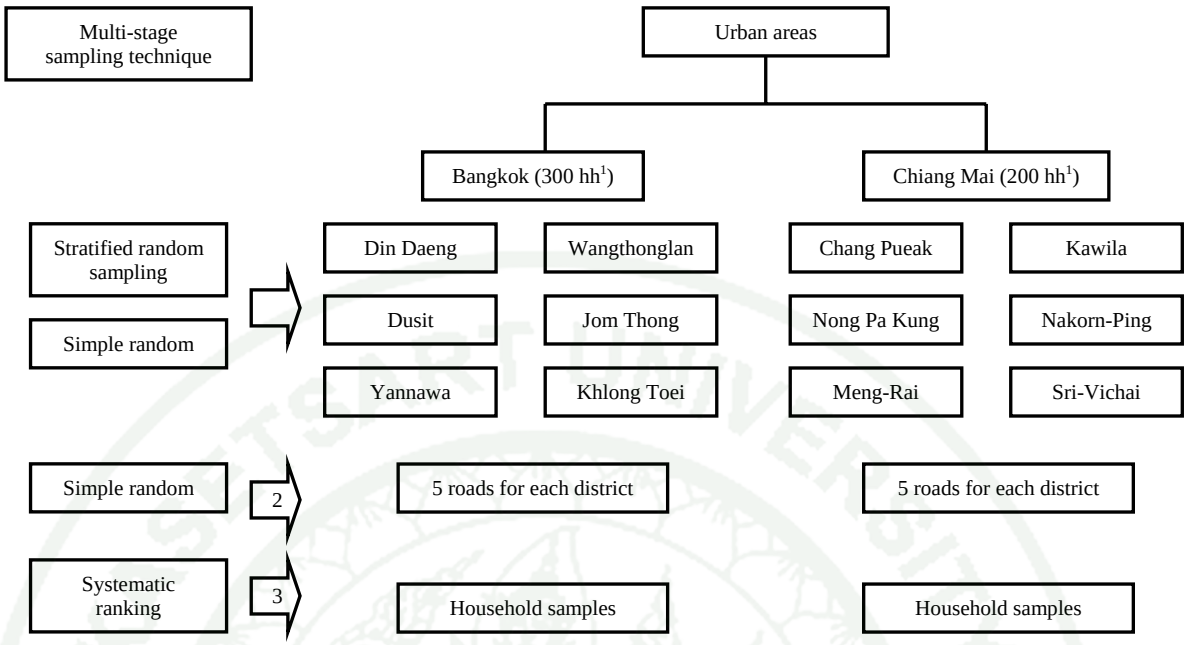
	ln_p1	ln_p2	ln_p3	ln_p4	ln_p5	ln_p6	ln_p7	ln_p8
ln_p1	1.0000							
ln_p2	0.3257	1.0000						
ln_p3	0.1227	0.2688	1.0000					
ln_p4	0.1261	0.1633	0.1945	1.0000				
ln_p5	0.1545	0.2404	0.2400	0.2650	1.0000			
ln_p6	0.1043	0.1150	0.0808	0.0650	0.1137	1.0000		
ln_p7	0.1058	0.0847	0.0710	0.0933	0.1517	0.0356	1.0000	
ln_p8	0.0748	0.1367	0.1561	-0.0095	0.1562	0.1148	0.0216	1.0000

Price correlation structure of disaggregate and aggregate food items in sub-demand system for source of production

	ln_p1	ln_p2	ln_p3	ln_p4	ln_p5	ln_p6	ln_p7	ln_p8
ln_p1	1.0000							
ln_p2	0.3109	1.0000						
ln_p3	0.2267	0.2275	1.0000					
ln_p4	0.1557	0.2854	0.1945	1.0000				
ln_p5	0.2224	0.3651	0.2400	0.2650	1.0000			
ln_p6	0.1268	0.2082	0.0997	0.0614	0.1009	1.0000		
ln_p7	0.1076	0.0619	0.0710	0.0933	0.1517	0.0669	1.0000	
ln_p8	0.1637	0.1194	0.1561	-0.0095	0.1562	0.1140	0.0216	1.0000

Appendix C

Sampling procedure and questionnaire design



Note: [1] household

Appendix Figure C1 Framework of survey design in Bangkok and Chiang Mai urban areas

Appendix Table C1 The calculation of sampling household in Bangkok by district

i	**District**	**Number of household*** ***(THD$_i$)***	**Number of sampling household** ** ***(SHD$_i$)***
1	Wangthonglang	47,392	53
2	Din Daeng	47,791	53
3	Yanawa	38,345	43
4	Dusit	29,452	33
5	Jom Thong	56,368	63
6	Khlong Toei	49,166	55
TH^{BKK}	Total of household	268,514	300

Note: * Data obtained by Bangkok Metropolitan Administration ** Own calculation

Appendix Table C2 The calculation of sampling household in urban areas of Chiang Mai by districts/sub-districts

i	District / Sub-district	No. of household* (THD_i)	Number of sampling household** (SHD_i)
7	Meng-Rai	16,299	44
8	Kawila	18,693	51
9	Nakorn-Ping	17,129	46
10	Sri-Vichai	14,111	38
11	Chang Pueak	6,128	16
12	Nong Pa Kung	1,777	5
TH^{CNX}	Total HH in district	75,872	200

Note: * Data obtained by local government in Chiang Mai ** Own calculation

Appendix Table C3 The calculation of sampling households by road in Bangkok

j	District / Road	Estimated no. of Household ($EHR_{j\ in\ i}$)	Number of Sampling Household** ($SHR_{j\ in\ i}$)
	Wangthonglang (THD_1)	**309**	**53**
1	Soi Lat Phrao 110	187	32
2	Soi Tawanrong 5	15	3
3	Soi Lat Phrao 120	44	7
4	Soi Nawa Si 11	7	1
5	Soi Jakkrit 1	56	10
	Din Daeng (THD_2)	**255**	**53**
1	Soi Rong Rian Ratcha Prasong	77	16
2	Soi Ratchadapisek 3	44	9
3	Soi Inthamara 24	28	6
4	Soi Sutthi Phong 1	35	7
5	Soi Prem Sombat Yak 2	71	15
	Yanawa (THD_3)	**481**	**43**
1	Soi Chan 23	34	3
2	Soi Sathu Pradit 28	139	12
3	Soi Sathu Pradit 15	196	18
4	Soi Amon	95	8
5	Soi Satu Pradit 53	17	2

Appendix Table C3 (Continued)

j	District / Road	Estimated no. of Household ($EHR_{j\ in\ i}$)	Number of Sampling Household** ($SHR_{j\ in\ i}$)
	Dusit (THD_4)	**256**	**33**
1	Soi Ratchawithi 40	29	4
2	Sukhantharami Road	95	12
3	Soi Ratchawithi 30	33	4
4	Soi Si Yan 1	88	11
5	Soi Sutcharit 2	11	2
	Jom Thong (THD_5)	**459**	**63**
1	Rama II Soi 38	233	32
2	Soi Wutthakat 47	34	5
3	Rama II Soi 39	56	8
4	Soi Chom Thong 7	53	7
5	Rama II Soi 24	83	11
	Khlong Toei (THD_6)	**201**	**55**
1	Soi Sukhumvit 30	27	8
2	Soi Sam Thahan	48	13
3	Soi Phunsap 2	34	9
4	Soi Sukhumvit 10	45	12
5	Soi Roem Charoen	47	13

Note: * the data from map sketches and estimations of household by enumerators.**
Own Calculation

Appendix Table C4 The calculation of sampling households by road in Chiang Mai

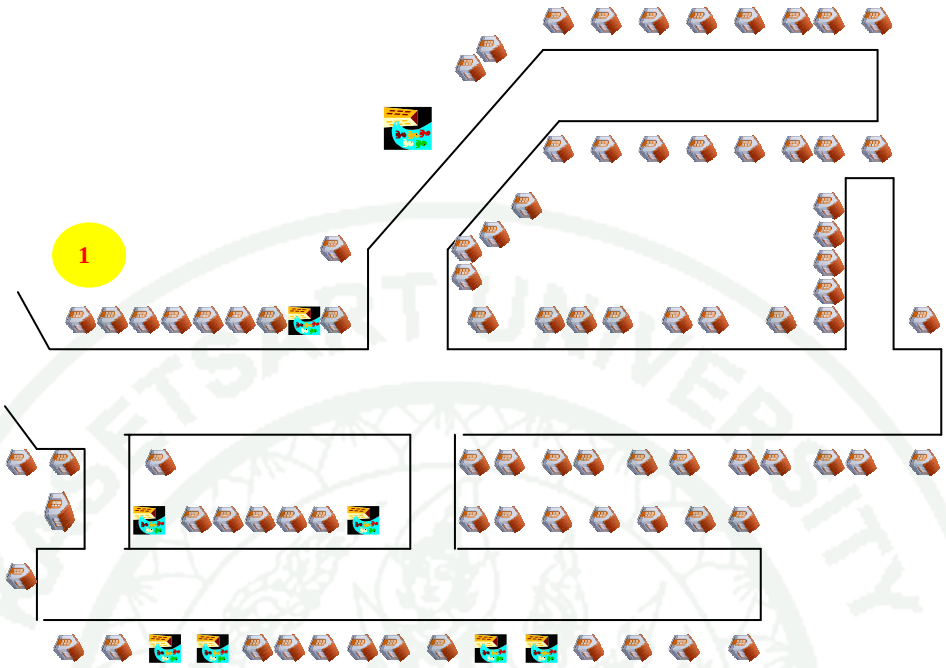
j	District / Road	Estimated no. of Household ($EHR_{j\ in\ i}$)	Number of Sampling Household** ($SHR_{j\ in\ i}$)
	Meng-Rai sub-district (THD_7)	**296**	**44**
1	Vaeing-Ping Road	91	14
2	Woa-Rai Road.	109	16
3	Sri-Don-Chai Road	23	3
4	Prachasumphun Ro//ad.	30	4
5	Kotchasarn Road (1-2-3)	43	7

Appendix Table C4 (Continued)

j	District / Road	Estimated no. of Household ($EHR_{j\ in\ i}$)	Number of Sampling Household** ($SHR_{j\ in\ i}$)
	Kawila sub-district (THD_8)	**303**	**51**
1	Soi Kai Daeng	57	10
2	Doi Sa-ket Kao	47	8
3	Charoen Rat Road.	50	8
4	Na Watket	22	4
5	Thung Hotel	127	21
	Nakorn-Ping sub-district (THD_9)	**310**	**45**
1	Sanam-Kela Road.	68	10
2	Soi Pa-ton Ngam	41	6
3	Ratchavitee Road.	67	10
4	Sukasem Road.	67	10
5	Chang-moi kao Road	67	10
	Sri-Vichai sub-district (THD_{10})	**182**	**37**
1	Ratchavitee Road.	8	2
2	Intharavararot Road	68	14
3	Sirithorn	66	14
4	Thepsatit lane	20	4
5	Maneenoparat	20	4
	Chang Pueak (THD_{11})	**64**	**16**
1	Soi Potharam 112	10	2
2	Soi Kaing Doi 3	6	2
3	Mae Kua Mung Rd.	24	6
4	Mae Kua Mung Soi 1	5	1
5	Kai Luk Suea Soi 1	19	5
	Nong Pa Kung (THD_{12})	**1,777**	**5*** **

Note: * the data from map sketches and estimations of hh by enumerators. ** own calculation

*** Due to Nong Pa Kung municipal district just became part of the municipal area, road data were not always consistent. Hence, we randomly selected households by a population list of the local government office.



Appendix Figure C2 Rama II Soi 24 in Jom Thong District, Bangkok

Note: Number 1 describes the starting point of the counting interval number, which equal to $83/11 \approx 8$ for this road.

Source: Estimation by mapping.

Appendix Table C5 Choice set of cabbage

Choice set	Attributes	Alternative I	Alternative II	Status quo
A	Price	70	70	20
	Chemical Residue	Safety	Organic	Conventional
	Certificate	Certificate	Non-certificate	Non-certificate
B	Price	35	50	20
	Chemical Residue	Safety	Organic	Conventional
	Certificate	Non-certificate	Certificate	Non-certificate
C	Price	20	20	20
	Chemical Residue	Organic	Safety	Conventional
	Certificate	Non-certificate	Certificate	Non-certificate
D	Price	35	35	20
	Chemical Residue	Conventional	Organic	Conventional
	Certificate	Non-certificate	Certificate	Non-certificate
E	Price	50	50	20
	Chemical Residue	Conventional	Safety	Conventional
	Certificate	Non-certificate	Non-certificate	Non-certificate

Source: Orthogonal design in SPSS and pre-survey

Appendix Table C6 Choice set of NamDokMai mango

Choice set	Attributes	Alternative I	Alternative II	Status quo
A	Price	75	75	35
	Appearance	Quite good	Good	Quite good
	Chemical-residue	Organic	Conventional	Conventional
	Certificate	Certificate	Non-certificate	Non-certificate
B	Price	55	55	35
	Appearance	Quite good	Good	Quite good
	Chemical-residue	Safety	Conventional	Conventional
	Certificate	Non-certificate	Certificate	Non-certificate
C	Price	75	75	35
	Appearance	Good	Quite good	Quite good
	Chemical-residue	Safety	Conventional	Conventional
	Certificate	Certificate	Non-certificate	Non-certificate
D	Price	35	35	35
	Appearance	Quite good	Good	Quite good
	Chemical-residue	Organic	Conventional	Conventional
	Certificate	Certificate	Non-certificate	Non-certificate
E	Price	35	95	35
	Appearance	Good	Quite good	Quite good
	Chemical-residue	Safety	Safety	Conventional
	Certificate	Certificate	Non-certificate	Non-certificate
F	Price	95	95	35
	Appearance	Good	Good	Quite good
	Chemical-residue	Organic	Conventional	Conventional
	Certificate	Non-certificate	Certificate	Non-certificate
G	Price	55	55	35
	Appearance	Good	Quite good	Quite good
	Chemical-residue	Organic	Conventional	Conventional
	Certificate	Non-certificate	Certificate	Non-certificate

Source: Orthogonal design in SPSS and pre-survey

Appendix D

Questionnaire

The Uplands Program

Consumer Questionnaire

Consumer demand for quality fruits and vegetables of the urban households in Bangkok and Chiang Mai, Thailand

			Code
Location:	O Bangkok: District…… Name of road/land…….	Begin	O L 01
	O Chiang Mai: Sub-District……Name of road/land…….	at……	O L 02

Part A Introduction REC A

1	Do you normally buy food product for your family? O_1 Yes O_0 No If the respondent answers "no", the interviewer still work in question 2 and also insert an explanation to the respondent that all information provided will be held strictly confidential followed your comments.	A01…….
2	Do you have at least knowledgeable about the food purchase? O_1 Yes O_2 Fairly O_0 No O_3 Others……. If the respondent answer "no" again, the interviewer ask "who is the person buy the product?" and appointment to interview again or break up the interview.	A02…….....
3	How far from your home to go to the supermarket? ……meter	A03…..…..
4	How far from your home to go to the fresh market? ……..…. meter	A04…..…..
5	Usually, where do you buy normal food? O_1 Fresh market O_2 Hyper/Supermarket O_3 Specific stores O_4 Trade Fair O_5 Farmer directly O_6 Own production O_7 Others.....	A05…..…..

HH-CODE……..

6	Usually, where do you buy fresh vegetables?				A06…..…..
	O_1 Fresh market	O_2 Hyper/Supermarket	O_3 Specific stores	O_4 Trade Fair	
	O_5 Farmer directly	O_6 Own production	O_7 Others.....		
7	Usually, where do you buy fresh fruit?				A07…..…..
	O_1 Fresh market	O_2 Hyper/Supermarket	O_3 Specific stores	O_4 Trade Fair	
	O_5 Farmer directly	O_6 Own production	O_7 Others.....		
8	How do you normally go to buy food? , how much time (minutes or hours)? (Refer place to purchase question no. 5)				A08…..…..
	O_1 Private car and use time……..	O_2 Taxi and use time……	O_3 Sky train or subway and use time……		
	O_4 Private motorbike and use time……..	O_5 Public bus and use time……..	O_6 Others……..and use time……		
9	What kind of safety and quality assurance do you normally use, when buying fresh fruits and vegetables? (more than 1 answer until 3 answers)				A09…..…..
	O_1 no concern		O_5 “Q” or “GAP” certificate from Department of Agriculture, Ministry of Agriculture		
	O_2 appearance of product		O_6 standard of organic agricultural products		
	O_3 trust to seller		O_7 brand ……..		
	O_4 food safety symbol from Ministry of Public Health		O_{99} not specified		

HH-CODE……..

10	Where do the fruits and vegetables you normally buy come from? O_1 The mountainous region in the north O_2 The lowland of the central region O_3 The western of Thailand O_4 The eastern of Thailand O_5 The south of Thailand O_6 The northeastern of Thailand O_7 China O_8 Japan O_9 Other Asian countries except China and Japan O_{10} Europe O_{11} United State O_{12} Australia & New Zealand O_{99} not specified……. (Unlabeled, label but no concern, etc.)	A10…..…..

11 Source of Information: Where do you usually get the information of quality fruits and vegetables? A11…..…..

Source of Information	Information of quality fruits and vegetables		
	Yes	No	
11.1 Television	1	0	A11.1….
11.2 Radio	1	0	A11.2……
11.3 Billboards	1	0	A11.3……
11.4 Print Media	1	0	A11.4……
11.5 Internet	1	0	A11.5……
11.6 Brochure	1	0	A11.6……
11.7 Others……	1	0	A11.7……

HH-CODE……..

Part B Household Expenditure REC B

B1 Food Expenditure B1

a Fresh vegetables (How often do you buy fresh vegetables? Respondent's answer……..) B1a

What kind of fresh vegetables did you buy or have in the last 7 days? B1a1	Product Code B1a2	Where did you buy or get the products? (Place of purchase) B1a3	Quantity B1a4	Amount of money (baht) B1a5		What kind of pre-processing did you buy fresh vegetable? B1a6	What kind of safety and quality assurance did you use, when you buy fresh vegetable? B1a7	Where did the vegetables you buy come from? B1a8	
				Price (baht/kg)	Value (baht)				
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8. .									
9.									
10.									
11.									
12.									
13.									
14									
15.									

b Fresh Fruits (How often do you buy fresh fruits? Respondent's answer……..) B1b

What kind of fresh fruits did you buy or have in the last 7 days? B1b1	Product Code B1b2	Where did you buy or get the products? (Place of purchase) B1b3	Quantity B1a4	Amount of money (baht) B1b5		What kind of pre-processing did you buy fresh fruit? B1b6	What kind of safety and quality assurance did you use, when you buy fresh fruit? B1b7	Where did the vegetables you buy come from? B1b8	
				Price (baht/kg)	Value (baht)				
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8. .									
9.									
10.									
11.									
12.									
13.									
14									
15.									

Part C Factors that have influence on purchased decision for quality fruits and vegetables REC C

C1 Products attribute

Which of the following three choices do you prefer for each choice set? (Use plan card to ask respondent and tick in the choice that you would prefer for each choice set.)

1. Fresh vegetables (cabbage)

Choice Set	Alternative 1	Alternative 2	Alternative 3	
A	O	O	O	
B	O	O	O	
C	O	O	O	
D	O	O	O	
E	O	O	O	

2. Fresh fruit (NamDokMai mango)

Choice Set	Alternative 1	Alternative 2	Alternative 3	
A	O	O	O	
B	O	O	O	
C	O	O	O	
D	O	O	O	
E	O	O	O	
F	O	O	O	
G	O	O	O	

C2 Willingness to pay (WTP) for safety fruits and vegetables					C2
a	Safety fresh vegetables				C2a
	1 You usually pay for conventional cabbage (last week)……..baht/kg.				
	2 Assume there is the same kind of vegetable but it is an safety vegetable, in the same amount as you normally buy, would you willing to pay for pesticide safe cabbage as……baht/kg.				
	O Yes (Please continue 3)		O No (Please continue 4)		
	3 If the price of pesticide safe cabbage increases to.....baht/kg. Would you still be willing to pay it?		4 If the price of pesticide safe cabbage decreases to.....baht/kg. Would you still be willing to pay it?		
	O Yes	O No	O Yes	O No	
	Why do you willing to pay for this price? O Health	O Environment	O Others……..		

b	Safety fresh fruits				C2b
	1 You usually pay for conventional yellow mango (CV. NamDokmai) (last week)……..baht/kg.				
	2 Assume there is the same kind of fruits but it is an safety fruits, in the same amount as you normally buy, would you willing to pay for pesticide safe yellow mango (CV.NamDokmai) as……baht/kg.				
	O Yes (Please continue 3)		O No (Please continue 4)		
	3 If the price of pesticide safe yellow mango increases to.....baht/kg. Would you still be willing to pay it?		4 If the price of pesticide safe yellow mango decreases to.....baht/kg. Would you still be willing to pay it?		
	O Yes	O No	O Yes	O No	
	Why do you willing to pay for this price? O Health	O Environment	O Others……..		

C3 Quality attribute Which attributes do you consider as quality attributes for fruits and vegetables in general? (Please tell the 3 attributes and ranking from 1 (most important) until 3 (least important)) 1…… 2…… 3……	C3

C4 Attitude and opinion							C4
Please score your opinion for these statements. 1 strongly agree 2 agree 3 neutral 4 disagree 5 strongly disagree 9 don't know							
statements	1	2	3	4	5	9	
4.1 Consuming fruits and vegetables is useful for health.							C4.1…….
4.2 Compare five years ago, you are more confident to consume safety fruits and vegetables from fresh market.							C4.2…….
4.3 Despite using chemical in plantation, you agree that it is safe for consumer because you usually wash the fruits and vegetables before cooking.							C4.3…….
4.4 Quality & safety fruits or vegetables are only in supermarkets or specialty store such as Doi Khum, Lemon Farm and etc.							C4.4…….
4.5 Higher price of fruits and vegetables indicates better quality and safety of the products.							C4.5…….
4.6 Controlling every production process can create more confidence for cooking to consumer							C4.6…….
4.7 You have confident probably in the claim promised fruits and vegetables which are certified by the "safety food" symbol.							C4.7…….
4.8 You have confident probably in the claim promised fruits and vegetables which are certified by the "Q" symbol.							C4.8…….
4.9 You have confident probably in the claim promised fruits and vegetables which are certified by the "Organic" symbol from the government.							C4.9…….
4.10 You have confident probably in the claim promised fruits and vegetables which are certified by the "Organic" symbol from the private.							C4.10…..
4.11 A package is used as a tool to create confidence probably in the claim promised fruits and vegetables.							C4.11…..
4.12 You have confident probably in the claim promised fruits and vegetables which are certified by the private brand.							C4.12…..
4.13 You have confident probably in the claim promised fruits and vegetables which are certified by the Royal Project brand.							C4.13…..
4.14 Government of Thailand should spend money to support farmer and producer to control quality in production strictly.							C4.14…..

C5 Important criteria for decision to purchase fresh fruits and vegetables. Which important criteria that you use when you decide to purchase fresh fruits and vegetables? (Please tell the 3 attributes and ranking from 1 (most important) until 3 (least important)) 1…… 2…… 3……	C5

c Preserved fruits and vegetables B1c

	How often do you buy preserved fruits and vegetables foods? Respondent's answer……..										
	What kind of preserved fruits and vegetables did you buy or have in last 1 month? B1c1	Product Code B1c2	Where did you buy or get the products? (Place of purchase) B1c3	Kind of Processing B1c4	Kind of packaging B1c5	Quantity B1c6	Amount of money (baht) B1c7		What kind of safety and quality assurance did you use, when you buy them? B1c8	Where did the preserved fruits and vegetables you buy come from? B1c9	
							Price (baht/unit)	Value (baht)			
	1										
	2										
	3										
	4										
	5										
	6										
	7										
	8										
	9										
	10										
	11										
	12										
	13										
	14										
	15										

d Other fresh foods B1d

	How often do you buy other fresh foods? Respondent's answer……..							
	What kind of other raw foods (uncooked and include frozen) did you buy or have in last 7 days? B1d1	Product Code B1d2	Where did you buy or get the products? (Place of purchase) B1d3	Kind of packaging B1d4	Quantity B1d5	Amount of money (baht) B1d6		
						Price (baht/unit)	Value (baht)	
	1 Rice							
	2 Glutinous rice							
	3 Noodles							
	4 Bread							
	5 Meat and frozen meat							
	6. Fish and frozen fish							
	7. Other seafood and frozen							
	8. Eggs							
	9. Tofu							
	10. Milk							
	11. Soy milk							
	12.Others…….							

e Other preserved foods B1e

	How often do you buy other preserved foods? Respondent's answer……..							
	What kind of other preserved foods did you buy or have last 1 month? B1e1	Product Code B1e2	Where did you buy or get the products? (Place of purchase) B1e3	Kind of packaging B1e4	Quantity B1e5	Amount of money(baht) B1e6		
						Price (baht/unit)	Value	
	1 Dried meat							
	2 Shredded pork and sausage							
	3 Dried seafood							
	4. Cooking oil							
	5. Sugar							
	6. Salt							
	7. Sodium glutamate							
	8. Fish sauce							
	9. Sauce							
	10. Ready food frozen							
	11. Shrimp paste							
	12. Coffee & Tea leaves & Cocoa							
	13. Products from milk							
	14. Flavor							
	15. Beverages							
	16. Cigarette							
	17. Alcoholic							
	18. Sweet, cake							
	19. Others……..							

Part B Household Expenditure B2 Out-of-home food expenditure					REC B B2
How much did your household spend during the last….. on ready cooked food eaten away from home or eaten at home?	# of meal/…	# of person	Price/meal/ person	Value/ HH./….	
1. Food eaten away from home at street stalls					B2.1…..
2. Food eaten away from home at tradition fast food restaurants in supermarket.					B2.2…..
3. Food eaten away from home at western-style fast food restaurants in supermarket.					B2.3…..
4. Food eaten away from home in traditional food at small restaurant.					B2.4…..
5. Food eaten away from home in western-style fast food at small restaurant.					B2.5…..
6. Food eaten away from home in traditional food at luxury restaurants.					B2.6…..
7. Food eaten away from home in western food at luxury restaurants.					B2.7…..

B3 Non-food expenditure					
How much did you spend during the last ……on ……?					
	Value	CODE		Value	CODE
1 Dwelling (rent, taxes, material and labor for repairing house)	฿/M	B3.1……	11 Medicine and health care.	฿/Y	B3.11……
2 Utility expenditures (water, electricity, etc.)	฿/M	B3.2……	12 Major equipment in household	฿/M	B3.12……
3 Own transportation (fuel, maintenance and expenses on private vehicles.)	฿/M	B3.3……	13 Hygienic articles (soap, toothpaste, cosmetic, etc.)	฿/M	B3.13……
4 Public transportation	฿/W	B3.4……	14 Out of home services (barber, repairs, laundry, beauty salon)	฿/M	B3.14……
5 Communication (Telephone, mobile phone, Internet, etc.)	฿/M	B3.5……	15 Clothing, shoes and accessory	฿/M	B3.15……
6 Media (magazine, newspaper, etc.)	฿/M	B3.6……	16 Games and toys	฿/M	B3.16……
7 Pocket money for children	฿/W	B3.7……	17 Family events (marriage, funeral etc.)	฿/Y	B3.17……
8 Tuition, school fees.	฿/Y	B3.8……	18 Donations to charities, temple and monks	฿/Y	B3.18……
9 Mortgage	฿/M	B3.9……	19 Insurance	฿/Y	B3.19……
10 Entertainment and leisure time activities.	฿/M	B3.10……	20 Other expenditures……..		B3.20……

Part D Household characteristics (Please give some information about the respondent and your family.)					REC D
1. How many persons including you live in your household in the last 1 year?				……..persons	D01……
2. How many persons including you live in your household in the last week?				……..persons	D02……
3. How many children are there in your household?					D03……
O_1 under 2 years	O_2 between 2-5 years	O_3 between 6-15			
4. Gender of respondent	O_1 Male	O_2 Female			D04……
5.1 Age of respondent				……..years	D05.1……
5.2 Age of household head/spouse				……..years	D05.2……
6. Marital status of respondent					D06……
O_1 Married	O_2 Divorced	O_3 Separated	O_4 Single	O_5 Other……	
7.1 How many years did you go to school? (Primary school and High school)				……..years	D07.1……
7.2 Which degree does the respondent have? (Please fill no. 1 into the circle)					D07.2……
7.3 and degree of education of household head/spouse (Please tick no.2 into the circle)					
O_1 Under graduated……	O_2 Bachelor's degree	O_3 Master's degree	O_4 Ph.D.	O_5 Other……	D07.3……
8. Occupation of respondent (Please fill no. 1 into the circle) and occupation of respondent's spouse (Please tick no.2 into the circle)					D08.1……
O_1 Doctor	O_5 Researcher	O_9 Lecturer	O_{13} Engineer	O_{17} Sale man	D08.2……
O_2 Marketer	O_6 Accountant	O_{10} Banker	O_{14} Administrator	O_{18} Government officer	
O_3 Private company officer	O_7 Merchant	O_{11} Artist	O_{15} Housewife	O_{19} Politician	
O_4 Reporter	O_8 Lawyer	O_{12} Economist	O_{16} Owner business	O_{20} Others……	

9. How many of major equipment do your household own?				D09……
Cook stove, gas or electric……	Electric fan……	Household water pump……	Water boiler……	
Microwave ovens……..	Sewing machine……	Washing machine……	TV……	
Electric pots……..	Vacuum cleaner……	Blenders, Mixers……	Car……	
Water filter……..	Refrigerators……..	Rice cookers……..	Motorbike……	
Electric iron……..	Lawn mower……..	Air conditioner……	Mobile……	
10. Please tell me about your household income per month. Which of the following income groups does it belong to?				D10……
(Interviewer explains the respondent about this data that is private information, we will not illustrate to the public in order to get unbiased income.)				
O_1 Below 10,000 baht	O_3 Between 25,001-50,000 baht	O_5 Between 80,001-100,000 baht		
O_2 Between 10,001-25,000 baht	O_4 Between 50,001-80,000 baht	O_6 More than 100,000 baht		
11 Are you aware of any particular health problems linked to quality food?				D11……
O_1 Yes, please describe……	O_2 No	O_{99} No answer		
12. In your household, Have any member effect by long-term diseases?				D12……
O Yes_1 (Specified……..)	O_2 No	O_{99} No answer		
13. What ethnic group do you belong?	Answer……			D13……

Part E Metadata (Fill by interviewer, not to be asked)

1. Name of respondent……Household code……
2. Address and phone/mobile number of respondent…….....
3. Date of interview……Start of interview……..End of interview……Duration of interview……..
4. Replacement household O Yes O No
5. Name of interviewer……

BIOGRAPHICAL DATA

NAME	Mrs. Rattiya Suddeephong Lippe
DATE OF BIRTH	June 23, 1976
PLACE OF BIRTH	Bangkok, Thailand
EDUCATION	1996-2000: Bachelor of Science (Chemistry), Kasetsart University, Bangkok, Thailand 2003-2005: Master of Economics (Business Economics), The National Institute of Development Administration, Bangkok, Thailand