SCALE AND SCOPE ECONOMIES IN THE UK LIFE ASSURANCE INDUSTRY

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To my father and mother

정윤조, 김정자

DECLARATION

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ABSTRACT

In order to examine cost economies in the UK life assurance industry, this thesis develops two models: the underwriting model and the intermediation model. The underwriting model focuses on the underwriting function whose outputs are premium income. The outputs are aggregated into four broad kinds of products: life assurance, general annuities, pensions and permanent health. The main theoretical novelty in this model is that we take into account the riskiness of contracts. In the intermediation model, a life company can be regarded as an intermediary whose role is to collect premiums, invest the funds and distribute bonuses to policyholders. The output of the intermediation function is bonuses and the source for the intermediation activity is premium income generated from the underwriting activity and investment income generated from the investment activity.

To model the production technology, we employ a revised form of the Hybrid Translog Cost (HTC) function. The HTC function using the traditional Box-Cox transformation has a limitation that hinders the estimation of the asymptotic covariance matrix of the parameters. We develop the Revised Box-Cox Transformation (RBCT) and then employ the Revised Hybrid Translog Cost (RHTC) function to overcome the limitation. The parameter estimates of the two models are used to estimate the degree of scale and scope economies. We also compare the cost structure for various groups such as: composite and non-composite companies, bancassurance and non-bancassurance companies. We also examine the cost structure by distribution channels and size.

The findings of this thesis are as follows: Firstly, we find significant overall scale economies and weak scope economies in the underwriting activity. However, weak diseconomies of scale are observed in the intermediation activity. Secondly, composite companies provide larger bonuses than non-composite companies. Thirdly, bancassurance companies exhibit lower scale and scope economies than non-bancassurance companies in the underwriting model and they also show higher diseconomies of scale in the intermediation activity. Fourthly, with regard to distribution, independent financial agents and the mixed channel with direct marketing show higher scale economies in the underwriting model. Company agents with direct marketing are not desirable for scale economies in both models, but this channel displays higher scope economies in the underwriting model. Finally, there are cost savings in expanding the level of output in the underwriting model. Small companies can realise greater cost savings than both large and medium-sized companies in terms of scale economies. Large and medium companies are favourable for scope economies in the underwriting model. Unlike the underwriting model, small companies are favourable for scale economies in the intermediation model.

CHAPTER ONE
INTRODUCTION

1.1. INTRODUCTION

The UK life assurance industry has experienced dramatic changes both in its market structure and its regulation framework over the last ten years. The changes were intensified after the 'big bang' when the government introduced the Financial Services Act 1986 and the Building Societies Act 1986. It is generally accepted that these changes increase the costs of producing and distributing of long-term products. For example, a trend to become a giant and a fierce competitive pressure from banks, building societies and direct writers have required life companies to compete with other financial institutions as well as within the life assurance market. This competitive shift would increase costs in carrying out their business. With regard to regulation, the new disclosure scheme and the training and competence scheme have forced them to increase their costs in providing services to their policyholders.

In the current dynamic marketplace, both the UK regulators and life assurers mainly concentrate on cost economies. A prime focus of most life assurers now is to improve productivity for survival. The necessary and sufficient condition for survival is to provide services to their policyholders at a relatively low cost. The goal of regulation in the industry is to improve market efficiency which can be realised primarily by understanding cost structure of the industry. In view of this, this thesis examines cost economies in the UK life assurance industry.

However, achieving the objective is not easy because of the nature and complexity of the life assurance system. There is no hard and fast rule to measure cost economies of life assurance companies. Different authors measure scale and scope economies in different ways and none of the approaches appears to be universally accepted. This is mainly because of the problem of identifying the inputs and outputs of life assurance companies.

To solve this problem and to find out the degree of cost economies in the UK life assurance industry, we construct two models: the underwriting model and the intermediation model. The former assumes that a life assurance company's outputs are premium income. The outputs are aggregated into four broad kinds of products: life assurance, general annuities, pensions and permanent health products. The cost factors of this model are acquisition and maintenance expenses and solvency margin. The intermediation model assumes that the role of a life company is to mediate between the supply of and demand for funds. We suppose that a life company ultimately produces bonuses for its policyholders in the intermediation model. It is assumed the income generated from the underwriting activity and the investment activity to be the source for this production process. In both models, we estimate the degree of cost economies and also test the cost differences of the divided groups such as composite and non-composite, bancassurance companies and non-bancassurance companies, distribution and size.

This chapter consists of five sections. The objectives of this study are demonstrated in Section 2. A logical framework for constructing the two models is discussed in Section 3 and 4. We present the motivation for this study in Section 3. The main issues of this study are discussed in Section 4. This chapter ends with a brief conclusion in Section 5.

1.2. THE OBJECTIVES OF THIS THESIS

This thesis has four objectives. The first objective is to review the problems of measuring outputs and costs of insurance companies and to propose solutions. The measurement of output is particularly problematic. The main innovation of this thesis is the identification of the main functions of an insurance company and the measurement of output which corresponds to these functions. This breakdown of activities and outputs reduces the output measurement problem significantly.

The second objective is to use the empirical results to evaluate corporate strategies with the results of estimating the two models. Firm managers who know the source of scale economies can manage resources more efficiently and they can choose the distribution channels that would be more profitable and lead to an increase in market share.[1] Recognition of the existence of scope economies can help in the design of product mix and diversification strategy. Firm managers can build an appropriate insurance product mix strategy based upon the existence of scope economies in the underwriting activity of a company.

The third objective of this research is to provide useful inputs to the formulation of regulatory policies by the UK authorisations. They can make use of the results in order to improve market efficiency and the policyholders' interest. We can help the regulators understand the degree of scale and scope economies in the UK life assurance industry.

The final objective is to provide answers to a number of questions frequently raised in the industry. These are (1) Do composite companies have a higher degree of scale and scope economies than non-composite companies? (2) Do bancassurance companies have a higher degree of scale and scope economies than the traditional life assurance companies? (3) Which distribution channel is the most efficient? and (4) Does the company size matter in gaining cost efficiency?

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[1]. Since scale economies are a necessary condition for profitability or growing market share, the degree of scale economies can be used as an indication of the profitability or market share measurement.

1.3. MOTIVATION FOR THE STUDY

The motivation for this study can be discussed from two perspectives: why a study of scale and scope economies is needed; and why the existing studies on cost economies of life assurance industry are not sufficient.

The existence of scale and scope economies has important implication for (a) the *individual firm*, (b) the *life assurance industry* and (c) the *national economy*. Cost efficiency arising from economies of scale and scope in long-term business is of primary interest to both a life company and the industry. Cost savings coming from the life assurance industry also contribute to the UK economy.

At the *individual firm level*, we can explain the need for the study by the importance of an efficient production structure that underpins a firm's activities. Cost efficiency is a necessary condition for gaining competitive advantage and for realising growth. More detailed sources for cost efficiency in life assurance can be found by examining the value chain (Porter, 1989: 42-44)[2]of a life assurance company. The activities of the value chain in a company are broadly divided into two groups: the primary and the support activities. The primary activities consist of the ongoing production, sales and marketing, and after-sale service. The support activities are involved in providing purchased inputs, technology, human resources and overall infrastructure. All these activities in the value chain then contribute to a company's margin and buyer value. So efficient management of the activities directly relates to a company's survival and growth.

In the case of life assurance, of the primary activities, sales and marketing, and the distribution channel used are the most decisive factor determining cost efficiency. This is because greater part of the costs incurred in long-term business is attributed to distribution management. Cost efficiency in managing distribution is, therefore, a vital factor for increasing market share. Of the supporting activities, Information

[2]. The concept of the value chain was developed for analysing firm's source of competitive advantage by Porter (1989, 40-44).

Technology (IT) plays a significant role in improving efficiency, reducing costs and increasing buyer value. If cost reduction by using appropriate IT is passed on to customers through lower premiums or by paying more bonuses, this process contributes to increase firm value as well as buyer value.

At the *life assurance industry level*, we can explain the need for the study by observing co-ordination of the overall activities in the value system at the industry level, not at the individual firm level. Understanding the existence and the extent of economies of scale and scope is essential for achieving market efficiency. Market efficiency means increasing public or buyer value through co-ordinating the activities of the value chains of suppliers, firms and distribution channels. These value chains are called the value system (Porter, 1989: 43-44). In the case of life assurance that is considered to be a more regulated industry than other industries, a primary co-ordination is normally carried out by regulators. Before co-ordinating or reconfiguring the value system, regulators should know whether cost economies exist and which value chain can create efficiency in the industry.

The recent issues in the UK life value system may be the regulation about bancassurance. The UK regulators (and elsewhere in Europe) have permitted banks and building societies to engage into the insurance business. The logic behind this is that banks and building societies have a countrywide branch network with huge number of staffs for the vast client base. Banks and building societies, by using these special opportunities, can introduce insurance products with banking product line and thus can enjoy scale and scope economies. However, to the best of our knowledge, no study has yet quantified this issue empirically as to whether bancassurance companies have greater degree of scale and scope economies than the traditional insurers. Therefore, undertaking research in this respect is very crucial.

The importance of cost efficiency for the national economy can be understood in the context of the contribution of the life assurance industry to a country's economy. Because insurance services consist of a number of other services and contribute to employment, the balance of payments, the provision of investment funds in the capital market, the cost efficiency of the industry is a material factor to a country's economy. Particularly, the role of life assurance is more important in contributing to the provision of investment funds[3] than that of general insurance. According to Table1.1, the life assurance industry has generated the investment funds and investment income much greater than the general insurance industry. The production process in managing the life investment funds is thus a crucial matter for the UK economy as well as the life assurance industry. This point of view is one of the reasons for constructing the intermediation model in which we take into account the investment activity of a life company.

Table 1.1 Size of Fund and Net Income by UK Insurers £ million

	Long-Term		General	
	Invested Funds	Net Income From Investments	Invested Funds	Net Income From Investments
1992	364,622	20,919	66,748	4,049
1993	465,864	22,110	74,856	4,051
1994	465,565	23,435	76,259	4,089
1995	557,051	30,640	87,242	4,926
1996	612,918	34,139	89,518	4,912

Source: ABI (Association of British Insurers)

We now examine three main limitations of the existing insurance productivity studies, which have motivated this research. These are (a) ignorance of the influence of the riskiness of insurance contracts upon the production process; (b) ignorance of the influence of the intermediation function upon the production process; and (c) the econometric limitation in the Box-Cox transformation. The first two shortcomings are related to modelling and measuring variables, while the third limitation is about the econometric method.

In spite of the fact that a number of output and input measurements have been used in insurance productivity studies, none of the existing studies considers the riskiness of insurance contracts in the underwriting activity. Unexpected changes in the level of

[3]. Insurance companies including life and general insurance contributed to the provision of investment funds about one-half of institutional investment holdings in 1994 (British Invisibles, 1995:32).

claims certainly burden insurance companies with unexpected costs and should be considered. Thus it is necessary to include the riskiness of insurance contracts as one of the cost factors.

Most of the existing studies in insurance mainly focus on the production process in the underwriting activity. However, this is only a part of an insurance company's activities. One of the most important activities may be the investment activity. Since the investment part of a life company is emphasised more than the protection part these days, this activity should be included in modelling the production technology of a life company. In this modelling we focus on the intermediation role of a life company. A life company ultimately exists to earn a return for its policyholders. The income generated from collecting premiums and the investment activity can be treated as the source for the intermediation activity and policyholders' bonuses can be regarded as output. Despite the importance of the intermediation function, none of the existing studies examines the cost structure and production in relation to the intermediation activity. Therefore it is necessary to model the production technology of this function.

As a large number of financial firms produce only a subset of the feasible outputs, a number of studies employing the translog function have used the Box-Cox transformation to recover the zero output problem.[4] However, this transformation still has a problem that is the difficulty in gaining the estimation of the asymptotic covariance matrix of the parameters estimated (Greene, 1997:480-481). Research is necessary to overcome this problem since a large number of insurance companies produce only a subset of the feasible outputs.

[4]. Some of the translog studies have used the Box-Cox transformation just for its general property, i.e. the transformation parameter approaches zero, the transformation approximates to a log function. This translog function is called the hybrid translog function. Thus the conventional translog function is a special case of the hybrid translog function.

1.4. SCOPE OF THIS THESIS AND CONTENT OF CHAPTERS

The issues studied in this thesis can be grouped into four areas: the market structure, regulation, the measurement of outputs and costs, and the choice of functional forms and estimators. The first two issues provide a logical background for a discussion of other two.

The market structure of the UK life assurance industry and its characteristics are discussed in Chapter 2. The market has been regarded as one of the most competitive in the world. The UK market seems likely to be more competitive because of its more liberal regulations and the dynamic changes such as the new disclosure scheme, more sophisticated customer demands and the emergence of new entrants including bancassurers and direct writers. The reason for emphasising competition in this study is that the degree of competition is a factor determining functional form for estimating productivity. If an industry to be analysed is competitive, prices rather than inputs might be determined in the market by supply and demand. In this case a cost function is preferable to a production function (Berndt, 1991:457).

Since the most important strategic issue in the UK life assurance industry is distribution (Whitaker and Dickinson, 1993), we focus on the distribution area in analysing the market structure. The UK distribution channels in life assurance can be divided into four categories: Independent Financial Agents (IFAs), Direct Sales Forces (DSFs), tied agents and bancassurance. We discuss each distribution in terms of market share, cost efficiency, its main product and customers. This discussion gives a rationale for examining a distribution effect on cost economies.

Secondly, we examine the UK regulation in terms of the regulatory framework, the solvency margin and the business border-regulation in Chapter 3. The regulatory framework is described by two factors: the necessary requirements for authorisation and the legislation in the UK life assurance industry. The insurance industry is typical of a regulated industry. An applicant who wants to carry out an insurance business must gain authorisation the Department of Trade and Industry (DTI). Getting authorisation is the starting point of the production process.

Although the UK insurance industry has the most flexible regulation system in the world, the industry has been regulated by a number of statutes and rules such as the Insurance Companies Act 1982, the Insurance Companies Regulations 1994, the new disclosure scheme and Life Insurance Directives. Thus the regulatory features which are related to production or productivity of long-term business should be examined in a study of cost economies.

The solvency margin plays a role in safeguarding the policyholders who invest money now for an uncertain future. This margin also plays an important part in stabilising the insurance market. If a few life assurers were to fail to meet the requirement of solvency, the insurance market would fall into disorder. In turn the market failure exerts an unfavourable influence upon productivity or the production process of all the life assurers. Before constructing the models for estimating cost economies, we should thus consider the concept and calculation of the solvency margin in the UK life assurance industry and how we can employ this variable in the empirical model. The solvency margin can be thought of as one of the cost factors in the insurance production process and is employed as a proxy for the riskiness of insurance contracts in the underwriting model.

As far as the business-border regulation is concerned, the regulation over composite and bancassurance companies examined. We call the cross-industry regulation the regulation over the entry into the life sector by banks and building societies. The performance of these companies is one of the important issues in the UK life regulation as well as in the market. This is because many of the major UK insurance companies are composite companies and bancassurance companies have exerted a great influence on the life assurance industry.

The third issue, which is the most controversial point in the insurance productivity study, is the measurement of outputs, costs and input prices. This issue is discussed in Chapter 4. There have been a number of studies to estimate cost economies in the insurance area. However, the measurement of variables, especially the output measurement in these previous studies, is not sufficient. This insufficiency may be caused by the intangible nature of insurance products. This intangibility makes it difficult to measure adequate activities for providing services by an insurance company to policyholders. We consider two activities of a life company: the underwriting activity and the investment activity. The underwriting model is constructed only with the underwriting activity, while the intermediation model is constructed with the two activities.

Finally, we discuss the choice of a functional form. This choice is very important because measurement methods and empirical results might be different according to a functional form. Before estimating the extent of cost economies, we offer the reasons for choosing a particular functional form. A favourable functional form should meet some requirements for its relevance to the UK life assurance industry and econometric estimation. If outputs are treated as exogenous variables by high competition in the market, a cost function is preferable to a production function. The cost function preference is discussed with the econometric convenience of this function in Chapter 4.

A particular functional form used for the empirical analysis is developed in Chapter 5. For an appropriate econometric estimation, a cost function fulfils three prerequisites: flexibility in terms of returns to scale and the elasticity of substitution, parsimony and the ability to accommodate zero value outputs. Out of many cost functions developed such as the Cobb and Douglas, CES (Constant Elasticity Substitution), GL (Generalised Leontief), quadratic, and translog cost function, the reasons for choosing the HTC (Hybrid Translog Cost) function are discussed on the basis of these three prerequisites.

However, the traditional Box-Cox transformation employed in the HTC function has a limitation of still remaining 'ln0' after the partial derivative of the transformation with respect to the transformation parameter. To recover this problem, we develop the Revised Box-Cox transformation and the Revised Hybrid Translog Cost (RHTC) function.

In Chapter 5 and 6, we empirically estimate the underwriting model and the intermediation model, respectively. The measurements for the degree of scale and scope economies are explained. Our sample is based upon all the life assurance companies in the UK that reported their Returns to the DTI for the years 1985 to 1995. The sample size of each year is different, because the two models require the total cost variable, i.e. the dependent variable, to be greater than zero. The average size for each year is 167 and 158 in the underwriting model and the intermediation model, respectively. We summarise the findings and suggest implications in Chapter 7.

1.5. CONCLUSION

Cost economies in the UK life assurance industry are estimated by constructing the two models. The four main issues will provide suitability for constructing the models. We also compare the cost structure for various groups such as: composite and non-composite companies, bancassurance and non-bancassurance companies. We also examine the cost structure by distribution channels and size. We divided the sample companies into IFAs, company agents and the mixed distribution according to distribution. Taking into account direct marketing, the distribution channels are further divided into six groups. Three groups are divided according to size. Premium income is used for the criterion of the size division.

CHAPTER TWO

THE MARKET STRUCTURE OF THE UK LIFE ASSURANCE INDUSTRY

2.1. INTRODUCTION

The main purpose of this chapter is to explain the market structure of the UK life assurance industry in relation to production. The market has recently experienced dynamic changes that have increased the competitive pressures on insurance companies. The competitive factors in the UK life assurance industry, for example, are the growth of new entrants such as bancassurers and direct writers, and the emergence of outsiders such as Marks & Spencer and Sainsbury. These factors force insurance companies to carry out their business in a more cost effective way than ever before.

In particular, in the case of life assurance, its business is closely connected with cost efficiency in the distribution channels. Whitaker and Dickinson (1993:12-17) pointed out the importance of distribution in a study of the life assurance industry.[1] They observed that the most important issue in the UK life assurance industry would be the control of distribution. For a cost analysis of the UK life assurance industry, it is, therefore, necessary to examine the characteristics of the distribution channels, i.e.

[1]. Whitaker and Dickinson (1993: 12-17) conducted a survey about on competitive factors in the UK life and general insurance. They classified the factors into six groups: the financial considerations, the sales and marketing, the controlling costs, the gaining and maintaining of the competitive edge, the industry-related problems and the issues specific to a particular company such as restructure after a take-over or merger. The results showed the most important issue of life assurance to be different from that of general insurance. Whereas the dominant issue for the general insurance industry is financial consideration, the main issue for the life assurance industry is sales and marketing, notably the control of distribution channel.

which distribution channel is more cost effective and what effect new distribution channels can bring about.

This chapter is organised as follows. In order to analyse the market structure, a synopsis of the industry is outlined in terms of participant groups, products and investments in Section 2. In Section 3, we, firstly, describe the conspicuous characteristics of the UK life distribution. Secondly, each distribution channel is examined in order to explain the close relationship between cost efficiency and the market share of each distribution. Each distribution channel is examined in terms of products, premiums, and customers. In Section 4, the bancassurance channel is further examined because it has exerted a great influence on the life assurance industry with respect to competition and cost. In Section 5, we summarise the discussion of this chapter.

2.2. SYNOPSIS OF THE LIFE ASSURANCE INDUSTRY

Like other markets, the UK life assurance market has three participant groups: (a) suppliers, (b) distributors and (c) consumers. The principal suppliers are the life assurance companies, authorised by the Department of Trade and Industry (DTI). They manufacture different types of life and pension products and supply the products to consumers via a number of distribution channels and/or directly through the direct marketing method. There were 236 companies authorised to carry out long-term business in 1996. The number of companies was 258, 253, 248, 232 in 1992, 1993, 1994, 1995, respectively. Most of these companies have their head office in the UK.

The distributors are a large number of different intermediaries between suppliers and consumers. They can be classified broadly into 'Independent Intermediaries' and 'Company Agents'. According to Table 2.1, independent intermediaries have continuously improved their market position in the area of individual life and pensions since 1994, while company agents have lost market share. However, business volume for both channels declined in 1994 and 1995 because of lower consumer confidence, the impact of mis-selling, the new disclosure scheme, the introduction of Personal Equity Plans (PEPs) and other tax-efficient saving products (MINTEL, 1996:17). However, business volume recovered slightly in 1996.

We can further divide the distributors into five categories: Independent Financial Agents (IFAs), Direct Sales Forces (DSFs), tied agents, bancassurance and direct marketing. The first three distributors have been the traditional channels, while bancassurance and direct marketing represent new ways of distribution. The new channels have focused on simple products and have mainly served less sophisticated customers, while the traditional channels have marketed all the products and have provided services for all the customers including high net worth individuals. It is noted that bancassurance companies play a dual role in the life assurance market as manufacturer and distributor.

Table 2.1 APE[2] for Individual New Life and Pension Premiums by Polarisation

	Independent Intermediaries	Company Agents
1991	1472.5 (37.1%)	2388.7 (60.2%)
1992	1634.7 (39.1%)	2464.6 (58.9%)
1993	1597.2 (37.3%)	2593.5 (60.5%)
1994	1477.3 (39.2%)	2193.6 (58.2%)
1995	1411.4 (44.3%)	1728.5 (53.1%)
1996	1868.7 (46.7%)	2046.2 (51.1%)

Note : The figures in parentheses are the market share of each distribution.
Source: ABI.

All three participants, i.e. suppliers, distributors and consumers, have increased competition in the life assurance market. Recently the supply market has become competitive because of the growth of new entrants and the cross-border permission of EC companies. Moreover, the distribution market has also become more competitive because banks and building societies have actively participated in insurance

[2]. Annualised premium equivalent (APE) is calculated as regular premiums plus 10 % of single premiums.

distribution through their countrywide branch networks as well as through their IFA subsidiaries. The growth of direct marketing is also one of the reasons for the high competition in the distribution market. In addition, the customer's demand has become more sophisticated in the choice of suppliers, distributors and products This is also one of the reasons for the high competition in the market.

Insurance companies have two sources of income: premium income coming from selling products, and investment income coming from investing available funds. The total net premium income of the UK life industry was £ 66.4 billion in 1996. It is the highest in Europe and the third in the world market behind Japan and USA. Just under 80 % of the premium income was produced in the UK and the rest was generated outside the UK.

With regard to products, there are four broad kinds of products: life assurance products, pensions, annuities and permanent health products. In the individual life assurance product market there have been considerable changes. New regular premium for the products has fallen, while new single premium has risen since 1992. This is shown in Table 2.2. This is because low interest rates, from 1992 onward, stimulate people to buy single premium life policies instead of purchasing bank and building society deposit accounts (ABI, 1997:9). Another change in the products is a continuous decrease of premium income from the industrial business, which is also shown in the table.

Table 2.2 New UK Individual Life Business £ million

	1992	1993	1994	1995	1996
Ordinary Branch	9,228	11,541	10,731	10,337	13,681
Of which					
Regular Premium	1,670(18.1)	1,510(13.1)	1,339(12.5)	1,130(10.9)	1,204 (8.8)
Single Premium	7,558(81.9)	10,031(86.9)	9,393(87.5)	9,206(89.1)	12,478(91.2)
Industrial Branch	228	152	129	92	83

Note : The figures in parentheses are percentage of each category.
Source: ABI.

Over 97 % of net premium income in the UK ordinary business came from the life assurance products and pensions in 1996. Pensions accounted for almost 50 % of net premium income in the UK ordinary long-term business in 1996. Pensions business can be divided into two parts: (a) personal pensions for the individual and the self-employed, and (b) occupational pensions for employees. Pensions business has increased rapidly since the introduction of personal pensions in July 1988. Personal pensions accounted for 55 % of total pension business in 1996. Generally, the pension business requires more complicated knowledge than the life assurance products and thus the traditional life companies have enjoyed a dominant position as pension providers compared to other financial institutions such as banks and building societies. In addition, selling annuities with some of the maturity pension funds is permitted only to the traditional life companies. Banks and building societies can provide the annuities only through insurance company subsidiaries.

Annuities and the permanent health products are insurance contracts against longevity risk and against loss of earnings from long term illness, respectively. The premium income from annuities was £ 848 million in 1996 and some 94 % of the premium income derived from single premium annuities. The premium income of permanent health was £ 635 million in 1996.

With regard to the investment activity, life assurance companies are allowed to invest their premiums in various assets: land, company securities, debt instruments, and so on. They had total investments of £ 613 billion in 1996, while the total investments of general insurance were £ 90 billion in the same year. Moreover, the long-term nature of life business enables life companies to pursue a longer-term investment strategy. This strategy is reflected in their portfolio. Table 2.3 shows that the holdings in ordinary stocks and shares are 47 % for life assurance, while these are just 27 % for general insurance. The comparisons in terms of the total investment amount and the portfolio show that life assurance companies' investment management is a more important part than general insurance companies'. This importance provides one reason for constructing the intermediation model for a study of life assurance.

Table 2.3 Investment Portfolio of Long-Term and General Insurance £ million

	Long-Term 1995	Long-Term 1996	Long-Term %	General 1995	General 1996	General %
Index-Linked British Government Securities	8,947	11,027	1.8	1,034	1,303	1.6
Non Index-Linked British Government Securities	68,558	79,799	13.1	13,408	13,565	17.0
Other UK Public Sector Debt Securities	4,504	2,355	0.4	301	326	0.4
Overseas Government, Provincial and Municipal Securities	22,889	24,639	4.0	15,193	14,617	18.3
Debenture, Loan Sharks, Preference and Guaranteed Stocks and Shares						
:UK	34,798	37,901	6.2	3,573	5,981	7.5
:Overseas	30,887	28,064	4.6	6,704	3,925	4.9
Ordinary Stocks and Shares						
:UK	199,560	225,983	37.1	12,948	13,487	16.9
: Overseas	57,051	61,571	10.1	6,818	7,937	10.0
Unit Trusts						
:Equities	41,218	47,014	7.7	390	421	0.5
:Fixed Interest	4,141	3,850	0.6	80	25	0.0
Loans Secures on Property	14,945	13,254	2.2	1,678	2,134	2.7
Real Property and Ground Rents	38,366	39,054	6.4	4,344	4,333	5.4
Other Invested Assets	27,059	34,782	5.7	11,508	11,643	14.6
Total Invested Assets	552,924	609,293	100.0	77,978	79,699	100.0
Net Current Assets	4,172	3,626		9,264	9,819	
Total	557,051	612,918		87,242	89,518	

Source: ABI.

2.3. THE UK LIFE ASSURANCE DISTRIBUTION

2.3.1 The Distinguishing Characteristics of the UK Life Distribution

The distinguishing characteristics of the UK life distribution are described in the following paragraphs.

Firstly, competition among the distribution channels has increased. The reasons for this can be explained by both the aspects of supply and demand. With regard to the supply aspect, there are a large number of intermediaries in the UK life distribution. Nobody can agree which distribution will dominate in the future. Life assurance companies have continuously changed their distribution strategy and this trend will continue. For example, Scottish Mutual became 100 % IFA oriented after closing down the tied agent channel in 1993. Guardian became committed to IFAs to provide a more focused service after closing down the DSF channel (Financial Adviser & AKG, 1996:22). After Merchant Investors had operated exclusively through the IFA channel in 1994, some 57 % of business was generated through direct marketing in 1995 (Moore, 1996:62). The emergence and growth of the new entrants are also the reason for putting competitive pressure on the distribution channels, especially to the traditional channels. Bancassurance has threatened DSFs and tied agents[3], and direct writers will probably pose a threat to all the channels. The emergence of non-financial institutions such as Marks & Spencer is also a force to increase competition in the distribution sector.

With regard to the demand aspect, more sophisticated demand of customers forces the distribution channels to be competitive. It is firmly believed that the customers require better information and their wants and needs have become more specific. As a result of the introduction of the new disclosure scheme, customers can easily judge which distribution channel is better than others in terms of cost. In other words, the choice of the distribution channels is facilitated by virtue of specific information such as the commission disclosure at the point of sale, expressing commission and charges in cash terms, and the own charge basis instead of the standard charge basis.

Secondly, the development of a '*focus and multi-channel strategy*' is conspicuous. The '*focus and multi-channel* strategy' means more than one channel to be managed by insurance companies and one or two of the distribution channels to be concentrated on for the purpose of scale economies. The trend of an increased use of this strategy is also explained by both the aspects of supply and demand.

With regard to the supply aspect, this strategy enables a life assurance company not only to achieve scale economies (focus), but also to stabilise the channels used by the company (multi-channel). Chetham (1995:137) noted the cost efficiency of the focus strategy as: 'Companies that do not concentrate on only one channel, have higher expense ratios: the costs of running a specialised distribution network are lower than

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[3]. For this threat, see Section 3.

for a mixed strategy'. Exclusively using the focus strategy, however, has a disadvantage that drives the insurance company to employ the '*focus and multi-channel* strategy'. Using only one channel exclusively is a risky strategy in the current dynamic marketplace (MINTEL,1996:43). If an insurance company is selling products exclusively through one channel, the company may lose a great deal of market share when the relationship between the company and tied agents, or between the company and IFAs comes to an end for whatever reason. This risk explains why the number of companies using only one distribution channel has fallen from 43 % in 1992 to 33 % in 1993 (LIMRA1, 1994:2). So it can be said that many insurance companies use the *focus and multi-channel* for stabilising their distribution channels as well as for achieving scale economies.

With regard to the demand aspect, the '*focus and multi-channel* strategy' can be seen as a reflection of diversified consumer demands leading to diversification and simplification of products. It seems that consumers change their attitude in favour of multi-choice. The multi-choice preference of consumers in choosing distribution is described by PIMS1 (1996:15) as 'Consumers often do not commit themselves to one channel or individual for all of their financial advice, preferring to buy from different sources at different times rather than place all of their eggs in one basket'. Thus multi-channel status can be seen as responding to the preference of consumers that leads insurance companies to provide a wide range of products. A trend of product simplification also provides an explanation for the increasing use of the *focus and multi-channel*. With this trend, many insurance companies decided to use the direct marketing channel in addition to their current distribution channel or channels. For example, Friends Provident, Norwich Union, NPI, Scottish Amicable and Scottish Widows have used the direct marketing channel in addition to their main IFA channel. Allied Dunbar also carried out a telesale operation as well as its traditional DSF (Leach, 1996:29).

Finally, Information Technology (IT) is profoundly affecting the distribution channels. The survey result of PIMS1 (1996:3) indicated that IT was the second most important factor to competition in determining the future shape of distribution. IT is regarded as a vital factor in order to gain competitive advantage in the distribution sector as well as in other functions in insurance such as product development and underwriting.

One of the reasons for the growth of bancassurers is their ability to integrate detailed information about customers with highly sophisticated computer networks. Bancassurance already has details of customers' information such as occupation, income and credit history from the customers' bank account data base. For example, TSB has segmented its customers into five groups that are primarily stratified according to age (Hoschka, 1994:64-65). Barclays has stratified its customer base by age, family and income (Whitaker, 1995:113). The sales people of National Westminster Life are equipped with complete point-sales lap-top computer systems that enable the company to market customer demands such as fact-finds, needs analyses, quotations and proposed completion (Leach, 1996:132).

The development of Common Trading Platform (CPT) in the IFA channel also gives a good example of the importance of IT in marketing. The CPT system is data interchange networks in the process of a product selection. When using the CPT, IFAs can select the best products for customers because the CPT is backed up by on-line systems. The quantitative survey conducted by PIMS2 (1996) indicated that three-quarters of the 500 respondents had access to the CPT. The importance of IT is also found in the increasing expenditure on IT and in the trend for most employees to be equipped with a computer terminal. The survey of PIMS2 (1996) showed that 80 % of the respondents expected the expenditure on IT to increase and only 2 % of respondents were not equipped with a terminal or laptop on their desk.

From the above discussion, the three distinguishing characteristics of the UK life distribution tell us the importance of cost efficiency in distribution. The first characteristic, the high competition in distribution, requires life companies to manage their distribution channels more effectively than ever before in order to survive and grow. A cautious choice of distribution channels is required in the market situation where many insurance companies have continuously changed their distribution strategy, and where the new entrants have rapidly developed, and where customers' demand has been more sophisticated. The '*focus and multi-channel* strategy' can be used for the purpose of gaining cost efficiency as well as stability in managing distribution. The main purpose of using technology in marketing is also to achieve cost efficiency. PIMS1 (1996:3) mentioned this point as: 'Unless we drive out costs from the industry through the use of technology ... then competitiveness will be reduced'. It seems that the growth of the IFA networks has been stimulated by their potential for reducing costs in distribution.

2.3.2 Types of the Distribution Channels in Life Assurance

Before examining the five types of distribution channels in life assurance, we examine two tables to show the market share of each distribution in terms of products selling. Table 2.4 shows APE for the individual new life and pension premiums earned from each distribution from 1991 to 1996. Table 2.5 presents data for APE of each distribution breaking down the distribution further into three product categories for the same period.

Table 2.4 APE for Individual New Life and Pension Premiums by Channel

	IFAs	DSFs	Tied Agents	Bancassu -rance	Direct Marketing	Total
1991	1290.2 (32.8%)	1718.1 (43.7%)	338.8 (8.6%)	474.7 (12.0%)	106.6 (2.7%)	3928.3 (100%)
1992	1416.5 (33.8%)	1791.1 (42.7%)	313.8 (7.5%)	589.4 (14.1%)	84.2 (2.0%)	4195.0 (100%)
1993	1439.8 (33.6%)	1865.4 (43.5%)	262.2 (6.1%)	623.3 (14.6%)	93.4 (2.2%)	4284.1 (100%)
1994	1349.1 (36.0%)	1311.7 (35.0%)	211.1 (5.6%)	776.4 (20.7%)	98.0 (2.6%)	3746.3 (100%)
1995	1313.3 (40.5%)	1127.9 (34.8%)	152.3 (4.7%)	563.8 (17.4%)	85.1 (2.6%)	3242.3 (100%)
1996	1738.0 (43.2%)	1313.5 (32.6%)	178.8 (4.4%)	707.7 (17.5%)	86.3 (2.1%)	4024.2 (100%)

Note 1: The independent intermediaries are broken down into IFAs and bancassurers, and company agents are classified into DSFs, tied agents and bancassurers.
Note 2: Prior to 1994, some business sold by bancassurers was included under company agents.
Source: ABI.

IFAs

IFAs are independent agents who offer customers the most suitable product from different insurance companies. This channel is more appropriate to high net worth individuals and to complicated products. Table 2.4 shows that there has indeed been a significant increase in the market share of IFAs since 1994. According to Table 2.5, the main product of this channel, in terms of premium income, is pensions. Three factors can be considered for the success of IFAs: the growth in sales of pensions, the existing niche market for the channel, and the cost efficiency of this channel. These are discussed in the following paragraphs.

Firstly, the growth of pensions has contributed to the increasing use of the IFA channel. Whereas the proportion of pensions to the life assurance products was 16.5 % in 1986, the proportion increased by 35.0 % in 1995. It is believed that this growth is a reflection of demographic changes and the expected government's withdrawal of support in retirement. A striking increase in the ratio of the elderly relatives to the working population has stimulated privately-funded pension scheme. This scheme will be further encouraged by the belief that government will no longer provide for retirement.

In general, since pensions are more complicated than the life assurance products, and since IFAs have better professional knowledge and experience than other channels, the IFA channel can contribute to the growth of pensions more than any other channel.

Secondly, the sophistication and complication of IFAs have made the channel hold a niche market for IFAs. The existing niche market has contributed to maintenance or increase of the market share of IFAs against the growth of bancassurance whose target market has been simpler products and a slightly less sophisticated class of customers. The niche market for the IFA channel can be found in the single premium market as well. Whereas the other channels have mainly focused on the regular premium market, IFAs have traditionally been stronger in the single premium market. IFAs have continuously maintained the highest market share in the single premium market. This is shown in Table 2.6. This channel also has the highest market share in occupational pensions, which is shown in table 2.7. This majority market share can be explained by the high level of knowledge of IFAs about sophisticated customers and complicated products. So it can be said that there has been an existing niche market for the IFA channel.

Table 2.5 APE for Individual New Life and Pension Premiums by Channel and Product

	Products	1991	1992	1993	1994	1995	1996
IFAs	•Non-Linked Life	531.1 (38.7)	545.1 (39.1)	446.6 (37.7)	342.2 (31.8)	406.6 (37.3)	573.0 (41.2)
	•Linked Life	250.6 (24.9)	296.4 (26.4)	412.5 (29.1)	438.0 (33.3)	332.1 (36.6)	409.7 (37.8)
	•Pensions	515.6 (33.3)	552.7 (32.9)	583.3 (35.2)	575.8 (41.9)	590.9 (47.4)	755.2 (49.4)
DSFs	•Non-Linked Life	407.9 (29.7)	450.9 (32.3)	438.5 (37.0)	375.1 (34.9)	365.8 (33.6)	429.6 (30.9)
	•Linked Life	462.6 (46.0)	457.8 (40.8)	525.7 (37.1)	348.2 (26.5)	247.5 (27.3)	287.1 (26.5)
	•Pensions	842.2 (54.4)	897.0 (53.3)	900.5 (54.3)	604.4 (44.0)	510.8 (41.0)	582.8 (38.1)
Tied Agents	•Non-Linked Life	111.1 (8.1)	93.5 (6.7)	73.8 (6.2)	56.5 (5.3)	40.9 (3.8)	48.3 (3.5)
	•Linked Life	133.3 (13.3)	125.5 (11.2)	108.6 (7.7)	95.4 (7.3)	80.6 (8.9)	96.5 (8.9)
	•Pensions	87.9 (5.7)	94.1 (5.6)	77.3 (4.7)	60.1 (4.4)	34.1 (2.7)	51.6 (3.4)
Bancas -surance	•Non-Linked Life	256.4 (18.6)	241.1 (17.2)	166.9 (14.1)	241.7 (22.4)	223.7 (20.5)	286.5 (20.5)
	•Linked Life	143.1 (14.3)	228.6 (20.4)	348.9 (24.6)	405.3 (30.9)	233.9 (25.8)	269.3 (24.9)
	•Pensions	98.3 (6.6)	121.1 (7.2)	91.0 (5.5)	129.9 (9.4)	103.7 (8.3)	124.2 (8.1)
Direct Market -ing	•Non-Linked Life	66.8 (4.7)	63.4 (4.6)	58.4 (4.9)	59.6 (5.5)	51.8 (4.8)	55.0 (3.9)
	•Linked Life	16.0 (1.6)	14.9 (1.3)	21.4 (1.5)	26.6 (2.0)	13.1 (1.4)	21.1 (1.9)
	•Pensions	5.1 (0.3)	16.8 (1.0)	6.6 (0.4)	4.4 (0.3)	7.6 (0.6)	15.2 (1.0)

Note 1: The independent intermediaries are broken down into IFAs and bancassurers, and company agents are classified into DSFs, tied agents and bancassurers.

Note 2: Prior to 1994, some business sold by bancassurers was included under company agents.

Note 3: The figures in parentheses are percentage of each product indicating the market share of each distribution.

Source: ABI.

Finally, the cost efficiency of IFAs can account for the success of the IFA channel. The cost efficiency of this channel can be explained by two facts: a lot of M&A

among IFAs and the growth of the IFA networks. The number of IFA firms was reduced to 4,000 in 1995 compared to 8865 in 1988 (Hancock, 1995:65). This reduction may be interpreted as showing a marked trend toward M&A among IFAs for the purpose of scale economies.

Table 2.6 RP and SP for Individual New Life and Pension Premiums by Channel

		1991	1992	1993	1994	1995	1996
IFAs	RP	687.8	696.3	654.4	610.7	658.7	809.6
	SP	6024.0	7201.8	7853.6	7383.8	6546.3	9284.5
DSFs	RP	1320.5	1285.4	1258.5	950.0	838.3	925.2
	SP	3975.8	5056.6	6068.7	3616.6	2895.5	3882.6
Tied Agent	RP	302.6	267.8	226.5	181.0	139.7	161.9
	SP	3975.4	5056.6	6068.7	3616.6	2895.5	3882.6
Banca -ssurers	RP	330.1	374.9	302.0	429.7	299.4	370.1
	SP	1445.8	2145.2	3212.8	3465.9	2643.7	3376.2
Direct Marketing	RP	82.5	53.6	75.5	67.9	59.9	69.4
	SP	241.0	306.5	178.5	301.4	251.8	168.8

Note 1: The independent intermediaries are broken down into IFAs and bancassurers, and company agents are classified into DSFs, tied agents and bancassurers.
Note 2: Prior to 1994, some business sold by bancassurers was included under company agents.
Note 3: RP denotes regular premium income and SP denotes single premium income.
Source: ABI.

Table 2.7 APE for Occupational Pensions by Distribution Channel

	Occupational Pensions	1994	1995	1996
IFAs	•Executive Pension	281.6 (78.7%)	258.2 (80.3%)	330.3 (80.8%)
	•Occupational Group Pension	491.4 (81.6%)	435.8 (79.1%)	
DSF	•Executive Pension	64.1 (17.9%)	55.5 (17.3%)	69.0 (16.9%)
	•Occupational Group Pension	87.6 (14.6%)	90.3 (16.4%)	
Tied Agent	•Executive Pension	12.1 (3.4%)	7.7 (2.4%)	9.7 (2.4%)
	•Occupational Group Pension	22.9 (3.8%)	25.0 (4.5%)	

Note : The figures in parentheses are percentage of each product indicating the market share of each distribution.
Source: ABI.

The growth of the IFA networks also enables this channel to be competitive in terms of cost. In fact, the IFA networks were made in order to achieve cost efficiency among members. After the first network, DBS Financial Management, was launched over ten years ago, the networks have developed in terms of number of members and size. The IFA networks made up around one quarter of the total IFA in 1995 (Leach, 1996:30) and the largest IFA network had 3,400 firms in 1995 (Hancock, 1995:65). The members can share information about products, and customers' needs and wants, which enables the members to achieve scale economies in the marketing sector.

According to Bacon & Woodrow (1996:11), the companies selling products primarily through IFAs are the second most cost effective after bancassurance. Bacon & Woodrow (1996:10-12) examined the expense ratio in a sample of 82 life companies according to their main distribution channels over the period 1985-1994.[4] In particular, the study observed that only the IFA channel has improved the expense ratio in the last three years, 1992 to 1994, while the ratio of other channels has become worse and there has been no change in the case of bancassurance. Bacon & Woodrow (1996:11) mentioned the 'weeding out' for the trend of M&A and the development of ORIGO/The Exchange for scale economies of the IFA networks.

However, one thing to note about the success of IFAs is that the growth of the networks and IFAs may not always be desirable for life assurance companies. The companies operating exclusively through the IFA networks or the channel have a possibility of losing market share abruptly because the IFA channel is less controllable than any other channel. Moreover, the largest networks with powerful bargaining power force a life assurance company to accept higher commission or an inordinate demand. This potential force may well explain the trend that several insurance companies, such as Abbey National Life, National Westminster, Prudential and Halifax and Leeds, want to acquire an IFA office for the purpose of control. This potential force also accounts for the eminence of the '*focus and multi-channel* strategy'.

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[4]. They used a single composite index that was calculated by two key ratios: the ratio of acquisition commission and management expenses to new business premiums, and the ratio of other commission and management expenses to all premiums.

DSFs

DSF is the agent representing only one company, which means that the company will accept all the responsibilities coming from the agent's business dealing with the company's products. The agent can offer customers only the products of one company where he/she is employed. The agent does not have the authority to change any terms and conditions of the products. The most important advantage of DSFs for an insurance company is that it is well under control of the channel since most DSFs are employees of a company.

According to Table 2.5, the main product of DSFs in terms of premium income is pensions like IFAs. Some companies are using DSFs as their main distribution channel to satisfy high net worth individuals. An example is Equitable Life (Whitaker, 1995:71). However, it is believed that the products and the customers of DSFs are less complicated and sophisticated than those of IFAs. Another difference between the two channels is that the DSF channel has focused on the regular premium business compared to the IFA channel. This is shown in Table 2.6.

According to Table 2.4, the market share of DSFs has declined considerably since 1994. This is because of a sharp decrease of sales force numbers. According to the LAUTRO, the number of people employed in this channel declined from 190,000 in 1991 to some 80,000 at the beginning of 1996 (MINTEL, 1996:22).

The difficulty in prospecting may be the second reason for a considerable reduction in the market share. It can be presumed that this channel has more difficulty in finding customers and making sales than any other channel.

The other reason for the decline may be provoked by the reduced cost efficiency of this channel. According to Bacon & Woodrow (1996:12), this channel showed a similar performance to the IFA channel in their previous study for the period 1985-1992, but was less cost efficient than bancassurance and IFAs for the period 1992-1994 in their second study. It is likely that the Personal Investment Authority's (PIA) training and competence scheme worsens the cost burden to this channel. Because the DSF channel is less professional than the IFA channel, DSFs have a greater cost burden than IFAs in carrying out this scheme.

However, many insurance companies will maintain this channel owing to the well controllable advantage of DSFs, even though some companies have sold their DSFs.

Tied Agents

The logic of tied agents is to unite the insurer's manufacturing capability with the agent's marketing capability. Tied agents are similar to DSFs in terms of representing one company, but they do differ from DSFs with respect to being separate entities such as banks, building societies, estate agents and tied representative firms. This channel is thus less controllable than DSFs to insurance companies. This channel mainly covers the linked individual life products. This is shown in Table 2.5. It is likely that this channel orients less sophisticated customers compared to the IFAs and the DSF channel.

According to Table 2.4, the market share through this channel has continuously declined. The first reason for this decline can be explained by the fact that bancassurers have succeeded in the tied agent sector and that the major banks and some of building societies have ended up with the appointed agents. We discuss why bancassurers have developed the market share in the tied agent sector; and why some bancassurers have terminated the tied relationship with life assurance companies in Section 4.

The second reason for the decline might be the trend of insurers who dislike taking new tied agents. As life assurance companies have to provide unpaid services such as compliance, training and computer services for the separate entity, which occurs an arm-length cost (Whitaker, 1995:87), a tied relationship is less attractive than other channels to the companies. The inflexible characteristics of this channel are also an obstacle in using this channel to insurance companies. It is likely that the separate distribution form from the companies and the restricted range of products of this channel can produce inflexibility in providing services to customers.

The other reason for the decline is the cost inefficiency of this channel. Bacon & Woodrow (1996:12) found that the companies that mainly use tied agents are the least efficient. It can be said that the training compliance results in this channel being less cost efficient like DSFs.

Bancassurance

The market share of bancassurers has increased although it declined in 1995. They have manifested the highest growth rate according to Table 2.4. Bacon & Woodrow (1996:10) showed that bancassurance is the most cost efficient channel.

According to Table 2.5, the main products of this channel are less complicated products, for example, the life assurance products. Bancassurers have succeeded in the area of less sophisticated customers and the regular premium income[5]. We discuss the reasons for this restricted range of products and customers in Section 4.

Direct Marketing

LIMRA2 (1994:1) defined direct marketing as ‘a marketing technique and distribution channel which brings the purchase decision into the customer’s home, by-passing middle men and bringing the customer directly into contract with the manufacturer or supplier'. The advantage of this channel is that the distance between the channel and customers is shorter than other channels. Hence, an insurance company employing this channel is able to reduce the costs accompanied by communication with customers. Many studies pointed out this cost saving advantage of direct marketing. Lindsay and Lindsay (1990) concluded that direct marketing is more cost effective than face-to-face personal selling in their study of the UK direct marketing. Spicer (1995:39) described the advantage of direct marketing over other channels as the cost savings of sales forces and other overheads. Standard & Poor's (1996:48) also pointed out the low overhead cost of this channel.

According to Table 2.5, this channel is similar to bancassurance in terms of its main products. However, direct marketing has offered a more limited product range than any other channel. This channel has been used for execution only services except for Direct Line Life and Virgin Direct; moreover, it would take about 45 minutes to carry out a fact-find in these two companies (Whitaker, 1995:31). Because of this limitation, many life assurance companies have normally used the direct marketing channel for supporting the activities of their traditional distribution channels. This supporting function was shown by LIMRA2 (1994:2) survey. Of the 25 participating companies carrying out direct marketing, 24 companies employed the direct marketing method to support their DSFs, tied agents or IFAs. This supporting function can explain that the market share of direct marketing has not been changed abruptly as shown in Table 2.4.

However, it is expected that the use of direct marketing by life assurance companies will increase and this channel will be a serious threat to other channels. The number of companies starting up direct marketing is increasing, and technology development and the trend of product simplification will escalate the use of this channel. PIMS1 (1996:11) indicated the reason for the increasing appeal of direct marketing to insurance companies as 'complexity at the point of sale is both burdensome in cost

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[5]. However, this channel has recently focused on the single premium business. This is shown in Table 2.7.

terms and off-putting to clients who often do not want to go through the full fact find process'.

It is likely that the growth of direct marketing will increase competition in the UK life assurance market. The influence of direct marketing on insurance companies was noted by LIMRA2 (1994:8) as 'direct marketing can be seen by insurance companies as both an opportunity to support their existing distribution channels, as well as a threat to their to their very existence'.

2.4. BANCASSURANCE

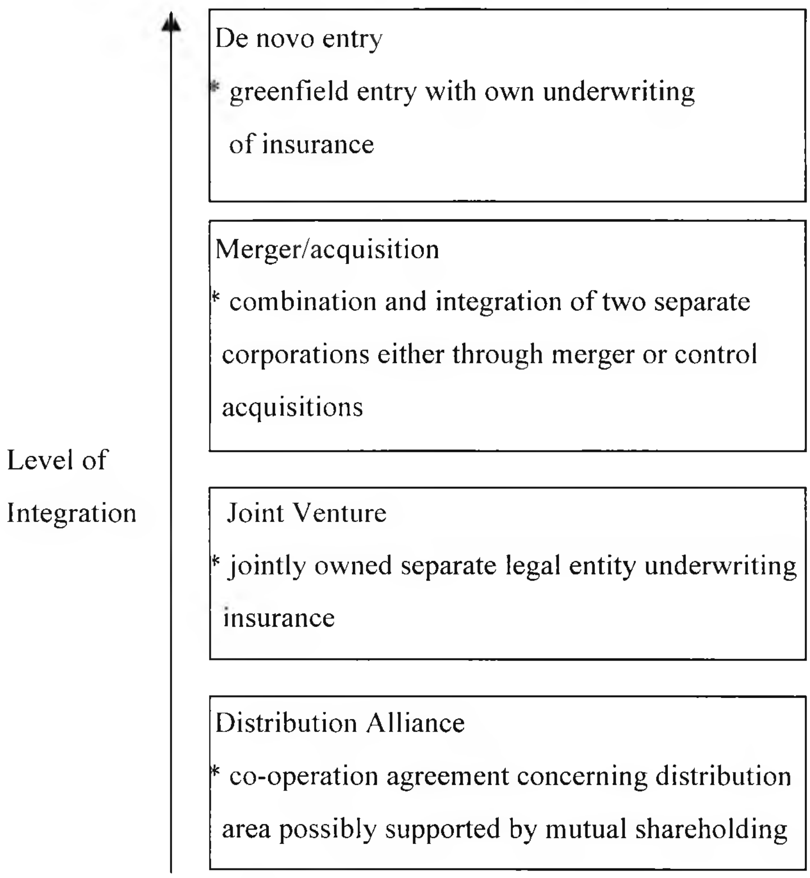
In this section, we examine why banks and building societies entered the life assurance sector; and what consequences to competition in the life assurance market are caused by bancassurance. To answer these questions, we, first of all, define the concept of bancassurance.

2.4.1 Definition of Bancassurance

Bancassurance is generally defined as the direct involvement of banks or building societies in the insurance business. There are two criteria in defining the UK bancassurance. One criterion is the degree of involvement and the other is the type of involvement. We can divide bancassurance into four categories according to the former criterion: De novo entry, merger & acquisition, joint venture and straightforward distribution agreement. Figure 2.1 shows the degree of involvement. De novo entry is the most integrated involvement, while distribution alliance is the least integrated entry vehicle. Under the latter criterion, bancassurance can be divided into the 'Independent Intermediaries' and the 'Company Agents' by the polarisation of the Financial Services Act 1986. In other words, bancassurance is the agent for customers in the case of the independent intermediaries, but it is the agent for one company in the event of company agents.

In order to define bancassurance or bancassurer concretely, we can classify bancassurance into the narrow definition and the broad definition according to the degree of involvement. In the narrow definition, only an entrant who owns an insurance subsidiary or has the majority of a controlling equity stake is treated as bancassurance. On the other hand, the entry mode through straightforward distribution alliance such as IFAs or tied agents can be included in the domain of bancassurance, only if we use the broad definition of bancassurance.

Figure 2.1 Alternative Entry Vehicles For Bancassurers



Source: Hoschka (1994:59).

We use the broad definition in examining the UK life assurance market because the market share through the distribution alliances between life insurers and banks or building societies cannot be negligible. In 1994, it was estimated that the distribution alliances accounted for 5.7 %[6]of the individual new annualised premiums. Another reason for using this broad definition is that most building societies are tied agents or IFAs as the intermediaries of life assurance companies. These tied agents who can be perceived to impact on competition in the life assurance market are able to be included in the category of bancassurance only by using the broad definition.

2.4.2 The Reasons for the Entry into the Life Assurance Sector by Banks and Building Societies

In order to discover the rationales for the entry into life assurance by banks and building societies, we examine seven major sources of barriers to entry into another industry as stated by Porter (1980:7-13). These are government policy; economies of scale; access to distribution channels; product differentiation; capital requirements; switching costs; and cost disadvantages independent of scale. The first five sources have promoted the entry. However, the other sources have restricted the entry to a less integrated entry mode. The sources are discussed as follows.

Government Policy

A government policy can limit or even prohibit entry into another industry. Regulated industries such as munitions, railroads, banking and insurance are typical examples. However, banks in the UK, for example, Barclays and TSB were allowed to enter the insurance sector in the 1960s. There are fundamentally no legal barriers to the entrance in the UK. In particular, low profits of the banking industry in the 1980s and deregulation in the industry such as the Banking Act 1987 and the FSA 1986[7] have increased competition between banks. This increasing competition stimulated the UK

[6]. This figure can be gained through the difference between ABI figure (Table 2.5) and Datamonitor estimation. Datamonitor estimated the market share of bancassurers with the narrow definition.

[7]. The FSA 1986 allowed banks to distribute insurance products if they followed the principle of polarisation.

banks to enter the life assurance sector through distributing long-term products, owning an insurance subsidiary or forming a financial group.

In the case of building societies, the ending of the interest rate cartel in 1983 and the Building Society Act 1986 deregulated the market although it occurred later than banks. The ending of the interest rate cartel enabled building societies to deal with new products such as low-cost endowments or shared-equity mortgages, and resulted in increasing competition within the industry. The Building Society Act 1986 allowed building societies to provide insurance broking and to establish stakes in a life company or to own a life assurance subsidiary.

Thus the UK regulation over banks and building societies can be perceived to stimulate competition within each industry and to enable them to enter life assurance. This penetration created a greater degree of competition in the life assurance market as well as among the financial institutions.

Economies of Scale

It is very difficult to enter another industry where economies of scale or scope are the key factor to success in that industry. The steel industry is a good example. The potential entrants may not enter the industry where the entrants have to come in at a large scale in order to survive and succeed. The benefits of *joint costs*[8] that the established firms possess also deter entry. Economies of scale or scope can be found in an entire functional area or a particular operation of established firms. If the entrants do not have enough resources to compete against the established firms that

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[8]. Porter (1980:8) included joint costs into the category of scale economies. He explained the definition of joint costs 'Joint costs occur when a firm producing product *A* (or an operation or function that is part of producing *A*) must inherently have the capacity to produce product *B*'. However, it is accurate to separate joint costs from the concept of scale economies. The savings from joint costs mean nothing less than economies of scope. For the difference of definition and measurement between scale and scope economies, see Chapter 4.

have economies of scale or scope in marketing, production, research and development, and service, the entrants do not want to enter the industry.

However, this barrier may have exerted a favourable influence upon the entry into life assurance by banks and building societies, since they have been perceived to hold economies of scale and/or scope in the areas of marketing and services. Hoschka (1994:38-41) pointed out scale economies in marketing and scope economies in services in a study of bancassurance in Europe:

> In the context of bancassurance, economies of scale ... may arise from spreading overheads over a larger income or result from greater market power that reduces operating costs due to lock-in effects of customers and lower commissions .... Bancassurance involves multiproduct services and is most frequently justified with the existence of economies of scope between banking and insurance.

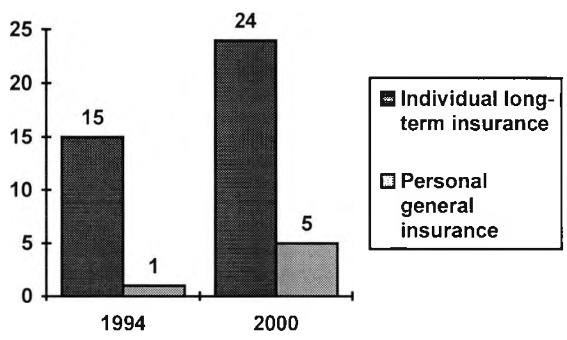
To put it in another way, life assurance is viewed by banks and building societies as a way to offer multiproducts through the existing delivery systems, without adding proportionately to the overhead and fixed costs, resulting in economies of scale and scope.

Access to Distribution Channels

A new entrant encounters a barrier to entry into the industry where the established firms already dominate the distribution channels. To overcome this barrier, the new entrant must be able to bear the expenses in persuading the existing channels to accept its products or services, or to seek an entirely new distribution channel.

This barrier, conversely, has encouraged bankers and building societies to enter life assurance. Banks and building societies can use their existing branch networks as the distribution channel for selling long-term products without incurring large costs thus resulting in scope economies in marketing. Since the ratio of distribution costs to total costs is much greater in life assurance than in general insurance, banks and building societies have preferred to enter life assurance for the purpose of the cost savings. Figure 2.2 shows this predominant preference.

Figure 2.2 Bancassurance in Life and General Insurance



Source: Leach (1996:125).

Product Differentiation

A barrier to entry can be created by the advantage of product differentiation of established firms such as customer loyalty, brand identification and firm reputation. The potential entrants always have difficulty in overcoming the advantage that existing firms have because product differentiation has the characteristic of taking a long time to acquire this advantage.

However, bancassurance companies, especially all the large UK clearing banks and building societies, can be perceived as having good reputations and high levels of customer credibility. In order to enhance these advantages, almost all large banks and building societies have possessed their own life companies, namely the greenfield or full-scale entry mode.

Capital Requirements

Huge capital requirements can create a barrier to entry, particularly if the capital is required for a risky business. However, banks and building societies are likely to reduce an insurance business risk. The business risk can be reduced in bancassurance because the correlation of margin between banks or building societies, and life assurance companies is likely to be lower. The lower correlation is generated from a different margin source and duration between two financial institutions. Whereas the source of margin in life companies is commissions, that of margin in banking or building society is interest differentials. Whereas commissions are relatively stable owing to the long-term characteristic of life business, interest differentials are sensitive to economic conditions. The two different sources of margin can reduce the risk in the overall bancassurance activity. Bancassurers can also expect to have a benefit of risk reduction in the area of asset-liability management. Life assurance companies tend to have a longer duration in their liabilities (insurance premiums) than in their assets (investments), while banks tend to have a shorter duration in their liabilities (deposits) than in their assets (lending). So matching the assets and liabilities of two institutions can make risk reduction possible.[9]

Switching Costs

Switching costs must be accompanied when a new entrant goes into another business that requires slightly different skills and equipment from those of the original business. The switching costs are inevitable costs for locking customers. Porter (1980:10) defined the switching costs as 'one-time costs facing the buyer of switching from one supplier's product to another's'. He regarded the costs for employee retraining, new ancillary equipment, technical help, product redesign, etc. as the switching costs. Hoschka (1994:53) gave examples of the switching costs in financial services as 'new account numbers need to be communicated to business relations, standing orders need to be re-directed'. If the switching costs are high, and a new entrant cannot realise the lock-in effect in spite of investing the costs, the new entrant may not want to enter a new business.

The switching costs are likely to be a deterrent factor to the entry into life assurance by banks and building societies. In particular, the switching costs caused by the product redesign certainly restrict the entry or limit the degree of involvement. This is because of the different product characteristics between banks and building societies, and life assurance. We fully investigate the effects of this barrier on bancassurance in the examination of the next barrier, cost disadvantages independent of scale.

Cost Disadvantages Independent of Scale

A barrier to entry can be created if the existing firms have the specific cost advantages that are independent of scale. Porter (1980:11) stated that these advantages are not easily replicated even by a new entrant who attained economies of scale in its *original business*. The advantages, for example, come from proprietary product technology, favourable access to raw materials, favourable locations, government subsidies and cumulative experience.

It is regarded that this barrier, in particular the proprietary product technology and cumulative experience, certainly creates an entry barrier to banks and building societies. The barriers come from the different nature of the insurance products compared to other financial products. The reasons for intrinsically incoherent characteristics between them were reported by the OECD (1992:19):

> ... an insurance product is different from other financial products to the extent that it is based on an inverted cycle of production and specific control techniques, notably actuarial techniques, the

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[9]. However, in a practical way, this matching is constrained owing to the separation of assets and liabilities and the restriction of transferring long-term assets in the Insurance Companies Act 1982.

> handling of which requires specialised professional knowledge not normally available outside the insurance profession.[10]

Thus banks and building societies who want to provide or carry out an insurance business should take the cost disadvantages compared to the established insurance companies owing to the product redesign, poor product know-how, inexperience, retraining, and/or scouting. We can examine the effects of these cost disadvantages on bancassurance in the UK life assurance market with respect to two entry characteristics. One can be found in the entry mode and the other is a type of entry product that means the main insurance product of bancassurance.

With regard to the entry mode, banks and building societies initially chose the entry vehicle through distribution alliance, joint venture or merger & acquisition instead of the greenfield entry owing to the cost disadvantages. This less integrated mode is backed up by the following examples. Except for TSB and Barclays Bank, other UK large banks that own a life assurance company or companies did not take the form of starting from scratch. Prior to setting up its own life assurance company, Abbey National Bank had ties with Friends Provident. Before Midland Life, National Westminster Life and Royal Scottish Life were launched, each parent bank had established joint ventures with Commercial Union, Clerical Medical and Scottish Equitable, respectively. Lloyds Bank entered life assurance through the merger & acquisition entry mode. Abbey Life was acquired by Lloyds Bank in 1988. The reason why Lloyds Bank did not take the greenfield entry, namely De novo entry, is well explained by Hoschka (1994: 104-105):

> The strategic rationale for the acquisition was to acquire the know-how base of Abbey Life to improve the life assurance business ...

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[10]. However, life assurance, compared to general insurance, cannot strictly be regarded as an inverted cycle of production, because the costs (claims) of life assurance are almost determined by mortality tables before fixing the prices (premiums) of life assurance. This is one of the reasons why bancassurance generally consists of banks and building societies entering into life assurance, not general insurance.

> to offer one-stop shopping to customers .... De novo entry was excluded due to the fact that management felt that the required know-how base and expertise required to establish a successful life assurance business in a short period of time could not be built up sufficiently quickly.

The same entry method applies to building societies. For example, before Halifax Life, Leeds Life, Nationwide Life and Alliance & Leicester Life were launched, each parent building society had ties with Standard Life, Norwich Union, Guardian Financial Services and Scottish Amicable, respectively. Woolwich building society had withdrawn its tied agency-ship and had established a joint venture with Sun Alliance and then founded its own life assurance subsidiary. National & Provincial entered life assurance through the formation of joint venture with General Accident. Britannia Life started life assurance through merger & acquisition. FS Assurance and three more companies, Crusader Insurance, BL Unit Trust Managers and Britannia Life Managed Pension Funds, were acquired by Britannia Life.

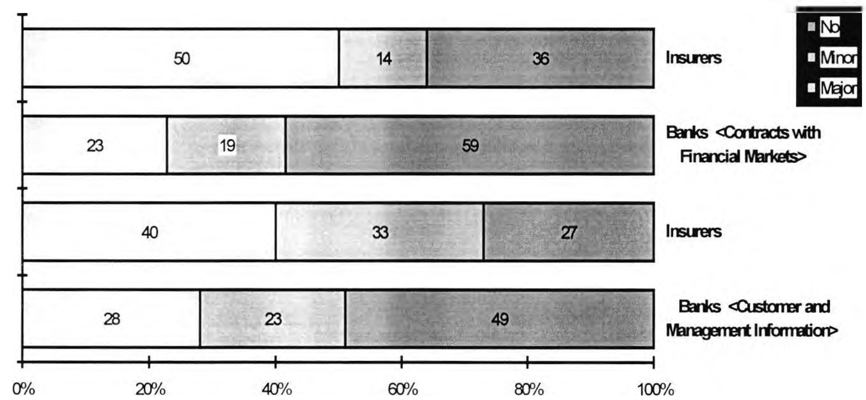
In the area of entry product, bancassurers have focused on the simpler products. Leach (1996:38) pointed out the fact that bancassurers have failed to the penetrate pension sector as: 'With respect to individual pensions, UK bancassurers have failed to penetrate the market ... bancassurers have tended to experience greatest success in selling simpler products ... life insurance policies are more straightforward than pensions'. This failure shows the cost disadvantages of bancassurers in the complicated products.

In conclusion, the first five barriers seem to exert a favourable influence upon the entry. In particular, the marketing advantages, multiproduct services to customers, and generally higher brand recognition of large banks and building societies can reduce the costs accompanied by the entry. However, the switching costs and the cost disadvantages have restricted the entry to a less integrated entry mode and less complicated products.

2.4.3 The Influence of Bancassurance on the Life Assurance Industry

The emergence of bancassurance has given opportunities as well as threats to the traditional life assurance companies. With regard to the opportunities, the branch networks of banks or building societies have been ideally suited to provide an alternative distribution system for the traditional life assurance companies. They view bancassurance as a new distribution channel that has superior customer information and an extensive network. The survey of European financial institutions' policies and practice by Coopers & Lybrand (1993:14-15)[11] showed that insurance companies expected to realise more scale economies from bancassurance than banks in terms of improving contracts with financial markets, and gaining customer and management information. The survey results are shown in Figure 2.3.

Figure 2.3 Scale Effects from Bancassurance (%)



Source: Coopers & Lybrand (1993:14).

Now we discuss three circumstances causing threats to the traditional life assurance companies. Firstly, the opportunities can turn into a threat to the traditional life companies as bancassurers become more involved in the life assurance business. For example, after terminating the distribution agreement with a life assurance company, a

[11]. Coopers & Lybrand surveyed European bancassurance by interviewing with senior executives of some 50 leading banks and insurance companies across Europe (the UK, France, Germany, Italy, the Netherlands and Spain) as well as its own extensive research and project.

bancassurer who wants to set up its own life assurance subsidiary will encounter severe repercussions for the company. The case of Friends Provident and Standard Life can illustrates this threat. Leach (1996:126) reported that Abbey National accounted for 30% of Friends Provident's business in 1993 when the distribution agreement between two institutions came to an end. Halifax had also played a considerable part as a tied agent in the new business of Standard Life before Halifax Life was launched. Friends Provident and Standard Life suffered a severe blow after ending the distribution agreements.

Secondly, conflict of interest between life assurance companies and banks is one of the reasons for changing the involvement from tied agents to their own life subsidiaries and it is producing a threat to life assurance companies. This conflict arises from the different properties of the two financial institutions. Coopers & Lybrand (1993:15) pointed out the different properties of banks and insurance companies, which lead banks to integrate further than insurance companies;

> Because banks have a more stable distribution network and a generally more stable customer base than insurance companies, they aspire to greater integration of the supply of insurance products. Insurance companies own relatively fewer distribution outlets and client data bases because a major part of distribution is through some form of intermediary. In addition, several insurance companies expect to gain largely in terms of prestige and image from their bank links. Full integration is harder to realise and is perceived as less necessary.

The conflict of interest is also caused by the different cultures of life insurers from banks and building societies. Banks and building societies are perceived to be more conservative than insurance companies. Banks focus on reactive personal service and building societies develop their business within a climate of providing mortgage service, while insurance companies take pro-active and sales-oriented approaches.

According to Table 2.8, the cultural differences of two financial institutions create conflicting interest that may lead banks to prefer a more integrated organisation.

Table 2.8 Cultural Differences between Banks and Insurance Companies

	Culture	Core Product	By Product
Banks	Reactive service/order-taking orientation	Money	Risk
Insurance Companies	Pro-active sales Orientation	Risk	Money

Source: Swiss Re (1991).

Table 2.9 APE for Individual New Life and Pension Premiums by Bancassurers in the Independent Intermediaries and Company Agents

	Bancassurers in the Independent Intermediaries	Bancassurers in the Company Agents
1991	154.8 (10.5%)	319.9 (13.4%)
1992	229.7 (14.1%)	359.7 (14.6%)
1993	157.4 (9.9%)	465.9 (18.0%)
1994	120.6 (8.2%)	655.8 (29.9%)
1995	115.5 (8.2%)	448.3 (25.9%)
1996	130.7 (7.0%)	577.0 (28.2%)

Note : The figures in parentheses are percentage of bancassurers in the Independent Intermediaries or company agents
Source: ABI.

Finally, there is a threat to the traditional life assurance companies that use only the company agent distribution, especially tied agents. The market share of bancassurers has increased through company agents such as tied agents and DSFs. This is shown in Table 2.9. The table confirms the fact that bancassurers have penetrated the life assurance market to a slightly less sophisticated class of customers through tied agents instead of IFAs who are generally used by a financially more sophisticated customer. Owing to this penetration of bancassurers, the traditional life assurance companies whose distribution channels were mainly tied agents lost their market shares in the UK life assurance market.

It seems that opportunities and threats force the UK life assurance market to increase competition and require life assurance companies to be more cost efficient for their survival. The competition has mainly happened in the area of distribution since the primary advantage of bancassurers is their marketing strength. This competition and the cost efficiency force in the distribution channels will continue in the future.

2.5. CONCLUSION

We have explained the market structure of the UK life assurance industry. We have observed that there has indeed been a significant increase in the competition in the market. For example, the emergence of new entrants, the cross-border permission of EC companies and more sophisticated customer demands have characterised the life market as a highly competitive market. Moreover, a large number of take-over activities including those among IFAs can be seen as a way of achieving scale and scope economies in order to survive and to grow in such a competitive market. These competitive characteristics in the life assurance market are one of the reasons for employing a cost function instead of a production function. The relationship between the degree of competition and a functional form will be discussed in Chapter 4.

We have also examined the life assurance market with respect to selling products and investments. The life assurance products and pensions account for most of the long-term premium income. Pensions business has increased rapidly because of a striking increase in the ratio of the elderly to the working population and the personal pension scheme. The long-term nature of life business and heavy investment in ordinary stocks and shares account for the important role of investment management in the activities of life assurance companies. This importance provides one reason for constructing the intermediation model for a study of life assurance.

With regard to distribution, we have examined the factors influencing the market share of each distribution. Of these factors, cost efficiency is the basic force for determining the growth of each distribution channel. Tied agents and DSFs are supposed to lose their market share owing to their cost inefficiency, while IFAs and the direct marketing channel are expected to dominate the market share in the life distribution. The '*focus and multi-channel* strategy' is believed to be widely used in distributing life products. We will estimate the cost differences among the distribution channels in Chapter 5 and 6. The comparison between bancassurance and non-bancassurance in terms of cost economies will also be examined in Chapter 5 and 6.

CHAPTER THREE
THE REGULATION OF THE UK LIFE ASSURANCE INDUSTRY

3.1. INTRODUCTION

The purpose of this chapter is to examine the regulatory framework of the UK life assurance industry in relation to production. In any regulated industry the regulatory framework has an influence on the products and the production process. The insurance industry has traditionally been characterised by a high degree of regulation. Thus a study of life assurance productivity in a specific market primarily requires knowledge of the regulatory system in that particular market. The UK life assurance regulation is examined laying particular emphasis on two issues: protection of the policyholders and solvency of a life company. The reason for focusing on the two issues in examining the regulation can be explained by the following regulation theories.

Regulation may be regarded as correcting market imperfection and improving market efficiency for customers. Brady, Melinger, Scoles and Hamilton (1995:18-30) explained the regulation theories and justified the reasons for regulation in the insurance sector. They divided the regulation theories into three categories: the *public interest theory*, the *public choice theory* and the *political theory of regulation*. By the *public interest theory*, the insurance regulation exists to protect the public's interests in the insurance market. Whereas the *public interest theory* focuses on the use of governmental authority for protecting the public's interests, the *public choice theory* emphasises the public's right in selecting a regulator to protect its interests.

The *political theory of regulation* recognises that regulation is developed and implemented by a political environment and political institutions. The political institutions that formulate regulatory policies consist of four major groups: the regulatory agency, the regulated industry, the non-industry interests, and the political elite. The four institutions corresponding to insurance are (1) the government regulators (2) the insurance company representatives, the insurance agents and brokers (3) policyholders and (4) the courts and legislators. The *political theory* has recently emphasised the increasing power of consumers and the role of regulators in meeting consumers' needs and wants. Thus the essence of all the theories in the insurance regulation can be summarised as protecting policyholders.

The reason why the government regulators are always concerned about the solvency of the insurer can be explained in the summary of the three regulation theories. In order to protect policyholders, the financial soundness of an insurer should be set forth as a premise. It can be said that (1) the protection of policyholders and (2) the solvency of the insurer are the main issues in a study of insurance regulation. The examination of the two issues will be the focus of this chapter.

This chapter consists of 6 Sections. In Section 2, the regulatory framework of the UK life assurance industry is explained. This section is divided into two sub-sections: describing the necessary requirements for authorisation and the legislation in the UK life assurance industry. In Section 3, the importance of maintaining the solvency margin is discussed and the method of determining the solvency margin is described. In this section, we also suggest the reason for employing the *required minimum margin of solvency* as a proxy for the riskiness of contracts. In Section 4, we explain the business-border regulation from two perspectives: the regulation of composite insurer and the cross-industry regulation. This chapter ends with a brief conclusion in Section 5.

3.2. THE REGULATORY FRAMEWORK OF THE UK LIFE ASSURANCE INDUSTRY

3.2.1 The Requirements for Authorisation

The regulatory framework is investigated in terms of authorisation and legislation. Getting authorisation is the starting point of the production process. In the authorisation process, we investigate the qualifications necessary to obtain authorisation. It is normally said that getting authorisation in the UK is easier than in other countries because of lower entry barriers in the UK insurance market (Price Waterhouse, 1995). The reasons for the lower entry barriers were pointed out by Price Waterhouse (1995:35). The first reason is that it is comparatively straightforward to gain authorisation from the Department of Trade and Industry (DTI). The second reason is the highly developed nature of the UK broker market in contrast to most European countries. The third reason is the relatively light regulatory requirements for the reinsurer. In the UK, traditionally there has been no difference between the regulation of the insurers and that of the reinsurers. Thus the UK insurance market can be characterised as giving insurance companies more freedom and a simpler procedure for carrying out[1] an insurance business.

In spite of this freedom and simplification, an applicant must gain authorisation from the DTI under the Insurance Companies Act 1982 that came into force on 28 January 1983. The authorisation is also needed from the DTI in the case of the external companies[2] to carry out an insurance business in the UK. However, this does not apply to the European Economic Area (EEA) insurer operating under so called the

[1]. The meaning of *carrying out (or carrying on) an insurance business* is different from that of *providing an insurance business* in terms of authorisation and establishing a branch (Cooper & Lybrand, 1995:9). It is necessary to have an authorisation to carry out an insurance business in the UK, but it is not necessary to have any authorisation in order to provide an insurance business. Carrying out an insurance business normally means that a company sells or writes an insurance business with establishing a branch, but providing an insurance business normally means doing the business without a branch.

[2]. The external companies are the insurance companies where the head office is outside EEA.

'single licence'. The single licence means the Home State supervision in the Third Directives. The Home State supervision means that if an insurance company is authorised in one Member State, it can carry out its insurance business in any other Member State without further authorisation. The EEA life insurer can, therefore, carry out the life business in the UK without any further approval of the DTI, subject to only the supervision in its home state. The UK implemented the Third Directives in July 1994.

The application for an authorisation must contain some information about the applicant and the proposed company. The necessary requirements for authorisation were described by Ellis (1990:279-283) [3], Cooper & Lybrand (1995:9-12) and Arthur Young (1988:11-13). Key factors for the authorisation may be divided into three aspects: (a) The financial aspect; (b) The human aspect; and (c) The business aspect.

(a) The financial aspect

The financial aspect can be divided into two main points: financial soundness and financial planning. With regard to financial soundness, the applicant must demonstrate to the DTI that there are sufficient financial resources available to support the proposed level of business. Even though legal minimum paid-up share capital is not required, the applicant should be able to maintain assets in excess of liabilities by a specified margin at all times. This margin is referred to as the *required solvency margin*. The required solvency margin is used for determining the solvency position that is designed to protect the policyholders as well as for the purpose of remedial action for a financially troubled insurer. The method of determining the solvency position will be explained in Section 3.

As far as financial planning is concerned, the applicant must submit the financial projections covering a forecast balance sheet, detailed estimates of income and

[3]. Ellis (1990:280) classified the licensing requirements under the broad headings of legal, financial, accounting, technical and accounting requirements.

spending, and estimates on the financial resources. The DTI will examine the financial soundness and maintenance capacity of the applicant based on the projections.

(b) The human aspect

The human aspect is related to an insurance company's philosophy and commitments to society. The insurance products are types of public goods. The decision of a controller[4], manager or chief executive of an insurance company will have a great influence on society. Thus the DTI requires the personnel holding key positions in the company to be *fit and proper* for their appointments. *Fit and proper* signifies that the personnel should have appropriate experience in the insurance industry and a good moral character. For the assessment of *fit and proper* the DTI requires the personnel mentioned in the application to submit their biographical details, details of any court convictions and details of any bankruptcy declaration.

(c) The business aspect

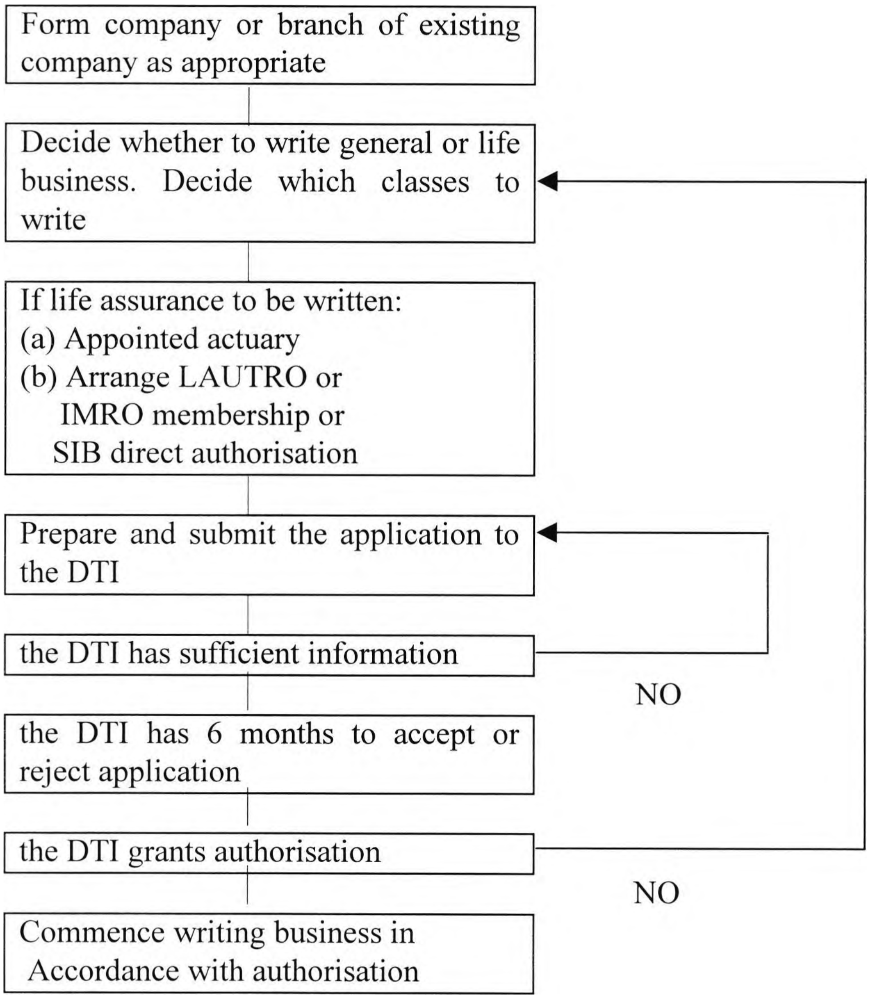
The business aspect deals with a number of requirements related to the general level of business activities of the proposed insurance company. These requirements, with particular reference to the life assurance business, can be summarised as follows.

Firstly, the DTI requires that the assets covering the non-linked liabilities should be of appropriate safety, yield and marketability and that the investments from the non-linked life business should be appropriately spread and diversified. In particular, the investments coming from the unit linked life business must match, as closely as possible, the linked liabilities. Secondly, a life assurance company has to appoint a qualified actuary, i.e. the Appointed Actuary, who will be responsible for investigating the financial condition of their long-term business once a year and at any

[4]. The controller of an insurance company is the person such as a managing director; a chief executive; a person who controls 10 % or more of the voting power; or a person who is able to exercise a significant influence over the management. An insurance company must need the approval from the Department should a controller be changed.

other time when the company distribute a surplus. Finally, the DTI requires both the optimistic and the pessimistic statements for each type of contract, covering the number of contracts, total premium income, and total sums assured or amounts of annuity.

Figure 3.1 Simplified Flowchart of Authorisation Process



Source: Price Waterhouse (1990:81).

One recommendation that is not a legal requirement but a guideline is the limitation of reinsurance. The DTI expects a company to retain, for its account, a significant part of total business underwritten. In addition, the Department will not normally wish to see more than 20 % of liabilities of a company reinsured with one in the group companies; more than 10 % of those reinsured with one of the other companies; and more than 25 % of those reinsured in any one country, unless its head office is located in that country.

The DTI, if satisfied with the above requirements, will then grant authorisation within six months of receipt of the application. The authorisation process is shown in Figure 3.1.

3.2.2 The Legislation in the UK Life Assurance Industry

The principal statute governing the UK life assurance business is the Insurance Companies Act 1982. There are also two supporting regulations: the Insurance Companies (Accounts and Statements) Regulations 1983 and the Insurance Companies Regulations 1994. In addition, the investment business related to life assurance is regulated by the Financial Services Act (FSA) 1986.[5] Another statute is the Policyholders Protection Act 1975 established for the protection of the policyholders when an authorised insurer becomes insolvent.

It is said that the most important characteristic of the Insurance Companies Act 1982 is *flexibility* in the regulatory system. Ernst & Young (1995:9) point this out as:

> In many respects the 1982 Act is an enabling measure; that is to say it lays down the broad principles of the law but allows the Secretary of State to prescribe the detail by making the regulations contained in a statutory instrument. The advantage from the point of view of the legislators of proceeding in this fashion is flexibility since it is far easier to make or amend a statutory instrument than it is to place an Act on the statute book.

[5]. Under the FSA 1986, all the life assurance contracts are regarded as the investment business except for (1) the permanent health insurance policies; (2) policies where death benefits are payable within ten years or before the insured reaches a specific age; (3) policies with no surrender value; and (4) single premium policies where the surrender does not exceed the premium.

This flexibility has stimulated the UK domestic insurance market to be more competitive. For example, this flexibility has enabled the UK insurance market to be characterised as having lower entry barriers and thus a large number of companies are able to provide or carry out an insurance business.

There are six parts in the Insurance Companies Act 1982. The main part of the Act is part II that sets out the framework for governing the regulation of the UK insurance companies. This part deals with (1) the authorisation; (2) actuary and the DTI's powers of intervention; (3) the maintenance of a solvency margin; (4) notification of changes in directors, controllers and managers; (5) the requirement for annual account and returns; the separation of assets and liabilities; and (6) the restrictions on the transfer of long-term assets to shareholders.

Even though the Insurance Companies Act 1982 is the main statute, the Act simply presents a guideline in regulating insurance companies. More detailed regulations are supplemented by the two supporting regulations: the Insurance Companies (Accounts and Statements) Regulations 1983 and the Insurance Companies Regulations 1994. We need to examine these two because they will be further cited in this thesis and the data to be used in the empirical models of this thesis are based on the two sets of regulations.

The Insurance Companies (Accounts and Statements) Regulations 1983 sets out the required format for the annual accounts and returns made under Regulations 17, 18 and 25 of the Insurance Companies Act 1982. Under the Insurance Companies Act 1982, all the companies carrying out an insurance business with the UK authorisation must submit an annual return to the DTI. This is usually called the *DTI Returns*.[6]

Another report is the *annual reports*. All the insurance companies including insurance intermediaries must issue the annual reports to their shareholders or members under

[6]. The DTI Returns is regulated by the Insurance Companies (Accounts and Statements) Regulations 1996 since 1996

the requirements of the Companies Acts 1985. In the opinion of the CII (1991:120), the DTI Returns is a better data source than the annual reports: 'The DTI Returns contains much more comprehensive information than the annual report and is the source for most published financial statistics on insurance companies'. Some forms of the DTI Returns that are the main data source of this thesis are given in Appendix A.

The DTI Returns consists of 6 Schedules. Schedule 1 demonstrates solvency margin, profit and loss account and balance sheet. The revenue accounts of life assurance are reported in Schedule 3 and those of general insurance are reported in Schedule 2. Schedules 4 and 5 contain detailed actuarial information on the life assurance business such as abstracts of valuation reports and a summary of the in-force data in the actuarial valuation. Schedule 5 has to be produced every five years as opposed to the other Schedules which are produced annually. Schedule 6 contains the director's certificate, actuary's certificate and auditor's report. In June 1994, the DTI issued a Consultative Document entitled *Updating the DTI Returns* in the light of the Government's deregulation initiative, the EC Insurance Accounts Directive, the completion of the Single Market and the compliance with the Insurance Companies Regulations 1994. For example, one of the updating items is that other management expenses are subdivided into one-off costs and ongoing costs in Form 41.[7]

The required format for the DTI Returns is regulated by the Insurance Companies (Accounts and Statements) Regulations 1983, whereas the methods and assumptions for reporting the DTI Returns are regulated by the Insurance Companies Regulations 1994. The 1994 Regulations extends the regulations under the Insurance Companies Act 1982. The 1994 Regulations consists of nine parts. These are (1) preliminary; (2) more detailed requirements about authorisation; (3) deposits for authorisation in the case of external companies; (4) the required solvency margin and *minimum guarantee fund*; (5) matching liabilities and assets; (6) change of control; (7) contents of advertisements and disclosure; (8) the valuation of the assets; and (9) the determination of liabilities. Of these parts, the solvency margin in part (4) and

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[7]. For more discussions on *Updating the DTI Returns,* see Coopers & Lybrand (1996) or PGN (1996).

determination of liabilities in part (9) are relevant for our research purpose. These parts will be examined in detail in Sections 3 and 5, respectively.

It follows that the important statute related to the investment business of life assurance companies is described. The FSA 1986, which came into force in April 1988, established a new framework for investors' protection and the self-regulatory organisations. This Act was designed by government-commissioned Professor Gower with the regulatory philosophy of *freedom with disclosure*. The self-regulatory organisation means that the regulatory agency is funded not by the government, but by the financial services industry itself. Most of the governing powers were transferred to the Securities and Investment Board (SIB). The SIB is a body to which the Secretary of State delegates many of his governing powers. The SIB regulates all the major investment markets with the exception of Lloyd's of London and monitors them through the Self Regulation Organisations (SROs). These are as follows:

a) The Security Association (TSA), covering most aspects of the securities trading such as shares, bonds, warrants, depository receipts, futures and options.
b) The Association of Futures Brokers and Dealers (AFBD), regulating those who deal, advise or manage future contracts and options.
c) The Investment Management Regulatory Organisation (IMRO), covering the management of the collective investments such as pension funds, unit trusts and investment trusts.
d) The Financial Intermediaries, Managers and Brokers Regulatory Association (FIMBRA), regulating the independent financial intermediaries and brokers.
e) The Life Assurance and the Unit Trust Regulatory Organisation (LAUTRO), regulating the selling practices of life assurance companies.

The main SROs in the FSA 1986, relevant to marketing and investment of life assurance companies, are the IMRO and the Personal Investment Authority (PIA). The PIA was formed in 1994 for the purpose of combining the functions of the FIMBRA and the LAUTRO. Some rules of the PIA about selling practices and protecting investors in the life assurance business are summarised as follows (Cooper & Lybrand, 1995:20):

a) The Code of Conduct

Before offering any product the salesmen must state that the product they intend to offer is the best one for that particular investor. They must adhere to the best advice that involves assessing an investor's financial position and offering a product in the interests of the investor. They are also required to keep a record of all transactions with investors.

b) Polarisation

Persons selling a life product must either be the independent intermediaries or be company agents. The independent intermediaries can recommend products chosen from the range of all the life companies, while company agents are tied exclusively to a particular life company as company representatives (DSFs) or as appointed representatives (tied agents), as discussed in Chapter 2.

c) The New Disclosure Scheme

The PIA members disclose commission, expenses and charges. This scheme became effective from 1 July 1994 and required implementation from 1 January 1995. This scheme was created for the purpose of giving customers more easily understood information of products and protecting customers. This has become one of the reasons for increasing competition as well as decreasing the business volumes in the life assurance industry.

The commission disclosure changed from *soft* disclosure of commission to *hard* one.[8] In the soft disclosure, the disclosure of commission was limited to IFAs. The figures disclosed were expressed as a percentage of premiums and the disclosure occurred after the sale in the soft disclosure. However, in the hard disclosure, the commission disclosure must be made at the point of sale, which is called the up front disclosure of commission, and the figures must be expressed in cash terms for customers to follow easily. Moreover, all the distribution channels including tied agents and DSFs must disclose commission under all circumstances.

In addition to the commission disclosure, the disclosure of expenses and charges has been strengthened. The disclosure changed from a *standard charge* basis to an *own charge* basis. Surrender values and maturity values are also included in the scope of the own charge basis. As with the new commission disclosure, the figures of expenses and charges should be expressed in cash terms for the same purpose.

d) The Training and Competence Scheme

This specifies the core curriculum that all the persons providing advice to customers should have a minimum level of investment and financial service knowledge. The scheme also requires life companies to keep training and assessment results. These requirements have enforced a more professional service on the distribution channels of life assurance industry.

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8 . Boléat (1995:2) has drawn attention to the fact that the hard disclosure has been caused by the characteristics of life assurance products such as greater influence on a family's well-being, difficulty in knowing the price and long term in nature. Inappropriate purchase of a life assurance product can be more harmful to an individual's or family's welfare than a suit of clothes bought unsuitably. The customers of life assurance products cannot easily understand what they are buying or what factors contribute to the price because of the complex nature of products and pricing. The nature of the long-term contract intensifies the complicated characteristics of life assurance since there is a great uncertainty about the future.

Another important piece of legislation is the Policyholders' Protection Act 1975 that seeks to protect the policyholders of UK contracts. The Act established a board named as Policyholders Protection Board. The task of the Board is to try to secure the transfer of business from a company to another authorised life assurer when the initial life assurer fails to meet its obligations under the policy. If this transfer is not possible, the Board then pays the policyholders 90 % of the value attributed to the policy. The compensation funds are financed by means of a levy on the industry, which broadly will not exceed 1 % of net premium income of each company.

3.3. THE SOLVENCY REGULATION

3.3.1 The Importance of Maintaining the Solvency Margin

The main concern of the regulators in insurance is to maintain the solvency margin for the purpose of protecting policyholders and stabilising the insurance market. Details of the solvency regulation are set out in Regulations 16 to 26 of the 1994 Regulations. Ettlinger, Hamilton and Krohm (1995:130) defined *solvency* in insurance as: 'Solvency is used to describe its [an insurance company's] ability to meet financial obligations as they become due, even those resulting from insured losses that might be claimed at a time several years in the future'. It is noted that *insolvency*, namely the opposite concept of solvency, should be distinguished from *bankruptcy*. Whereas bankruptcy in insurance means that a company's *mathematical reserves* exceed its *total assets*, insolvency means that the *required minimum margin of solvency* exceeds its *available assets*. The insurer's *available assets* are computed as the difference between total assets and mathematical reserves including other liabilities.

Now we discuss the reasons for the importance of maintaining solvency and protecting policyholders in the insurance regulation. One reason can be explained by considering the future characteristic of insurance contracts. A greater degree of safeguards for policyholders is demanded in view of the inherently uncertain nature of insurance contracts. In other businesses, consumers can have utility immediately after buying goods or services. In the insurance business, however, policyholders merely have less worry and fear immediately after the contract. Direct utility in buying an insurance product, namely the insured benefits, may be given after the occurrence of the insured losses in the future because of the future characteristic of insurance contract. It is thus necessary for the insured to have a safeguard at the point of contract, that is to be indemnified against the insured losses in the future. So the safeguard for policyholders can be guaranteed when the insurer maintains solvency consistently. This safeguard may be more important in life assurance than in general insurance since life assurance contracts may be in force for periods of ten, twenty, even forty years or longer.

Allen (1995:1-2), working for the DTI Insurance Division, pointed out why it is a major part of the insurance regulation in the UK to protect the policyholders, especially in the life assurance business.

> As regulators we see our primary responsibility as being to protect the consumer . . . The UK regulatory regime for insurance seeks to stick as closely as possible to this basic framework: but it recognises that there are special features of insurance which require a more specific set of rules. The essence of the insurance contract is that it is a promise to pay in defined circumstances at some point in the future – often many years in the future. The policyholder needs some assurance that the insurer will still be around, and in a position to pay, if a future claim arises . . . This is most clearly the case with long-term business such as life assurance and pensions.

The other reason for the importance of maintaining solvency can be explained by the influence on the insurance market after insolvency. A financial failure of an insurer incurs a loss to the other insurers, who are solvent in that market, as well as to the insureds. The more insurers become insolvent, the more compensation funds in the Policyholders Protection Board will be needed. Since the costs incurred for settlements paid through the funds are levied on the remaining solvent insurers in the market, the consequences of insolvency exert unfavourable influence upon productivity or the production process of all the insurers.

3.3.2 The Solvency Margin

A pre-condition for protecting policyholders is that an insurance company continuously maintains financial soundness. Two methods can be used for satisfying this condition: the *deposit requirement* and the *solvency margin*. The disadvantage of deposit method is that it is insensitive to circumstances because the deposit is determined purely by the classes of business.[9] Conversely the solvency margin method enables the regulator to judge the solvency position of each insurance company which varies according to the level of business carried out (Ernst &Young, 1995:33). The DTI uses the solvency margin method. The calculation of the solvency margin can be summarised in the following paragraphs.

The *required minimum margin of solvency* is the higher of the required solvency margin and the *minimum guarantee fund*.[10] The required solvency margin, R, is computed as:

$$R = (M^*r) + (C^*r)$$

where M is mathematical reserves; C is capital at risk; and r is a factor ratio according to the classes of business, the investment risk, the period of insurance risk and the ceding ratio.

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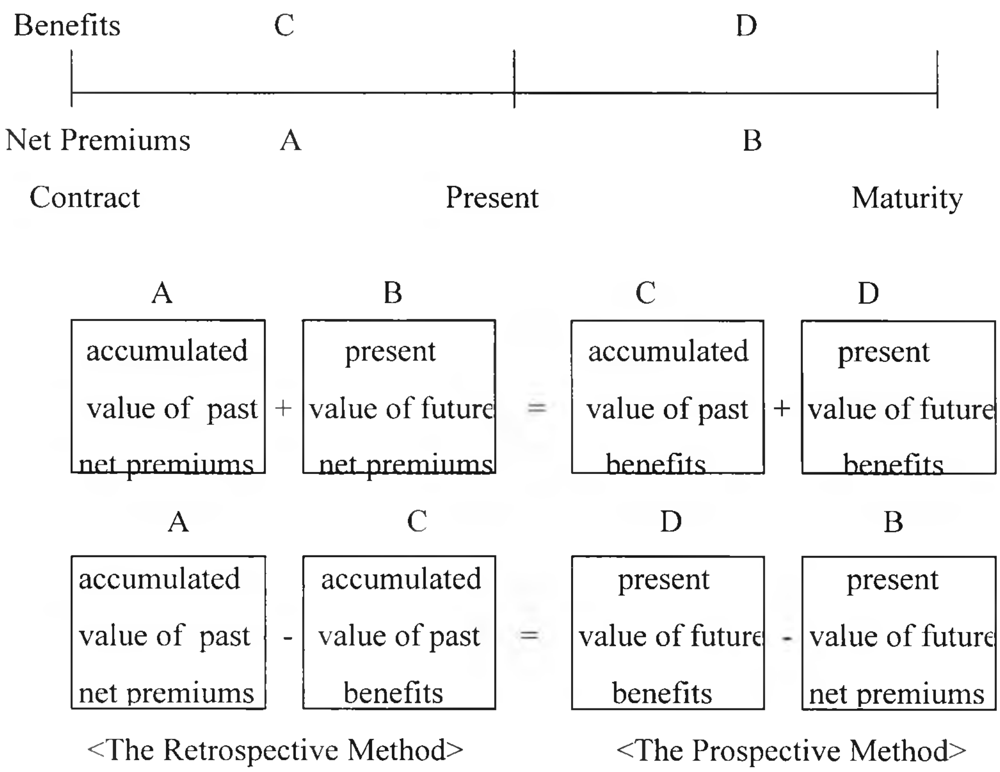
[9] . In the case of a direct external insurer, a deposit is required prior to authorisation (Ernst & Young, 1995:33).

[10] . The *minimum guarantee fund* is a fixed minimum reserve required by the Insurance Companies Act 1982. This fund is not sensitive to the classes of business carried out. In the case of life business, the normal amount is 800,000 ECU.[10] However, the amount is reduced by 25 % in the case of mutual and by 50 % with respect to the UK margin of solvency maintained by the external direct insurer.

The mathematical reserves are a part of premiums that should be reserved to cover the future in the level premium system. In this system, the sufficient amount on the premiums in the early years must be reserved to compensate for the later years. The amount to be reserved is referred to as the mathematical reserves. There are normally two approaches to calculating the mathematical reserves: the retrospective method and the prospective method. These methods are shown in Figure 3.2.

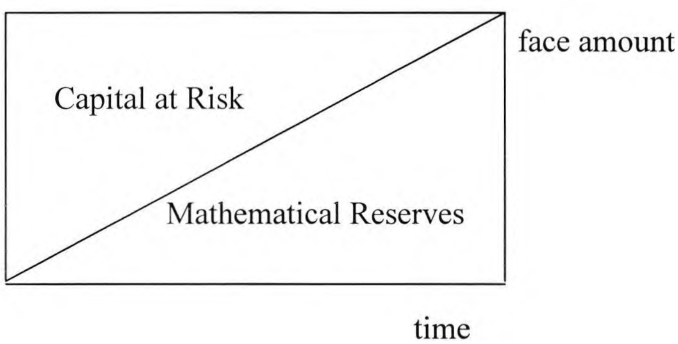
If two methods use the same mortality table and interest rates, both methods produce the same result. However, the Insurance Companies Regulations 1994 recommends that the mathematical reserves should be calculated by the prospective method except for where the prospective method cannot be applied. The influence of interest rates on the mathematical reserves is straightforward. Calculation with a lower interest rate produces higher mathematical reserves. On the other hand, the influence of mortality rates has no singular effect on the mathematical reserves, because in practice the reserves comprise a mixture of a benefit payable in the case of survival as well as of death (de Wit, 1990:253).

Figure 3.2 The Retrospective Method and the Prospective Method



The *mathematical reserves* steadily increase over time. Thus the pure insurance portion of a policy declines over time. This portion is the *capital at risk* that can be calculated as the amount payable on death less the mathematical reserves with respect to the contract. We can interpret the mathematical reserves as a saving element and the capital at risk as a protection element. Therefore, the sum of the mathematical reserves and the capital at risk is the amount of the insurer's whole responsibility, that is a face amount of the policy. The relationship between the two concepts is shown in Figure 3.3.

Figure 3.3 Mathematical Reserves and Capital at Risk



With regard to the factor ratios, four factors are considered: the classes of business, the investment risk, the period of insurance contract and the ceding ratio. The calculation details are shown in Table 3.1. For instance, the factor ratio for the mathematical reserves in the case of non-linked long-term contract is 4 % and is also 4 % in the case of linked long term contract if there is investment risk and 1 % if there is no investment risk. In general a non-linked long-term contract is riskier than a linked long-term contract to a life assurance company because policyholders take some of the contact risks, i.e. investment risk, when they buy a linked long-term contract. This is the reason for the different factor ratio of 4 % for non-linked long-term and 1 % for linked long-term contract. The factor ratio for capital at risk is generally 0.3 %. This ratio can reduce according to the period of insurance contract. The factor ratio for capital at risk in the case of life and annuity products is 0.1 % if the period of insurance contract is three years or less. However, the ratio increases by 0.15 % if the period is more than three years but less than five.

Another factor affecting the required solvency margin is the retention ratio. In general the higher the reinsurance ceding ratio, the lower the required margin of solvency. However, if the ceding ratio is greater than 15 %, then 85 % of the mathematical reserves before deduction for reinsurance is used for the calculation of the required margin of solvency. With respect to the capital at risk, the 50 % of the capital at risk is applied to the calculation if the ceding ratio is greater than 50 %.

Table 3.1 Calculation of the Required Solvency Margin

Class	Mathematical Reserves	Capital at Risk
Life and annuity Marriage and birth Social insurance	4%	0.3% reduced to: (1) 0.1% in the case of a pure reinsurer (2) 0.1% for term contracts with a three-year or less total term (3) 0.15% for term contracts with a term of more than three years but less than five
Linked long term Pension fund management Collective insurance	(1) 4% if there is an investment risk (2) 1% if no investment risk, total term in excess of five years and management expense allocation in the contract has a fixed upper limit which is effective as a limit for a period exceeding five years	(1) 0.3% if a death risk is covered reduced to 0.1% in the case of a pure reinsurer (2) Nil otherwise
Permanent health Capital redemption	4 %	Nil

Source: Ernst & Young (1995)

We have outlined the factors that determine the solvency margin. One thing to suggest with regard to the four factors determining the amount of the required solvency margin is that this amount can be used as a proxy for the riskiness of insurance contracts. The amount increases as life assurance companies carry out a contract that has higher insurance and investment risk, longer period, and higher retention ratio.

The solvency margin will be employed as one of the cost factors representing the riskiness of insurance contracts in the underwriting model.

3.4. THE BUSINESS-BORDER REGULATION

The business-border means the scope of carrying out business. We may consider two kinds of activities in the business-border regulation: composite and bancassurance.

A composite company can, in a broad sense, be defined as an insurer undertaking both life and general insurance business through separate departments. In this definition, a life company can be called a composite company if its parent company or one of the subsidiary companies carries out general business. There were 58 composite companies authorised on 31 December 1995 (Tillinghast-Towers Perrin, 1997:6). Composite companies are required to separate their long-term business from general business as required by Section 29 of the Insurance Companies Act 1982[11]. Section six of the Insurance Companies Act 1982 prohibits a formation of the composite company, unless life business is restricted to reinsurance business or general business is subjected to healthcare business. This prohibition was taken to comply with the first Life Insurance Directive[12] and to exclude a possibility of infringing on the security of the policyholders.

The activities of bancassurance are regulated by the cross-industry regulation which treats the outstanding trend of inter-relationships between the insurance sector and the banking or other savings institution sector. Traditionally, the cross-industry entry was

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[11]. The segregation is also applied to the solvency margin and the regulatory body over the investment activities. The investment activities of life assurance are mainly regulated by the IMRO and the PIA, while those of general insurance are regulated by the DTI. However, there are two exceptions in the segregation. One is free reserves and the other is exchange of the life assurance assets at fair market value. The life assurance assets may be used for purposes other than the life assurance business when the life assurance assets exceed the liabilities and they are exchanged at fair market value.

[12]. The composite insurers prior to implementing the first Life Insurance Directive on 1 January 1982 can still carry out both life and general insurance.

restricted by the principle of segregation. This principle is ultimately based on protecting consumers. Since the insurance characteristics are basically different from the banking or other savings institution characteristics, the cross-industry penetration was prohibited.[13]

However, the cross-industry activities have existed in the UK life assurance market relatively for a long time. Bancassurance is a typical example and the earliest evidence is Barclays and TSB. These banks formed their own life assurance subsidiaries in 1965 and 1967, respectively. They formed the foundation of the cross-industry penetration in the UK. The Building Society Act 1986 and the FSA 1986 accelerated the entry into the life assurance sector by building societies and banks.

The structure of the UK cross-industry regulation is observed in the study by OECD (1992:19-38). The study compared the state of bancassurance of Member Countries in terms of production, distribution of products, structural operations and supervision. The UK structure can be summarised as follows.

The UK banks are prohibited from producing an insurance product like all other Member States, but are allowed to distribute a life assurance product. The UK banks are permitted not only to own an insurance subsidiary but also to take an equity stake of an insurance company. The same rules are applied to the UK insurers except for the restriction on distributing a banking product. With regard to the structural operations, the UK regulators permit the UK banks to form a financial group in which a bank or an insurance company is the parent company or a company of the group. As far as supervision is concerned, the UK has introduced the idea of a lead regulator who is responsible for disseminating information and harmonising the sector authorities:

[13]. According to Dickinson and Dinenis (1993:2), the prohibition has existed in order to reduce the vulnerability of the financial system and to minimise the potential growth of power by large financial conglomerates. The reasons for this prohibition are also ultimately related with protecting consumers.

however, each of the sector regulators would still retain its own functions and responsibilities.[14]

It is interesting to test the performance of composite and bancassurance companies. Since many of the major UK insurance companies are composite companies carrying out both life and general business, their performance may be one of the important issues in the market. With regard to bancassurance, there are many arguments for and against the regulators' decision to permit or to restrict the cross-industry activities (OECD, 1992:17-19) (Hoschka, 1994:7-13). All the discussions for the bancassurance regulation were limited mainly to the difference of production between insurance and banking, or to the danger of using long-term assets in life assurance to fulfil short-term liabilities in banking. However, no study has yet quantified the performance of bancassurance companies empirically as to whether they have greater degree of scale and scope economies than the traditional insurers.

3.5. CONCLUSION

We have discussed the UK life assurance regulation. Even though the UK life regulation has the attribute of giving fewer restrictions to life companies, the DTI strictly requires life assurers to comply with some rules in order to protect the policyholders and to maintain solvency.

Firstly, we have examined the regulatory framework of the UK life assurance industry. In the examination of the necessary requirements for authorisation, financial soundness is the most important thing to be considered by the DTI. The recent changes in the legislation such as the new disclosure scheme and the training and competence scheme have forced life companies to increase their costs in providing

[14]. At the end of 1997, the Chancellor of the Exchequer announced a single regulatory and supervisory authority named as Financial Services Authority (FSA) headed by the Deputy Governor of the Bank of England. This authority will supervise banking, insurance and security business.

services to their policyholders and have required them to improve productivity for survival and growth.

Secondly, we have discussed the importance of maintaining the solvency margin and have investigated the calculation of the solvency margin. The main concern in the insurance regulation is to maintain the solvency margin for protecting policyholders and stabilising the market. The required solvency margin will be employed as a proxy for the riskiness of insurance contracts in modelling the underwriting activity. The four factors determining the solvency margin represent well the riskiness of insurance contracts.

Finally, we have examined the business-border regulation with respect to composite and bancassurance. The performance of composite companies may be important issue in the insurance market. The results of the empirical test for the performance of bancassurance companies will provide the regulators with useful information for formulating regulatory policies over bancassurance.

CHAPTER FOUR
MODELLING THE PRODUCTION STRUCTURE OF A LIFE ASSURANCE COMPANY

4.1. INTRODUCTION

The main purpose of this chapter is to model the production structure of a life assurance company. This chapter is divided into two parts. Firstly, we provide a general description of technology and functional forms that have been employed to describe it. Secondly, we define the inputs and outputs of an insurance company and then ways of describing the process of transforming inputs into outputs.

Defining and measuring outputs are a moot point in the insurance productivity study because of the intangible nature of insurance. However, it is beyond dispute that outputs and costs in insurance must reflect the activities for providing services to policyholders. We group the activities of a life assurance company into two functions: the *underwriting function* and the *intermediation function*. Each function generates different output and entails a different cost structure.

This chapter is organised as follows. In Section 2, a description of single and multiple output production technology is presented. In Section 3, we explain why we employ a cost function instead of a production function. In Section 4, we describe the production technology of a life assurance company. In Section 5, we deal with the measurement problems of inputs and outputs in the previous studies, and a summary is presented in Section 6.

4.2. GENERAL DESCRIPTIONS OF TECHNOLOGY

4.2.1 Single Output Production Technology

The efficient transformation of a vector of inputs $\mathbf{x}$ into a single output q can be represented by the following convex transformation function:

$$\Phi(q, \mathbf{x}) = 0 \qquad (1)$$

If the transformation function has a strictly convex input structure, the dual cost function can be derived by the duality theorem. The producer's cost function C is defined as the solution to the problem of minimising the cost of producing at least level of output q, given that the producer faces input prices vector $\mathbf{p}$:

$$C(q, \mathbf{p}) = \min_{\mathbf{x}}\{\mathbf{p}'\mathbf{x} : \Phi(q, \mathbf{x}) \geq 0\} \qquad (2)$$

The cost function satisfies the following regularity conditions:

a) C is non-negative

b) C is linearly homogeneous in input prices for any fixed output level

c) C is a concave function of $\mathbf{p}$

d) C is continuous in $\mathbf{p}$

e) C is non-decreasing in q for fixed $\mathbf{p}$.

Returns to scale can be defined as the ratio of the marginal product to the average product that is called the elasticity of scale, ε. If the marginal product is greater (less) than the average product, ε means increasing returns to scale (decreasing returns to scale). If $\varepsilon = 1$, this case is referred to as constant returns to scale. Another measurement of returns to scale is the elasticity of cost that is reciprocal to the elasticity of scale[1].

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[1]. For proof of reciprocal, see Heathfield and Wibe (1987:57).

The cost function assumes particular functional forms in special cases. For instance, if the cost function is homothetic, then it has the form:

$$C(q, \mathbf{p}) = \Gamma(q)H(\mathbf{p}) \tag{3}$$

The cost function in (3), however, has the restrictive property that relative input demands are independent of the level of output. Two homothetic cost functions that have been used widely are the Cobb-Douglas cost function,

$$C = \frac{q}{A}\left(\frac{p_1}{\alpha}\right)^{\alpha}\left(\frac{p_2}{\beta}\right)^{\beta} \tag{4}$$

and the constant elasticity of substitution cost function,

$$C = \frac{q^{\frac{1}{\mu}}}{A} p_1 p_2 \left[(1-\delta)^{\sigma} p_1{}^{-\sigma\theta} + \delta^{\sigma} p_2{}^{-\sigma\theta}\right]^{\frac{1}{\sigma\theta}} \tag{5}$$

where A is the efficient parameter; α and β are positive fractions; δ is the distribution parameter; θ is the substitution parameter; μ is returns to scale ; and σ is elasticity of substitution.

The homothetic functions possess the restrictive property that returns to scale is uniform. This is because the partial elasticity of optimal input level with respect to the output level is uniform for all inputs and thus the ratio of the marginal productivity to the average productivity is all the same for all inputs. So in order to be a flexible functional form, the ratios of cost-minimising input demands are allowed to depend on the level of output.

The restriction of homotheticity can be relaxed by using flexible non-homothetic cost functions. Flexible non-homothetic cost functions can be envisaged as a second-order Taylor's series approximations to any arbitrary cost function. The logarithmic function of this approximation is known as the translog cost function and is written as:

$$C(q,\mathrm{p}) = \alpha_0 + \alpha_q \ln q + \sum_{i=1}^{n} \beta_i \ln p_i + \frac{1}{2}\delta_{qq}(\ln q)^2 + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n}\gamma_{ij} \ln p_i \ln p_j +$$

$$\sum_{i=1}^{n} \eta_i \ln p_i(\ln q) \qquad (6)$$

We can impose parameter restrictions that restrict the production technology such as:

a) homotheticity or separability; $\eta_i = 0$,

b) constant returns to scale or linear homogeneity in q; $\eta_i = 0$, $\alpha_q = 1$, $\delta_{qq} = 0$,

c) constant returns to scale Cobb-Douglas function; $\eta_i = 0$, $\alpha_q = 1$, $\delta_{qq} = 0$,

$\gamma_{ij} = 0$.

Returns to scale in the non-homothetic function are not constrained a priori. The elasticity of cost in (6) can be written as:

$$\frac{\partial \ln C}{\partial \ln q} = \alpha_q + \delta_{qq} \ln q + \sum_{i=1}^{n} \eta_i \ln p_i \qquad (7)$$

The linear homogeneity condition in **p** in the cost function (6) implies the following restrictions:

$$\sum_{i=1}^{n} \beta_i = 1, \ \sum_{j=1}^{n} \gamma_{ij} = 0, \ \sum_{i=1}^{n} \eta_i = 0 \qquad (8)$$

Other regularity conditions can be checked by the first and second derivatives of the function (6) with respect to each input price: all the first derivatives are positive and the $n \times n$ matrix of the second derivatives is negative semidefinite. This curvature check is normally examined from the first order conditions for cost minimisation.

The cost minimising input demand functions $x_i(q,\mathbf{p})$ derived from the translog cost function are not linear in the unknown parameters. It is easy though to verify that the cost share equations by applying Shephard's (1970) Lemma.

$$S_i(q,\mathbf{p}) = \frac{p_i x_i(q,\mathbf{p})}{\sum_{k=1}^{n} p_k x_k(q,\mathbf{p})} = \frac{p_i x_i(q,\mathbf{p})}{C(q,\mathbf{p})} = \frac{\partial \ln C(q,\mathbf{p})}{\partial \ln p_i} \quad (9)$$

are linear in the unknown parameters:

$$S_i(q,\mathbf{p}) = \beta_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \eta_i \ln q \quad (10)$$

However, since the shares sum to unity, only N - 1 of the N equations defined by (10) can be statistically independent.[2] Although some of the parameters of the cost function do not appear in (10), given data on output, inputs and input prices, if we append the cost function in (6) (which is also linear in the unknown parameters) to N -1 of N equations in (10), all the parameters can be statistically determined.

We have assumed so far that all inputs can be changed freely by the firm in the short-term. In reality there may be inputs which do not belong to the choice set. If one of the inputs in (1) is fixed in the short-term, we can write the transformation unction as:

$$\Phi(q, \mathbf{x}, k) = 0 \quad (11)$$

where k is a fixed input.

The corresponding short-term or restricted cost function is the solution to the following minimisation problem:

[2]. If we add random disturbances that are independently and identically distributed with zero mean and constant variance to the cost share equations, the sum of the disturbances across the cost share equations is zero. This is often called *adding-up condition* and gives rise to the singularity problem. Berndt (1991:472) described an econometric problem caused by the adding-up feature of the cost share equations. Because of the adding-up condition, both the disturbance covariance matrix and the residual cross-products matrix are singular and nondiagonal. Thus ML estimation in a system of equations, which minimises the determinant of $E'E$, will not be attainable.

$$C(q, \mathrm{p}, k) = \min_{\mathrm{x}}\{\mathrm{p}'\mathrm{x} : \Phi(q, \mathrm{x}, k) \geq 0\} \tag{12}$$

where k is a fixed cost.

Note that the cost minimising variable input demand equations are derived using Shephard's Lemma:

$$x_i^* = \frac{\partial C(q, \mathrm{p}, k)}{\partial p_i} \tag{13}$$

4.2.2 Multiple Output Production Technology

Companies in general produce more than one output. The efficient transformation of a vector of inputs **x** into a vector of outputs **q** can be represented by the following convex transformation function:

$$\Phi(\mathbf{q}, \mathbf{x}) = 0 \tag{14}$$

The cost function corresponding to the multi-output production function is given as a solution to the following problem:

$$C(\mathbf{q}, \mathbf{p}) = \min_{\mathbf{x}}\{\mathbf{p}'\mathbf{x} : \Phi(\mathbf{q}, \mathbf{x}) \geq 0\} \tag{15}$$

where again the cost function has the same regularity conditions as before.

If the production frontier is separable into a function of outputs and function of inputs, then

$$\Phi(\mathbf{q}, \mathbf{x}) = G(\mathbf{q}) - F(\mathbf{x}) \tag{16}$$

and the cost function takes the form (Hall, 1973)

$$C(\mathbf{q},\mathbf{p}) = C(\Gamma(\mathbf{q}),\mathbf{p}) \tag{17}$$

If the separable frontier is homogeneous in the outputs, the cost function will have the form:

$$C(\mathbf{q},\mathbf{p}) = \Gamma(\mathbf{q})H(\mathbf{p}) \tag{18}$$

An example of such a function is the hybrid CES-Cobb Douglas cost function:

$$C(\mathbf{q},\mathbf{p}) = A\left[\delta q_1^{\theta} + (1-\delta)q_2^{\theta}\right]^{\frac{1}{\theta\mu}} p_1^{\frac{\alpha}{\mu}} p_2^{\frac{\beta}{\mu}} \tag{19}$$

where A is the efficient parameter; δ is the distribution parameter; θ is the substitution parameter; the function is homogeneous of degree $1/\mu$; and returns to scale $\alpha+\beta$.

Flexible functional forms can also be employed to approximate an arbitrary multi-output cost function. A typical form is the translog multi-output cost function:

$$C(\mathbf{q},\mathbf{p}) = \alpha_0 + \sum_{i=1}^{m}\alpha_i \ln q_i + \sum_{i=1}^{n}\beta_i \ln p_i + \frac{1}{2}\sum_{i=1}^{m}\sum_{j=1}^{m}\delta_{ij}\ln q_i \ln q_j + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n}\gamma_{ij}\ln p_i \ln p_j + \sum_{i=1}^{m}\sum_{j=1}^{n}\eta_{ij}\ln q_i \ln p_j \tag{20}$$

Despite the fact that the translog cost function is flexible enough to describe the non-homothetic production process, it suffers from the zero output problem. That is it cannot be used when the output series take the value of zero. The quadratic cost function (Lau, 1974:176-199) and the Hybrid Translog Cost (HTC) function (Caves, Christensen and Tretheway, 1980:477-481) have been employed to solve this problem. The quadratic cost function can be written as:

$$C(\mathbf{q},\mathbf{p}) = \alpha_0 + \sum_{i=1}^{m} \alpha_i q_i + \sum_{i=1}^{n} \beta_i p_i + \frac{1}{2}\sum_{i=1}^{m}\sum_{j=1}^{m} \delta_{ij} q_i q_j +$$

$$\frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} p_i p_j + \sum_{i=1}^{m}\sum_{j=1}^{n} \eta_{ij} q_i p_j \qquad (21)$$

The HTC function also allows for zero variables, by means of transformation using the Box-Cox. The Box-Cox procedure involves transforming a variable q_i to q_i^* as follows:

$$q_i^* = \frac{(q_i^{\lambda} - 1)}{\lambda} \qquad (22)$$

where λ is a parameter to be estimated.

4.2.3 Scale and Scope Economies

When multiple outputs are included, scale economies can be divided into two categories: Overall Scale Economies (OSCE) and Product-Specific Scale Economies (PSSCE). The extent of *OSCE* is measured by the sum of the ratio of marginal cost to average cost, while *PSSCE* is measured by the slope of marginal cost.

Thus *OSCE* is defined as the ray elasticity of total cost with respect to composite output holding the production mix constant. For the translog cost function the *OSCE* is given by:

$$OSCE = \sum_{i=1}^{m}\left[\frac{\partial \ln C}{\partial \ln q_i}\right] = \sum_{i=1}^{m}\left[\alpha_i + \sum_{j=1}^{m}\delta_{ij}\ln q_i + \sum_{j=1}^{n}\eta_{ij}\ln p_i\right] = \sum_{i=1}^{m}\omega_i \qquad (23)$$

There are overall scale economies if $OSCE < 1$; overall diseconomies of scale if $OSCE > 1$; and constant overall scale economies if $OSCE = 1$.

In the case of multiple outputs, we can examine the contribution of each output to *OSCE* by measuring *PSSCE*. *PSSCE* can be measured by the rate of change of total cost with respect to each output, i.e. the second partial derivative of total cost with respect to each output, holding the product mix constant. For the translog cost function *PSSCE* is written as:

$$PSSEC = \frac{\partial^2 C}{\partial^2 q_i} = \frac{C}{q_i^2}\left[\delta_{ij} + (\omega_i)(\omega_i - 1)\right] \tag{24}$$

There are product-specific increasing returns to scale if *PSSCE* < O, which implies that marginal cost of product q_i is declining; product-specific decreasing returns to scale if *PSSCE* > 0; and constant product-specific scale economies if *PSSCE* = 0.

When multiple outputs are employed, scope economies can also be measured. Whereas the concept of scale economies is related to firm size or the level of outputs, that of scope economies is associated with product mix. We can observe the additional aspect of cost economies by examining scope economies. Scope economies are normally measured by Pair-Wise Cost Complementarities (PWCC). The focus of this measurement is to test as to whether joint production lowers total cost. That is to say, *PWCC* can be measured by the second partial derivative of total cost with respect to the pair of outputs *i* and *j*. For the translog cost function *PWCC* is written as:

$$PWCC = \frac{\partial^2 C}{\partial q_i q_j} = \frac{C}{q_i q_j}\left[\delta_{ij} + \omega_i \omega_i\right] \tag{25}$$

There are scope economies between q_i and q_j if *PWCC* < 0, which implies that joint production of two products q_i, q_j reduces total cost; diseconomies of scope between q_i and q_j if *PWCC* > 0; and constant scope economies if *PWCC* = 0.

4.2.4 Restrictive Multiple Output Cost Function

When there is a fixed input, the transformation function can be written as:

$$\Phi(\mathbf{q}, \mathbf{x}, k) = 0 \tag{26}$$

where k is a fixed input.

A second-order flexible cost function with a fixed input is written as:

$$C(\mathbf{q},\mathbf{p},k)=\alpha_0+\sum_{i=1}^{m}\alpha_i\ln q_i+\sum_{i=1}^{n}\beta_i\ln p_i+\beta_k\ln k+$$
$$\frac{1}{2}\sum_{i=1}^{m}\sum_{j=1}^{m}\delta_{ij}\ln q_i\ln q_j+\frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n}\gamma_{ij}\ln p_i\ln p_j+\frac{1}{2}\gamma_{kk}(\ln k)^2+$$
$$\sum_{i=1}^{n}\gamma_{ik}\ln p_i\ln k+\sum_{i=1}^{m}\sum_{j=1}^{n}\eta_{ij}\ln q_i\ln p_j+\sum_{i=1}^{m}\eta_{ik}\ln q_i\ln k \qquad (27)$$

where $\mathbf{p}$ is the vector of variable input prices and k is a fixed cost.

4.3. PREFERENCE OF COST FUNCTION OVER PRODUCTION FUNCTION

Production technology can be described by a production function or equivalently by a cost function. In this thesis we have employed the cost function as a description of the technology. The reasons for choosing the cost function instead of the production function are discussed in terms of the econometric assumptions of the two functions and of the econometric convenience in the following paragraphs.

When we want to know the characteristics of a production structure such as the elasticity of substitution, the degree of scale and scope economies, we can use either the production function or cost function. However, the econometric assumptions of the two approaches are different. According to Berndt (1991:457), the production function is preferable to the cost function when output prices are endogenous and inputs are exogenous. Under the opposite circumstances, by contrast, it is better to employ the cost function instead of the production function.[3] In other words, the cost

[3]. Different econometric assumptions of the two functions can be correspondent to two functional forms in the consumer theory: a direct utility function and an indirect utility function. The maximum utility is explained by constraining the purchasing power of consumer, namely the fixed budget in the direct utility function. Inputs, namely goods or services in the direct function, are assumed to be given. The indirect function, on the other hand, the maximisation of utility is explained by a given

function is normally used in a situation where outputs are determined outside a model and inputs are determined within the model. It is noted that the input prices are assumed to be exogenous variables in the both functions.

The exogeneity can be determined by the degree of competition in the market. The UK life assurance industry can be regarded as a highly competitive market because of there being fewer restrictions of the market, the new disclosure scheme, more sophisticated customer demands and the emergence of new entrants including bancassurers and direct writers. In the competitive industry, output prices rather than inputs might be determined in the market. Outputs are thus regarded as exogenous variables in that industry.

The other reason for choosing the cost function can be explained by an advantage of this function over the production function with respect to the econometric convenience. There are two ways to obtain the optimal demands of cost minimising inputs (Diewert, 1971: 482-483): using Shephard's Lemma in the cost function and using Lagrangean or programming estimator in the production function. Even though we can have the same optimal demands from both Shephard's Lemma and Lagrangean estimator, the latter is more complex and difficult than the former. The optimal demands can be gained simply by partially differentiating the cost function with respect to each input price by Shephard's Lemma. Shephard's Lemma can be expressed as:

$$x_i * = \frac{\partial C(\mathbf{q}, \mathbf{p})}{\partial \mathbf{p}_i} \tag{28}$$

where x_i * is the optimal input demands for given vector of outputs $\mathbf{q}$ and input prices $\mathbf{p}$.

In addition to this econometric convenience, we can easily calculate the elasticities of substitution such as the Allen partial elasticity of substitution, the own-price elasticity

level of the prices of goods and total income. So the direct utility function can be correspondent to the production function and the indirect utility function, to the cost function.

of substitution, and the cross-price elasticity of substitution by using Shephard's Lemma. The Allen partial elasticity of substitution in the translog cost function (20) is computed as:

$$\sigma_{ij} = \frac{CC_{ij}}{C_i C_j} = \frac{\gamma_{ij}}{S_i S_j} + 1 \tag{29}$$

where $C_i = \partial C/\partial p_i$, $C_j = \partial C/\partial p_j$, $C_{ij} = \partial C/\partial p_i \partial p_i$, and the cost share equations, $S_i = \partial \ln C/\partial \ln p_i$.

Other elasticities of substitution are calculated like this:

$$\sigma_{ii} = \frac{\gamma_{ii} + S_i^2 - S_i}{S_i^2} \text{ (Allen own elasticity of substitution)}$$

$$\varepsilon_{ii} = \frac{\gamma_{ii}}{S_i} + S_i - 1 \text{ (the own-price elasticity of substitution)}$$

$$\varepsilon_{ij} = \frac{\gamma_{ij} + S_i S_j}{S_i} \text{(the cross-price elasticity of substitution)} \tag{30}$$

In conclusion, the cost function is more applicable than the production function for estimating productivity in the UK life assurance industry.

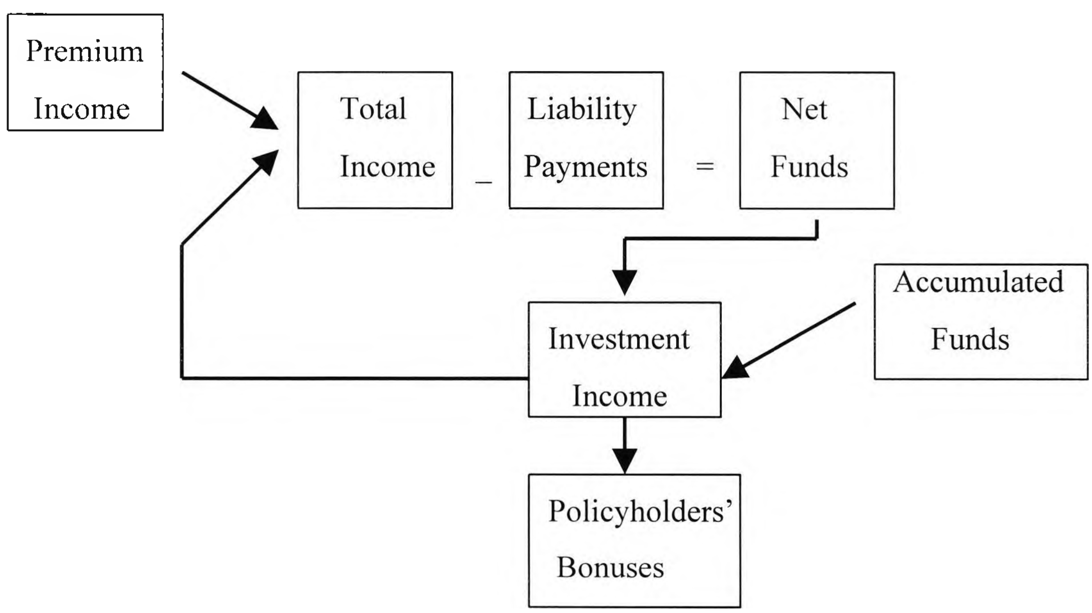
4.4. THE PRODUCTION TECHNOLOGY OF A LIFE ASSURANCE COMPANY

In Section 2, we described the relationship between factors of production and outputs in general. We examined two equivalent ways of representing technology, i.e. the transformation function and the cost function. The first issue we have to tackle in trying to model the production technology of an insurance company is the specification of inputs and outputs of an insurance company.

We can define inputs and outputs in life assurance on the basis of the main functions of a life assurance company. There is no objection to the fact that all financial institutions produce services rather than physical products. In the case of life assurance, the essence of life assurance production is to provide services to policyholders (O'Brien, 1989:13). Diacon (1990: 159-162) also addressed the fact that the insurers supply their clients with a number of services that can be categorised as guarantee, organisation, investment and advice.

An insurance company engages in a number of activities which involve the use of functions: underwriting, claim processing, investment of funds, determining policyholders' surplus, etc. We can group the activities of an insurance company into two categories: the underwriting activity and the investment activity. The *underwriting function* focuses on the production technology of the underwriting activity that involves claim processing, while the intermediation function emphasises the production technology of the two activities. The activities of an insurance company are shown in Figure 4.1.

Figure 4.1 The Activities of an Insurance Company



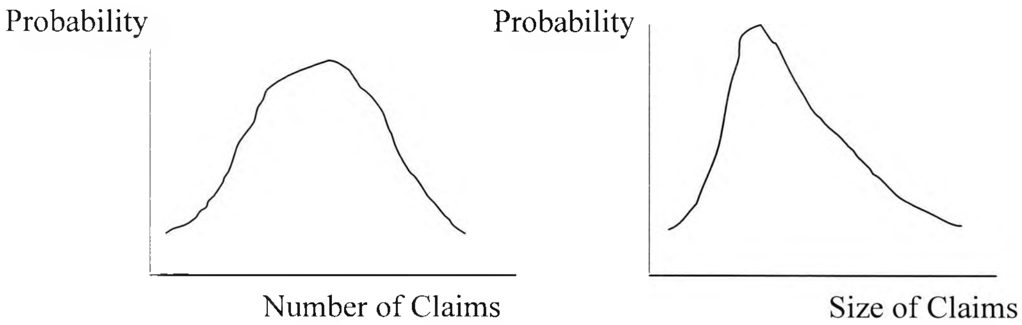
4.4.1 The Underwriting Function

The *underwriting function* is the basic function of a life assurance company. If we represent the level of underwriting activity by the number of contracts, then we can describe the transformation function as $\Phi(n, \mathbf{x}, m)$, where n is the number of contracts; $\mathbf{x}$ is the vector of primary inputs; and m is the number of claims.

The amount of actual claims, L, is calculated as the number of claims times size of claims. The distribution of L is determined by the convolution of two distributions: the distribution of m and the distribution of size. If we allow for multiple claims and assume the law of the large numbers, the distribution of the number of claims can be a symmetrical curve. The size itself is a random variable and the distribution of size may be a right-skewed curve. The two distributions are shown in Figure 4.2.

The costs of primary inputs also depend not only on the number of claims but also on the size of claims. The larger the size of a claim, the larger the amount of resources required to deal with claim. The transformation function can thus be written as $\Phi(n, \mathbf{x}, L)$.

Figure 4.2 The Distribution of the Number of Claims and the Size of Claims



We can use premium income, Y, instead of the number of contracts, n, in the above transformation function. Strictly speaking premium income is not an output measure, but many previous studies in insurance employed premium income as a proxy for output without justifying this proxy. Unlike manufacturing companies, insurance companies produce products which have different characteristics according to customers' needs and a type of policy. A typical example is the difference between a simple term insurance policy and a complex endowment policy. For example, even though two companies sell the same number of contracts, the policies of the two companies have different characteristics in terms of complexity and riskiness. These variations of products must, therefore, be reflected on measuring output. One way to capture the effects of these variations is to employ premium income instead of the number of contracts as output because the variations in the products are reflected on premium. The more complex and/or the higher the riskiness of a policy, the higher the policy premium. Therefore we can rewrite the above transformation function as:

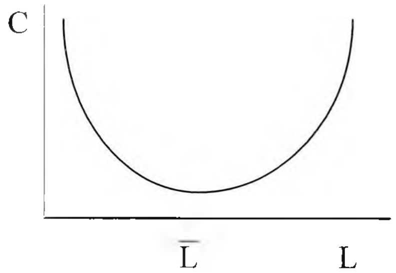
$$\Phi(Y, \mathbf{x}, L) = 0 \qquad (31)$$

where $Y = p_1n_1 + p_2n_2 + ... + p_mn_m$ and p is premium of each policy. So Y is the price (quality) adjusted level of output.

In practice insurance companies, like most other companies, employ factors of production at a level higher than the optimal one. The reason for this is that changes in the level of inputs are subject to costs. Moreover, there are costs associated with not meeting the target in terms of claim processing. Insurance companies would normally retain a level of factors to meet unexpected changes in the level of claims. We assume that these costs can be represented as the variance of claims, $\psi(L - \bar{L})^2 \approx \psi\sigma_L^2$, where $\bar{L}$ is the expected claims.

These costs reflect the riskiness of insurance contracts which burdens insurance companies with unexpected costs. For example, if insurance companies hold additional labour capacity or capital for the purpose of unexpected changes in the level of claims, they may lose benefits produced by the opportunity cost. In the case of having too little labour or capital, insurance companies also bear unexpected costs to absorb the risk caused by claims more than the expected claims. So the level of inputs **x** required to produce Y is also affected by the riskiness of the contracts. The higher the insurer experiences the riskiness, the higher costs incurred. This relationship is shown in Figure 4.3.

Figure 4.3 Costs and the Riskiness of Contracts

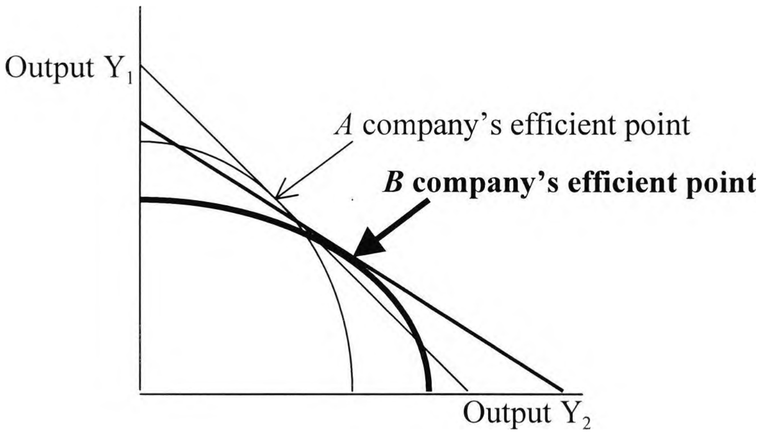


The amount of actual claims, L, in the transformation function (31) thus consists of two parts: the expected claims, $E(L)$, and the riskiness of contracts, $\psi\sigma_L^2$. We can thus write the transformation function as $\Phi(Y, \mathbf{x}, E(L)+\Psi\sigma_L^2)$. If we assume that the expected claims are a linear function of premiums, they can be written as '$E(L) = cY$', where c is a positive constant. Consequently the transformation function for describing the underwriting activity can be written as:

$$\Phi(Y, \mathbf{x}, cY + \Psi\sigma_L^2) \approx \Phi(Y, \mathbf{x}, \sigma_L^2) \qquad (32)$$

We can derive the cost function that obviates the undesirable properties such as nonjointness and separability due to the advent of the flexible multiple output production and cost functions. If the restriction of nonjointness is maintained, we cannot analyse a multiplicity of products. The undesirable property of separability implies that the marginal rate of transformation between any two outputs is independent of the level of primary factors (Hall, 1973:880). However, in the case of life assurance most companies produce more than one line of product from their underwriting activity such as life assurance products, general annuities, pensions and permanent health products. In the case of multiple outputs the transformation function can be described as $\Phi(\mathbf{y}, \mathbf{x}, \sigma_L^2)$, where $\mathbf{y}$ is the vector of underwriting outputs. In practice the marginal rate of transformation (MRT) between any two of the products is not independent of the level of primary factors. Moreover, if a company A has a different isocost from a company B, the MRT of each company is also different. This is shown in Figure 4.4. Since the slope of marginal revenue is normally negative, the curvature of MRT is concave.

Figure 4.4 The Marginal Rate of Transformation in the Underwriting Activity



We use the required minimum margin of solvency, R, as a proxy for the riskiness of contracts, σ_L^2. This proxy can be justified since the four factors determining the required solvency margin of solvency well reflect the riskiness of contracts. The four factors are the insurance contract risk, the investment risk, the period of contract and the retention ratio (Ernst & Young, 1995). All the factors are positively related to the riskiness of contracts.

The relationship between inputs and outputs can be captured equivalently by a cost function, $C(\mathbf{y}, \mathbf{p}, R)$, where **p** are the vector of input prices. The underwriting profit can be written as $\pi_u = \mathbf{y} - C(\mathbf{y}, \mathbf{p}, R) - L$. The optimal vector of inputs will be given by $\mathbf{x}^* = \dfrac{\partial C(\mathbf{y}, \mathbf{p}, R)}{\partial \mathbf{p}}$. The functional form for this cost function is the *restrictive multiple output cost function*. The underwriting model will be constructed by this function.

4.4.2 The Intermediation Function

A life company in the *intermediation function* exists to earn a return for its policyholders. The source for the *intermediation function* can be divided into two activities: the underwriting activity and the investment activity. The primary source for the *intermediation function* is insurance premiums generated from the underwriting activity. The other source is investment income. Since premiums are paid in advance, they can be invested until needed to pay claims and they generate investment income. The income generated from both activities is used for distributing bonuses to policyholders.

A life assurance company in the *intermediation function* can be viewed as an intermediary whose role is to collect premiums, invest available funds and distribute bonuses to policyholders. When the insured chooses a life assurance company to buy an insurance product, one prefers a company that gives more benefits such as protection and bonuses. This service enables a life company to strengthen its financial position and to uphold its existing policyholders and to attract new clients (Weiss, 1986:57). This service is important in its relationship with clients.

The production technology of the *intermediation function* can be described as a production function, which underwriting income and investment income are producing bonus payments:

$$\Omega(S, A, Y) = 0 \qquad (33)$$

where S is bonuses; A is investment income; and Y is premium income.

We can assume that a life company sells **n** policies at a price of **p** in order to generate a return for its policyholders. Premium income, Y, can be expressed as '$\mathbf{p'n}$'. The total number of contracts can be used as the underwriting output [(Burgess and Walker, 1982) and (Kellner and Mathewson, 1983)] and it can be employed as input in the intermediation function of a life company. We can rewrite the above transformation function as:

$$\Omega(S, A, \mathbf{n}) = 0 \qquad (34)$$

where **n** is the vector of inputs representing the number of contracts.

If we assume the usual neo-classical properties, the transformation function in (34) does not restrict the substitution possibilities between outputs and inputs in any way. The relationship between inputs and output in the *intermediation function* can be captured equivalently by a cost function:

$$C(S, A, \mathbf{p}) = \min_{\mathbf{n}}\{\mathbf{p}'\mathbf{n} : \Omega(S, A, \mathbf{n}) \geq 0\} \qquad (35)$$

where **p** is the vector of input prices.

4.5 REVIEW OF MEASURING OUTPUTS AND COSTS

4.5.1 Review of Measuring Outputs

Measuring the output of manufacturing firms appears to be relatively straightforward: the output can be measured in physical terms. Multiplying the number of units produced by the unit market price is a method frequently used in the industries where output is tangible. However, measuring output may be less obvious for a company in the service sector where the intangible nature of the products may cause a number of difficulties.

In life assurance, one of the difficulties may arise from the different forms of the life assurance contracts. Minto (1989:4) emphasised a number of difficulties in measuring the output of life assurance companies. In the case of whole-life with-profit contracts, for example, any measurement for life companies' productivity should take account of the investment management service in addition to the insurance service. Endowment contracts have not only the insurance element, reflected in death benefits, but also the savings element, reflected in maturity benefits.

The intangible nature and complexity of the insurance products have caused a number of output measurement problems in the insurance productivity studies. The studies can be classified into five methods:

(a) The method of using premium income as a proxy for output

Houston and Simon (1970), Pritchett (1971,1973), Rutledge and Tuckwell (1974), Blair, Jackson and Vogel (1975), Colenutt (1977), Praetz (1980, 1981), Kaye (1991), Prosperetti (1991), Grace and Timme (1992), Hardwick (1994) and Khaled, Adams and Pickford (1995);

(b) The method of excluding loss payments from premiums in measuring output

Geehan (1977), Hirshhorn and Geehan (1977,1980), Denny (1980), Weiss (1986), O'Brien (1989) and Diacon (1990);

(c) The method of using claims as output

Doherty (1981) and Skogh (1982);

(d) The method of using claims as well as premiums

Allen (1974), Fecher, Perelman and Pestieau (1991) and Suret (1991); and

(e) The method of using the number of policies as output

Burgess and Walker (1982) and Kellner and Mathewson (1983).

Before discussing the problems of each of the five methods, we outline each method. The first method used premium income or premiums in force as the measurement of output. Most studies in insurance employed premium income as a single output or one of the outputs. The costs usually consist of commissions and management costs. The profit function in this method can thus be expressed as '$\pi = Y\text{-}C(\mathbf{y}, \mathbf{p})$', where Y is premium income.[4] The second and third methods pointed out the problems of using premium income as output and employed the amount of services to policyholders as

[4]. Grace and Timme (1992) included the amount of investment as well as premiums as outputs.

the measurement of outputs. The services that insurance companies provide vary according to the studies. Hirshhorn and Geehan (1977), for example, viewed premium income, except for transfers to reserves, and the investment activity as services. Weiss (1986) extended the output measurement of Hirshhorn and Geehan by including *return to capital*. Doherty (1981) regarded claim payments as service in his study of Canadian property-liability insurance. The fourth method used premium income as well as claims as outputs. The fifth method used the number of policies that insurance companies issue as output, which is analogous to measuring the output of manufacturing firm.

We now explain each method in detail and then discuss the problems below.

(a) <u>The method of using premium income as a proxy for output</u>

Numerous authors used insurance premiums as a proxy for output in their productivity studies in the insurance area. This method is further divided into three approaches: the single output approach, the multiple output approach and the premiums in force approach.

The study by Houston and Simon (1970) is a typical case of the single output approach. They used premiums paid as the measurement of output and introduced several other independent variables, such as product mix, rate of growth, lapse ratio and corporate form, to control inter-firm differences. Rutledge and Tuckwell (1974) used the same approach as Houston and Simon in their study of 41 Australian life assurance companies. They also included several variables that would affect the insurance companies' cost structure: ratio of new business to total output, proportion of policies surrendered and forfeited, and average size of policies. Blair, Jackson and Vogel (1975) also used premium written as the measurement of health insurance output and employed other explanatory variables for the same reason as Houston and Simon. Colenutt (1977) studied scale economies in 49 UK ordinary life assurance companies using total premium income as a proxy for output and employing other variables for the same reason as Houston and Simon. Other explanatory variables used by Colenutt are corporate types, average policy size and the underwriting characteristic variables.[5] Praetz (1980, 1981) followed the approach of Houston and Simon for 90 US life insurance companies and 38 Australia life assurance companies, respectively. Kaye (1991) and Prosperetti (1991) used premiums as a single output and studied scale economies in the UK life assurance industry and the Italian non-life assurance companies, respectively. Prosperetti tried to employ the distribution ratio and companies' characteristic variables[6] to explain the impacts of these variables on costs. The distribution variable is defined as a proportion of commissions paid to total cost incurred. This variable can be thought of as a degree of dependence on the distribution system in Italy.

The approach of Houston and Simon has the advantage of obtaining premium figures with ease. However, the single output approach has limitations in terms of measuring productivity. We estimate only scale economies when we employ the single output approach. Scope economies cannot be analysed in this approach.

Another limitation of the single output approach is that all these studies are appropriate only if the product is homogeneous and is sold at the same price by all the companies. According to Houston and Simian (1970:856), the homogeneity and the same price assumptions are realistic because the insurance industry is carefully regulated and many consumers are almost totally unaware of the name of firm insuring them. However, these assumptions cannot be thought of as being practical. For example, annuity contracts have a different risk from life assurance contracts. The risk of annuity is living too long, whilst that of life assurance contract is dying too soon. The two assumptions can be satisfied by using the multiple output approach.

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[5]. The underwriting characteristic variables are the percentage of single premiums, immediate annuity considerations, annuity contracts, new yearly business, group business, lapses and surrenders, and overseas business.

[6]. The characteristic variables are the ratio of compulsory auto premiums to total premiums and transport-related premiums to total premiums to test an effect on cost of specialisation in particular businesses. There are other two dummy variables: one is institutional type variable (the Italian branch of a foreign company or not) and the other is one of group companies or not.

The multiple output approach uses premium income of each product divided as multiple outputs. Grace and Timme (1992) used net premium income of the life insurance products, annuity, and accident and health products as outputs for 423 US life insurance companies. The first two products are divided into ordinary and group premium income. The dollar value of investments in bonds, stock and real estate is also employed as one of the outputs for the purpose of considering the investment activity of life assurance companies. They also employed the agency/non-agency dummy variable and the mutual/stock dummy variable to account for possible differences in cost structures from these variables. Hardwick (1994) divided outputs into three products and used the value of each premium income as multiple outputs for 76 UK life assurance companies. The three products are life assurance policies, pensions and permanent health policies. Khaled, Adams and Pickford (1995) also used net premium income as the measure of outputs for 33 New Zealand life assurance companies. These are life assurance, superannuation, annuity receipt and investment-only contributions.

The third approach is to use business in force, namely the sums insured, as output instead of premium income. Pritchett (1971,1973) studied the relationship between company size and operating expenses and used the volume of ordinary business in force as the size variable. As Pritchett (1973:160) noted an extremely high correlation between the volume of business and the volume of premium income, the third approach may be regarded as the same measurement as the first approach. We can thus include the third approach into the method of using premium income as a proxy for output.

Using premium income as output was severely criticised by the second method which will be discussed below. The major controversy in measuring output is whether premium income is appropriate for the measurement of output. However, we would like to say at this stage that the approach of Houston and Simon or any other studies using premium income as output must be distinguished from the method of this thesis even though we use premium income as outputs in the underwriting model.

(b) The method of excluding loss payments from premiums in measuring output

The studies by Geehan (1977), and Hirshhorn and Geehan (1977) are typical cases of this method. They (1977:211) criticised the approach of Houston and Simon: 'They were only partially successful since they did not come to terms with the fact that only a fraction of premiums is a payment for services produced.' They insisted that the amount of payment for transfers to reserves must be excluded, since premium income constitutes a mix of payment for services performed and transfers to reserves that are not related to the defined inputs. O'Brien (1989:6) and Diacon (1990:162) also pointed out the inappropriateness of using premium income as a proxy for output because of the double-counting problem.

The study by Weiss (1986) can be included in this method. Weiss (1986:54) defined output as: 'the marketable result of the production process. For life insurers, this output consists of the set of services provided to policyholders.' He also excluded loss payments when measuring output for the same reason as Hirshhorn and Geehan (1977), O'Brien (1989) and Diacon (1990). However, Weiss's study differs from Hirshhorn and Geehan's in two ways. Whereas Hirshhorn and Geehan employed labour partial productivity index, Weiss used total productivity index.[7] The other difference is that Weiss included the *policyholders' welfare* as one of the output components. He claimed that an insurer with a larger surplus could provide a better service for policyholders and used return to capital as a proxy for the *policyholders' welfare*.

A moot point in measuring output is whether premium income can be used as a proxy for output measurement, which does not come to a reasonable conclusion even at this time. The controversy between Denny (1980), and Hirshhorn and Geehan (1980)

[7]. The partial and total productivity index measurements are the non-parametric approach which measures productivity without specifying a production or cost function. Partial productivity is calculated as the ratio of aggregated outputs to a single input. Total productivity uses aggregated inputs instead of a single input. For the comparison of the non-parametric approach to the parametric approach, see Chan, Krinsky and Mountain (1989:336).

shows the difficulty of measuring output. Denny sharply criticised Hirshhorn and Geehan's output measuring method. He mentioned that they excluded the risk-bearing factor that is the most important service provided by life insurers and the first reason for purchasing long-term product to policyholders. On the comments of Denny, Hirshhorn and Geehan (1980:153) refuted that ' ... Denny's measure of output which is unrelated to inputs is not useful for production function analysis.'

Both arguments are inadequate for a complete output measurement. With respect to services provided by life assurers, Denny's definition is more appropriate than Hirshhorn and Geehan's. So far as the association between output and cost[8] is concerned, Hirshhorn and Geehan's output measurement is adequate. We can solve this controversial problem, disputed over 25 years, by employing 'σ_L^2' as a proxy for the riskiness of contracts. The double-counting problem can be solved by employing premium income as outputs and 'σ_L^2' as one of the cost factors. 'σ_L^2' can be thought of as the counterpart for the part of premiums, i.e. 'the amount for transfers to reserves'. Both the risk-bearing factor and the association between output and cost are well incorporated in this measurement.

(c) <u>The method of using claims as output</u>

This method employs claim payments as output. Doherty (1981) argued the econometric problems of using premiums as a proxy for output. The first of these problems is that of measurement error and the second, simultaneous equation bias.[9]

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8 . It is precise to say 'the association between output and input' rather than 'the association between output and cost'. However, since most studies in the area of insurance productivity employ the price adjusted output, cost can be the counterpart for this output concept.

9 . The two problems can be explained as follows. Using C for cost and Q for true output, we assume the cost function to be $C \equiv Q+\varepsilon$, where the ε is disturbance obeying all the classical assumptions of OLS. Suppose that instead of observing the true Q, we observe P for premium income, where $P = Q+\mu$. So the cost function is $C \equiv P+(\varepsilon-\mu)$. The first problem arises from the errors in measuring the explanatory variable which is correlated with the disturbance term. We can use the OLS estimator if the regressor, P, can be considered fixed (nonstochastic) in repeated samples or if the explanatory variable is stochastic, but is distributed independently of the error term (Kennedy,1992:134).

Doherty stressed that the service performed by insurance companies must be to resolve risk and uncertainty. This service could be achieved by the delivery of the loss amount as defined in the policy to the insured. To avoid the two econometric problems and to coincide with the insurance service defined by Doherty, he employed claim payments as output in non-life insurance.

Skogh (1982) also pointed out the econometric problems when using premium income as output and employed compensations paid as the measure of output for Swedish property-liability insurance industry. Doherty and Skogh claimed that using premium income as output resulted in downward biased estimates of scale economies, because the measurement error is negatively related to output.

However, when we use claim payments as output, the above econometric problems still remain. As noted by Doherty (1981:393), the measurement error still remains when using claim payments as output. The simultaneous equation bias also remains in the approach of Doherty because the amount of actual claims is dependent on expenses arising from the loss prevention activities.[10] He claimed that a delivery-based output measure, namely the claim output, is less severe than an income-based measure, the premium income output, with respect to these econometric problems. He also mentioned that the measurement error in using claim payments as output could be

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However, we cannot use the OLS estimator when the explanatory variable, P, and the disturbance (ε-μ) are correlated. In particular, where the measurement error is related systematically to output, the result can be a serious bias in the coefficient estimates. The second problem arises when an endogenous variable appears as an independent variable. Premium income is not independent of the price policies. Premium income depends on cost in a *cost-plus* pricing policy. Premium will also depend on expenses in a marginalist pricing policy. As cost or expenses are the dependent variable in the cost function, using premium income as the independent variable in a single equation regression model violates the assumption that independent variables should be exogenous. In this situation, OLS will yield the biased and inconsistent estimates. This is the problem of simultaneous equation bias.

[10]. Furthermore, Doherty did not separated claim adjustment expenses from claim payments, which make claim payments the dependent explanatory variable.

solved by employing the Instrument Variable (IV) method.[11] However, it is hard to say that the result of using the IV method with the delivery-based output measure is superior to the method with the premium income output.

Another problem with Doherty is that he only stressed the amount of claims which is only a part of the *underwriting function*. Since collecting premiums must precede claim payments to policyholders, it is appropriate to employ the premium income output rather than the claim payment output. This point was insisted on by Johnson, Flanigan and Weisbart (1981:26) and Cho (1988:325).

(d) The method of using claims as well as premiums

Allen (1974) used net premiums as well as claims as the property-liability output measure. For premium comparability, he selected 49 companies based on premium mix, pricing policy and distribution system. Suret (1991) also used this method for Canadian property and casualty insurance industry. Suret followed not only Skogh's recommendation but also Cho's point. Fecher, Perelman and Pestieau (1991) also employed both gross premiums and claims as a proxy for outputs and studied scale economies in the French insurance industry. Fecher et al. (1991) tried to employ four institutional types, the reinsurance ratio and distribution ratio to explain the impacts of these variables on costs. They measured the proportion of commissions paid to total cost incurred as the distribution ratio like Prosperetti (1991).

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[11]. The instrumental variable is the variable that is correlated with the endogenous variable and is uncorrelated with the disturbances. There are two methods using instrumental variables in linear single equation methods: the Instrumental Variable (IV) method and Linear Two-Stage Least Squares (L2S). The L2S estimator is the most popular in the linear single equation model. The best instrumental variables are the estimated values gained by regressing each dependent explanatory variable on all the exogenous variables in L2S. The estimator of each instrumental variable ($\hat{D}_i$) can be calculated as:

$$\hat{D}_i = Z(Z'Z)^{-1} Z'D_i$$

where Z is a matrix of all the exogenous variables and D_i is each dependent explanatory variable.

(e) <u>The method of using the number of policies as output</u>

This method employs the number of policies as output. Burgess and Walker (1982) attempted to discover some evidence of model-misspecification in the study by Praetz (1981) with the same year data examined by Praetz. For this purpose, they used the number of policies in force at the beginning of the year instead of premium income as output. They regarded the number of policies as an unambiguous and simpler definition for output. Kellner and Mathewson (1983) also used the number of policies written and retained as the output measure for Canadian life assurance. The important difference between Burgess and Walker, and Kellner and Mathewson is that the former limited the output measure to a single output, but the latter extended the output measure to multiple outputs.

However, the number of policies cannot be viewed as being a reasonable output measure. In general, each policy has numerous variations in providing services for policyholders. We cannot say that a large number of policies produce more services to policyholders than a small number of policies since the policy numbers' measure itself cannot represent the variations of policies. No one would say that Consolidated Life, for example, produces more outputs than Prudential Assurance in the new ordinary business in 1993, simply because the former has a greater number of contracts than the latter.[12]

Based on the above discussion we can summarise the problems of the previous output measures as follows. Firstly, despite the fact that a number of output measurements have been used in the insurance productivity studies, most studies limit their output measures to the underwriting activity. Only a few studies [(Hirshhorn and Geehan, 1977) and (Grace and Timme, 1992)] expanded the output measures to the investment activity of insurance companies. Only one study (Weiss, 1986) indirectly considered the *welfare of customers* as one of the outputs. However, it is required to consider the *welfare of customers* as well as two activities for the purpose of a better measurement

[12]. The number of contracts in the new ordinary business of Consolidated Life and Prudential Assurance in 1993 was 1,694,137 and 1,453.801 respectively.

in the insurance productivity study. This study is the first one that examines the *intermediation function* of life companies by employing the income generated from the underwriting activity and the investment activity as the source for the *intermediation function* and the bonus payments as output.

Secondly, with regard to measuring the underwriting activity of a life assurance company, the first method is inappropriate since it did not consider the association between output and cost. In other words, the output measure including the amount of payment for transfers is not matched with the cost which is normally measured by the sum of labour and capital expenses. This measurement has the limitation of double-counting. The second method is unsuitable owing to its excluding the risk-bearing factor in the *underwriting function*, as pointed out by Denny. The method of using claims as output is also inappropriate since it incorporates only a part of the *underwriting function*. Moreover, the size of claims contains a cost property rather than output one. The fourth method has both the problems of first and third method. The fifth method, using the number of policies, has the straightforward and unambiguous advantage. However this method is also unsuitable since each policy has a great deal of variations in the qualification of services.

Finally, the single output approach has problems in the light of estimating just scale economies, and the unrealistic assumptions of homogeneity and the same price. Due to the limitations of the single output approach, most studies on insurance productivity have recently adapted the multiple output approach [(Kellner and Mathewson, 1983), (Suret, 1991), (Grace and Timme, 1992), (Hardwick, 1994) and (Khaled, Adams and Pickford, 1995)].

4.5.2 Review of Measuring Costs

The variables necessary for measuring costs vary according to the type of functional form. The production function, for example, just requires inputs, whilst the cost function calls for input prices as well as costs. The problem of measuring costs in the previous studies is caused by input prices rather than costs. Before discussing this problem, we outline the cost measures of previous studies using the hybrid translog cost function or translog cost function.

With regard to measuring costs, most studies employed labour and capital expenses [(Suret, 1991), (Grace and Timme, 1992) and (Khaled, Adams and Pickford, 1995)]. Suret employed labour and rental expenses as total cost, but, with the assumption of invariant capital cost across firms, excluded capital expenses. Grace and Timme used the sum of commissions, salaries, wages and benefits as labour expenses, and the sum of the rental cost of buildings, equipment, depreciation on furniture and equipment as capital expenses. Khaled et al. also employed the sum of commissions, management expenses and taxes[13] as labour expenses, and the values of buildings and equipment as capital expenses.

Taking into account the limited data availability in the insurance sector, we may consider the previous measures for costs as being reasonable. However, the problem arises from measuring input prices. The input prices in the previous studies differ from the realistic ones in the insurance business. Suret (1991), Grace and Timme (1992) and Khaled et al. (1995), for example, used the average wage rate in the finance sector as the price of labour. Suret used the average rental rate for the main cities in Canada as the price of rentals. Khaled et al. took the price index for buildings and equipment for the capital price. Because the wage and the rental rate of offices fluctuate from one geographic area to another, these input price measurements are not realistic. This problem was pointed out by Hardwick (1994:73).[14]

> ... the price of labour has been measured by dividing the total wage bill by the number of full-time equivalent employees. This assumes that all the companies in the sample employ different grades of labour

[13]. Most studies excluded taxes from a category of cost because this variable is uncontrollable and has no relationship with size variable.

[14]. Hardwick (1994) used a dummy variable to take account for the cost differences between London - based and other companies in the quadratic cost function model.

in the same proportions, an assumption which is clearly not realistic for insurance companies. Even more severe problems arise in attempting to measure the price of capital.

To lessen the above problem, we develop a new measure of input prices and costs that are also associated with the defined outputs (or output). The association of costs and outputs means that costs must associate with time and defined outputs (Benston, 1972). In other words, the costs for production in one period must correspond to the outputs in the same period. Measuring the variables of each model will be described in Chapters 5 and 6.

4.6. CONCLUSION

In this chapter, we, firstly, have described the general production technology. We can estimate the degree of scale and scope economies with multiple output production technology. As flexible functional forms have developed, we can estimate productivity without imposing arbitrary a priori restrictions on the structure of production.

Secondly, we have discussed the reasons for choosing the cost function rather than the production function from the viewpoint of the data specification in the UK life assurance industry and of the econometric convenience. The highly competitive market in the UK life assurance industry make the cost function appropriate in analysing the cost characteristics of the market. In addition, when using the cost function, we are able to gain the econometric convenience: easily obtaining the optimal demands of cost minimising inputs and the Allen partial elasticity of substitution.

Finally, we have described the production technology of a life assurance company and have examined the previous output and cost measurement problems. Most studies limit their output measures to the *underwriting function*. The main problem in measuring output in the *underwriting function* is whether we can use premium income as a proxy for output. As seen by the controversial arguments between Denny (1980), and Hirshhorn and Geehan (1980), most studies did not integrate both the double-counting problem and the risk-bearing factor. We solve this problem in the underwriting model by employing 'σ_L^2' as a proxy for the riskiness of contracts and also as the counterpart cost for the part of premiums, i.e. 'the amount for transfers to reserves'.

In addition to the limitations of measuring output in the *underwriting function*, none of the previous studies considers the *intermediation function* that can be thought of as the foremost function of an insurance company. We model this function by employing the income generated from the underwriting activity and the investment activity as the source for this function and the bonus payments as the intermediation output.

CHAPTER FIVE
EMPIRICAL ESTIMATION OF THE UNDERWRITING MODEL

5.1. INTRODUCTION

The purpose of this chapter is to estimate statistically the underwriting model. The results can be used for discovering the characteristics of UK life assurance in terms of cost economies in the liability business. The findings of this study can help answer the questions raised in earlier chapters. For example, the empirical result may also help us determine which distribution channel is the most efficient in carrying out the underwriting activity. Whether bancassurance companies are more efficient than non-bancassurance companies in producing premium income.

This chapter is organised as follows. The underwriting model is constructed in Section 2. In Section 3, we develop the Revised Hybrid Translog Cost (RHTC) function and discuss the econometric methodology and computation procedures used. The data and the variables are explained in Section 4. We discuss the empirical results in Section 5. We use the empirical estimates to investigate a number of issues: scale and scope economies in the UK life industry, the performance of composite versus non-composite, the performance of bancassurance versus non-bancassurance, the cost differences among the divided distribution channels, and the relationship between the company size and cost economies. This chapter ends with a brief summary of findings in Section 6.

5.2. MODELLING THE UNDERWRITING PROCESS

The underwriting model provides a description of the underwriting function. A life assurance company in this model can be thought of as a seller of services. Most studies in the insurance productivity belong to modelling the underwriting function. However, this study differs from other studies mainly because it takes into account the riskiness of contracts. The required minimum margin of solvency is used as a proxy for the riskiness of contracts. The transformation function, $\Phi(\mathbf{y}, \mathbf{x}, \sigma_L^2)$, described in the previous chapter, represents this assumption.

Factors of production are aggregated into two categories: factor of production used for the acquisition of new business, and factor of production used for the maintenance of existing business and the processing of claims. If we assume four outputs, the transformation function can be expressed as:

$$\Phi\ (Y_1, Y_2, Y_3, Y_4, X_a, X_m, R)$$

where Y_1, Y_2, Y_3, Y_4 are net premium income of each business line such as life assurance products, annuities, pensions and permanent health products, respectively; X_a, X_m are the acquisition and maintenance production factor, respectively; and R is the required minimum margin of solvency.

The relationship between inputs and outputs in the transformation function can be captured equivalently by the cost function:

$$C\,(Y_1, Y_2, Y_3, Y_4, P_a, P_m, R)$$

where C is the sum of acquisition and maintenance expenses; P_a and P_m are the price of acquisition and maintenance factors, respectively. The price of acquisition factor is calculated as the acquisition expenses divided by the number of new contracts. Similarly the price of maintenance factor is calculated as the maintenance expenses divided by the number of existing contracts.

Since we use the required minimum margin of solvency as one of the cost factors in the model and also as one of the independent variables, the functional form of this model is the restrictive cost function, g, which can be expressed as:

$$\ln C = g(\ln Y_1, \ln Y_2, \ln Y_3, \ln Y_4, \ln P_a, \ln P_m, \ln R)$$

This function should be transformed again when the output vector includes zero values. The function transformed by the Revised Box-Cox Transformation (RBCT)[1] can be written as:

$$\ln C = g(Y_1*, Y_2*, Y_3*, Y_4*, \ln P_a, \ln P_m, \ln R)$$

where the superscript '*' means the RBCT.

A life assurance company is assumed to minimise the costs associated for given values of outputs and input prices. The cost minimising input X_i * can be gained by using Shephard's Lemma in the underwriting model as follows:

$$\frac{\partial \ln C}{\partial \ln P_i} = \frac{Pi \times Xi*}{C}$$

where $\sum_{i=1}^{2} P_i X_i^* = C$ and the subscript i denotes acquisition and maintenance factor.

The underwriting model is written as:

$$\ln C = \alpha_0 + \sum_{i=1}^{4} \alpha_i Y_i * + \sum_{i=1}^{2} \beta_i \ln p_i + \beta_R \ln R + \frac{1}{2}\sum_{i=1}^{4}\sum_{j=1}^{4} \delta_{ij} Y_i * Y_j * + \frac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2} \gamma_{ij} \ln p_i \ln p_j + \frac{1}{2}\gamma_{RR}(\ln R)^2 + \sum_{i=1}^{2} \gamma_{iR} \ln p_i \ln R + \sum_{i=1}^{4}\sum_{j=1}^{2} \eta_{ij} Y_i * \ln p_j + \sum_{i=1}^{4} \eta_{iR} Y_i * \ln R + \mu_c$$

where C is cost which is calculated as the sum of the acquisition and the maintenance expenses; R is the required minimum margin of solvency; Y_1*, Y_2, * Y_3* and Y_4 *

1 . For RBCT, see Section 3.

are the RBCT net premium income of life assurance products, general annuities, pensions and permanent health products, respectively; p_1 and p_2 are the price of acquisition factor and maintenance factor, respectively; and μ_C is a disturbance term.

5.3. FUNCTIONAL FORM AND ECONOMETRIC METHODOLOGY

5.3.1 Criteria for Selecting a Functional Form

We have seen in Chapter 4 that any arbitrary cost function can be approximated by a quadratic flexible form:

$$C(\mathbf{q},\mathbf{p}) = C(\bar{q},\bar{p}) + \sum_{i=1}^{m} \frac{\partial C}{\partial q_i}(q_i - \bar{q}) + \sum_{i=1}^{n} \frac{\partial C}{\partial p_i}(p_i - \bar{p}) +$$
$$\frac{1}{2}\sum_{i=1}^{m}\sum_{i=1}^{m} \frac{\partial^2 C}{\partial q_i^2}(q_i - \bar{q})^2 + \frac{1}{2}\sum_{i=1}^{n}\sum_{i=1}^{n} \frac{\partial^2 C}{\partial p_i^2}(p_i - \bar{p})^2 + \sum_{i=1}^{m}\sum_{i=1}^{n} \frac{\partial C}{\partial q_i}\frac{\partial C}{\partial p_i}(q_i - \bar{q})(p_i - \bar{p})$$

where **q** and **p** are the vector of outputs and input prices, respectively.

However, some conditions are required for a cost function to be a flexible functional form. These regularity conditions are nondecreasing and convex in **q**, linear homogeneity, nondecreasing and concave in input prices.

A function is said to be homogeneous of degree r, if multiplication of each of its independent variables by a constant τ will alter the value of the function by the proportion τ^r. When r is 1, we call it linear homogeneity or homogeneity of degree one. Homogeneity of degree one in input prices is a prerequisite for the well-defined cost function since doubling all input prices and keeping all quantities constant must double costs. By imposing linear homogeneity in input prices, we can reduce the number of parameters estimated.

Whereas all cost functions should satisfy the regularity conditions, there are a number of properties that are associated with particular functional forms. These are

(a) Linear homogeneity in outputs;

(b) Homotheticity;

(c) Separability;

(d) Unitary or constant elasticity of substitution;

(e) Parsimony ; and

(f) Incapability of accommodating observations with zero values.

Each restriction is explained in the following paragraphs.

(a) Linear homogeneity in **q**

The first restriction comes from homogeneous function of the first degree. Provided that the cost function, C, is homogeneous of degree r in outputs, **q**, it is written as:

$$C(\omega\mathbf{q},\mathbf{p}) = \min\sum_{i=1}^{n}\omega^{r} p_i x_i = \omega^{r}\min\sum_{i=1}^{n} p_i x_i = \omega^{r}C(\mathbf{q},\mathbf{p})$$

where p_i and x_i are input prices and inputs, respectively.

The dual cost function is homogeneous of degree r in outputs, only if the production function is homogeneous of degree $1/r$. If r is 1, **q** and total cost always increase in the same proportion. Cost functions that impose this property cannot therefore be used to estimate scale economies.

(b) Homotheticity

The assumption of *homothetic function* restricts returns to scale as well. A *homothetic function* implies that relative input demands are independent of the level of output. In the case of the translog cost function, this means that

$$\frac{\partial}{\partial \ln q_l}\left[\frac{\left(\dfrac{\partial \ln C}{\partial \ln p_i}\right)}{\left(\dfrac{\partial \ln C}{\partial \ln p_k}\right)}\right] = 0$$

All the slopes of the isoquants in the homothetic function are same along any ray from the origin. This characteristic is called a linear expansion path, that is the locus of cost-minimising points is linear.[2] The homothetic function keeps returns to scale fixed because the ratio of optimal input demands is independent of the level of output. In order to be a flexible functional form, it is thus required to use non-homothetic function, which implies that returns to scale are not constrained a priori.

(c) Separability

The undesirable property of homotheticity can also be explained by the *separability* property. Homotheticity is special case of separability. Hall (1973:882-883) proved a necessary and sufficient condition for separability in the cost functions. The condition is that the cost functions should be multiplicatively separable, that is relative marginal costs are independent of input prices:

$$C = H(p_1,\ p_2,\ \ldots,\ p_n)\ \Gamma(\mathbf{q})$$

Thus $\dfrac{\partial}{\partial \ln p_l}\left[\dfrac{(\frac{\partial \ln C}{\partial \ln q_i})}{(\frac{\partial \ln C}{\partial \ln q_k})}\right] = 0$. This condition is the same as that for homotheticity.[3]

[2]. Homogeneity (of any degree) function produces the linear expansion path, but the inverse is not always true. For example of this, see Chiang (1984:423-425).

[3]. Homotheticity requires that $\dfrac{\partial}{\partial \ln q_l}\left[\dfrac{(\frac{\partial \ln C}{\partial \ln p_i})}{(\frac{\partial \ln C}{\partial \ln p_k})}\right] = 0$. For the translog cost function, this implies that $\dfrac{\partial}{\partial \ln q_l}\left[\dfrac{\beta_i + \sum \gamma_{ij} \ln p_j + \sum \eta_{ij} \ln q_j}{\beta_k + \sum \gamma_{kj} \ln p_j + \sum \eta_{kj} \ln q_j}\right] = 0$. It is thus sufficient that $\eta_{ij} = 0$. Separability requires that $\dfrac{\partial}{\partial \ln p_l}\left[\dfrac{(\frac{\partial \ln C}{\partial \ln q_i})}{(\frac{\partial \ln C}{\partial \ln q_k})}\right] = 0$. This implies that

According to Hall (1973:883), separability is an undesirable property for a complete econometric model:

> If technology is separable, the ratios of any two marginal costs are independent of input prices. In competitive equilibrium, prices equal marginal cost, so under separability, output price ratios are independent of input prices or input intensities. We see, therefore, that separability represents a generalisation of the one-sector technology, in that output price ratios can vary as the output mix varies. However, the interesting and possible important feature of two-sector and more elaborate technologies – dependence of output price ratios on input prices – is entirely absent. This suggests that separability may not be a suitable specification for a complete econometric model.

In order to construct a complete econometric model, it is thus necessary to employ the cost function in which the ratio of any two marginal costs is not independent on input prices.

(d) Unitary or constant elasticity of substitution

A unitary or constant elasticity of substitution severely restricts the structure of production and cost. It is unrealistic that the ratio of the relative change in inputs to the relative change in input prices is unitary or fixed along the isoquant. For example, the elasticity of substitution of the Cobb-Douglas function, $q = AK^{\alpha}L^{\beta}$, developed by Cobb-Douglas (1928:139-165), is unitary:

$\frac{\partial}{\partial \ln p_l}\left[\frac{\alpha_i + \sum \delta_{ij} \ln q_j + \sum \eta_{ij} \ln p_j}{\alpha_k + \sum \delta_{kj} \ln p_j + \sum \eta_{kj} \ln p_j}\right] = 0$. For the translog cost function to be separability, it is thus sufficient that $\eta_{ij} = 0$. The sufficient condition for homotheticity is therefore the same as that for separability.

$$\sigma = \frac{d\left(\frac{L}{K}\right) \Big/ d\left(\frac{p_k}{p_l}\right)}{\left(\frac{L}{K}\right) \Big/ \left(\frac{p_k}{p_l}\right)} = \frac{\frac{\beta}{\alpha}}{\frac{\beta}{\alpha}} = 1$$ [4]

where A is the efficient parameter such as an indicator of the state of technology; K and L are the inputs of capital and labour, respectively; p_l , p_k are the input prices of labour and capital, respectively; and α and β are positive fractions.

This restrictive property of the Cobb-Douglas function was argued by Thomas (1993:302-303) and he explained a background of the emergence of the constant elasticity of substitution (CES) function as:

> One of the purposes of production function analysis is to examine the extent to which input substitution is possible and such substitution may obviously vary between firms and industries. For example, if we wish to compare the substitution possibilities in two industries, the estimation of Cobb-Douglas functions for each industry could tell us nothing of value. An improvement would be some form of production function in which, σ, although still, maybe, a constant, could take alternate values other than unity.

The CES function was developed by Arrow, Chenery, Minhas and Solow (1961: 225-250) and is written as:

$$q = A[\ \delta K^{\phi} + (1 - \delta)L^{\phi}\ ]^{1/\phi}$$

where A is the efficiency parameter; δ is the distribution parameter; and ϕ is the substitution parameter.

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[4]. This equation is derived by the theory of marginal productivity that means the slope of isoquant, $-\frac{Q_k}{Q_l} = -\frac{\alpha L}{\beta K}$, equals the slope of isocost, $-\frac{p_k}{p_l}$, where Q_k and Q_l are the partial derivatives of output, q, with respect to K and L, respectively.

The elasticity of substitution of this function is 1/(1-ϕ). As ϕ approaches zero, the CES production function approaches the Cobb-Douglas function. Thus this function is more general than the Cobb-Douglas function. However, the two functions have so restrictive properties that a variable elasticity of substitution is required for a flexible functional form. In fact, both the production and the cost functions have been developed to retain the property of variable elasticity of substitution.

A good example of variable elasticity of substitution is the Generalised Leontief (GL) cost function developed by Diewert (1971:481-507). If we assume that the input prices and output are given, the GL cost function can be written as:

$$C\,(q, \mathbf{p}) = \Gamma(q)\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}\,(p_i\,p_j)^{1/2} = \Gamma(q)H(p)$$

where total cost is C; output is q; the parameters are such that $b_{ij} = b_{ij}$, for $i, j = 1, \ldots,$ n; and the input prices are p_i, p_j, for $i, j = 1, \ldots,$ n.

The Allen partial elasticity of substitution of the GL cost function can be calculated as:[5]

$$\sigma_{ij} = \frac{CC_{ij}}{C_iC_j} = \frac{C[b_{ij}(p_ip_j)]^{-1/2}}{h(q)[\sum_{j=1}^{n} b_{ij}(p_j / p_i)^{1/2}][\sum_{i=1}^{n} b_{ij}(p_i / p_j)^{1/2}]}$$

where $C_i = \dfrac{\partial C}{\partial p_i}$, $C_j = \dfrac{\partial C}{\partial p_j}$, and $C_{ij} = \dfrac{\partial^2 C}{\partial p_i \partial p_j}$.

The elasticity of substitution of this function is varied according to the relative input prices and output.

The property of the elasticity of substitution is also explained by means of separability. Berndt and Christensen (1973:403-410) integrated the conditions for

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5. For the proof of transforming the Allen partial elasticity of substitution into the equation, $\dfrac{CC_{ij}}{C_iC_j}$, see Berndt and Christensen (1973:405-406).

functional separability and elasticity of substitution in the production functions. They proved that a necessary and sufficient condition for separability is equivalent to certain equality restrictions on the Allen partial elasticity of substitution.

(e) Parsimony

If we wish to use a cost function to describe the possibility sets of a firm or industry empirically, then the cost function should be capable of being described by a relatively small number of parameters (Diewert, 1971:481).[6] Because the number of parameters to be estimated increases by geometric progression in quadratic approximations, it is a very important prerequisite for estimation to have a relatively small number of parameters.

(f) Incapability of accommodating observations with zero values

It is required that a cost function should have the ability to accommodate observations that contain zero values. Many studies on the production of financial institutions have employed a function or a transformation that admits multiple outputs with zero value outputs because a large number of financial firms produce only a subset of the feasible outputs.

5.3.2 The Revised Hybrid Translog Cost Function

In Chapter 4, it was stated that the dual cost function is preferred over the production function in the empirical analysis of the UK life assurance productivity. The next issue is which cost function is the most appropriate for econometric estimation. To answer this question, we discuss the choice of functional form for the cost function based on the properties of particular functional forms explained in the previous

[6]. Diwert mentioned the production functions, but this principle is also applicable to the cost functions.

section. Then the reasons for developing the Revised Hybrid Translog Cost (RHTC) function are argued.

A more flexible cost function may be selected using four criteria: no a priori restriction on returns to scale; the property of variable elasticity of substitution; parsimony; and a capability of accommodating observations with zero output values. The elasticity of substitution can be regarded as the representative property for *homotheticity* and *separability* since the condition for the elasticity of substitution is the same as that for *homotheticity* and *separability.*

The cost functions are divided into two groups according to the restriction on returns to scale. Whereas the Cobb-Douglas cost function, the CES cost function and the GL cost function have a restriction of non-varying returns to scale, the quadratic cost function and the translog cost function have no a priori restriction on returns to scale.

The cost functions are also classified into two groups according to the restriction on the elasticity of substitution. The elasticity of substitution of the GL cost function depends on the level of output and the ratio of input prices. The elasticity of substitution of both the quadratic cost function and the translog cost function also depend on both the levels of outputs and input prices. These cost functions are called flexible cost functions because of an arbitrary elasticity of substitution of the three functions. However, the elasticity of substitution is unitary in the Cobb-Douglas cost function and constant in the CES cost function.

Judging from the criteria of returns to scale and the elasticity of substitution, we can say that the quadratic cost function and the translog cost function are superior to the others. Of the two flexible functions, the choice of which function is preferable to the other can be determined by the other two criteria.

The translog cost function has the parsimony advantage over the quadratic cost function. When we assume the symmetry constraints and linear homogeneity in input prices, the translog cost function with m outputs and n inputs has $((m+n)\ (m+n+1))/2$

parameters. The quadratic cost function with the same assumptions has $(m + n + 1)$ parameters more than the translog cost function.

However, the translog cost function has the disadvantage that it cannot contain zero level variables because of log specification. From this point of view, the quadratic cost function and the Hybrid Translog Cost (HTC) function are preferable. The choice of functional form can thus be limited to comparing the number of parameters of the two cost functions to be estimated. The number of parameters to be estimated in the HTC function will become that of the translog cost function plus just one. Therefore the HTC function is superior to the quadratic cost function in terms of parsimony.

The HTC function using the Box-Cox transformation has, however, an econometric problem. We call this transformation the traditional Box-Cox transformation to distinguish it from a new transformation that we have developed here.

The traditional Box-Cox transformation has been used for its generalised attribute. That is to say, if λ approaches 0, the transformation approaches to a log function. Despite its generalisation, there is a problem when using the traditional transformation. The zero value variables still hamper the estimation of the asymptotic covariance matrix of the parameter estimates (Greene, 1997:480-481). The partial derivative of the traditional transformation with respect to λ is written as:

$$\frac{\partial((y_i^{\lambda}-1)/\lambda)}{\partial\lambda}=\frac{1}{\lambda}(y_i^{\lambda}\ln y_i-(y_i^{\lambda}-1)/\lambda)$$

where y_i is a variable containing zero value.

Since '$\ln y_i$' still remains, this derivative cannot be computed. Thus it is impossible to yield the standard errors of the parameter estimates. To solve this problem, we develop a new transformation. We call it the Revised Box-Cox Transformation (RBCT) which is expressed as:

$$y_i{*} = \frac{(y_i + \lambda)^{\lambda} - 1}{\lambda}$$

When λ approaches zero, this transformation also approaches a log function by L'HÔpital's rule:

$$\lim_{\lambda \to 0} y_i{*} = \lim_{\lambda \to 0} (y_i + \lambda)^{\lambda} \left(\frac{\lambda}{y_i + \lambda} + \ln(y_i + \lambda)\right) = \ln y_i$$

The RBCT has therefore the same general property as the traditional transformation; moreover, the problem that occurred in the traditional transformation can be solved. We can clarify the solution by showing the partial derivative of the RBCT with respect to λ. This new transformation now does not have the '$\ln y_i$' specification.

$$\frac{\partial y_i{*}}{\partial \lambda} = \frac{\lambda (y_i + \lambda)^{\lambda} \left[\frac{\lambda}{y_i + \lambda} + \ln(y_i + \lambda)\right] - \left[(y_i + \lambda)^{\lambda} - 1\right]}{\lambda^2}$$

This new development concludes the RHTC function that allows for zero variables by means of transformation using the RBCT.

5.3.3 Econometric Methodology

Before estimating the parameters of the underwriting model, we firstly discuss a search for λ in the RBCT, $Y_i{*} = \frac{(Y_i + \lambda)^{\lambda} - 1}{\lambda}$. Secondly, we outline the parameter restrictions imposed in the estimation of the RHTC function and then discuss the LSQ estimator and diagnostic such as the contemporaneous problem, heteroscedasticity and multicollinearity to gain asymptotically efficient estimates.

There has been an agreement about which estimator is suitable for the model including λ. Most authors scanned over λ which maximises the likelihood function of the sample to get the optimal λ. This is because the optimal value of λ minimises standard errors of the parameters in a model. We also employ the maximum likelihood estimation procedure[7] to gain the optimal value of λ.

In spite of this agreement, the practical method in searching for λ is still called to question. Even though Seaks and Layson (1983:164) developed a grid search to find out the optimal λ by using 'DO' command in TSP, their search is tedious and inaccurate. When using this command followed by the lower and upper limit and the increment, we have to scan λ many times. For example, '0.01 to 1 by 0.01' requires one hundred searches for λ; moreover, an optimal value can exist outside the increment.

We construct a more accurate and easy programme by using the 'CNORM' command in TSP. This command helps us find the optimal value of λ automatically. For example, when we restrict the range of λ from 0.001 to 1, this command is written as:

FRML LAM 0.001+0.999*CNORM(RLAM)

Whereas 'RLAM' can take any value, λ becomes the least squares estimate within the range. Many studies have normally taken the range of λ from -2 to 2 in the Box-Cox transformation. However, we have to restrict the range to be positive as $(0+\lambda)^{\lambda}$ cannot be defined when λ is non-positive; moreover, we need to limit λ to approach zero for the transformed value to approach the log value. So it is reasonable to scan over the range of λ from 0.001 to 1.

We now turn to a discussion of the parameter restrictions imposed. Before estimating the parameters of the underwriting model, we impose the usual symmetry constraints and linear homogeneity in input prices. These parameter restrictions increase the degrees of freedom. The cross partial derivatives of the RHTC function must be equal

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[7]. Because of iteration, the estimator using LSQ for the nonlinear equation in TSP converges to the maximum likelihood estimator if the error in the model is addictive and normally distributed.

because the translog is viewed as a second-order Taylor's series approximation. The symmetry constraints are expressed in the underwriting model as:

$$\delta_{ij} = \delta_{ji} \text{ and } \gamma_{ij} = \gamma_{ji}$$

The number of parameters estimated, 44, drops to 37, by the symmetry constraints, in the underwriting model.

The linear homogeneity restrictions are written as:

$$\sum_{i=1}^{2} \beta_i = 1 \text{ and } \sum_{i=1}^{2} \gamma_{ij} = \sum_{i=1}^{2} \gamma_{iR} = \sum_{j=1}^{2} \eta_{ij} = 0$$

By imposing linear homogeneity, the number of parameters estimated is reduced further. The number is 29 in the underwriting model.

The parameter restrictions of linear homogeneity in the underwriting model, however, cause the singularity problem when we estimate both the RHTC function and the cost share equations simultaneously. Although we can make the remaining equations independent by dropping one of the cost share equations, the problem in this process is to decide which equation will be dropped. According to Berndt (1991:473-474), if one employs ML estimation, one can get the estimates to be invariant to the choice of which equation is deleted. We drop the maintenance cost share equation.

We use the LSQ estimator in TSP to gain asymptotically efficient estimates. The objection function, G, in the LSQ estimator can be written as:

$$G = G(\mathbf{b}) = e(\mathbf{b})'(\mathbf{S}^{-1} \otimes \mathbf{I})\, e(\mathbf{b})$$

where $e(\mathbf{b})$ is the vector of residuals of both the RHTC function and the acquisition cost share equation; $\mathbf{S}$ is a large single estimated covariance matrix of the disturbances; and $\mathbf{I}$ is the identity matrix. The asymptotically efficient estimates in this objective function are expressed as:

$$b_G = (\mathbf{X'S^{-1}X})^{-1}\mathbf{X'S^{-1}y}$$

where **X** is a single large regressor matrix and **y** is a single large dependent variable vector.

The LSQ estimator is an iterative generalised least square method in the nonlinear multivariative regression. The iteration technique is the Gauss's method: the parameters and their standard errors are iterated until the pseudoregressors, derivatives of the equation with respect to each parameter, are orthogonal to the residuals. Thus the orthogonality condition on the least squares residuals is satisfied.

The LSQ estimator is also a useful method to remedy contemporaneous correlation across equations and heteroscedasticity. If we suppose addictive disturbances that are multivariate normal in both the acquisition cost share equation and the RHTC function, the disturbances within the equation and the RHTC function are uncorrelated. However, it is certain to have non-zero correlation between them. Since all the cost share equations are a part of the RHTC function, the nonsystematic part of the acquisition cost share equation will be correlated to the nonsystematic part of the RHTC function. This non-zero correlation in a multi-equation model is referred to as the contemporaneous correlation problem. However, the problem can be solved since the LSQ estimator is a so-called systems estimator.

If the assumption of zero correlations across observations is relaxed, there might be the likelihood that heteroscedasticity takes place in the cross-section data. However, the heteroscedasticity problem can also be solved by using the HETERO option. This option enables us to calculate consistent standard errors[8], even though there is unknown heteroscedasticity (TSP, 1993:85).

[8]. LSQ can compute standard errors of parameters by two methods: Gauss and Robust-White (HETERO). Both methods produce the same values for parameters, sum of squared residuals, standard error of regression and log likelihood function except for the standard errors of parameter estimates. There is not much difference between the standard errors of parameter estimates calculated by Gauss and by Robust-White in the two models of this thesis. We report the standard errors calculated by the heteroscedastic-consistent Robust-White method and their significant levels calculated by the Gauss method in the parameter estimate tables of the two models, Table 5.4 and

With regard to multicollinearity, most translog models have this problem owing to the increase in the number of parameters by geometric progression in quadratic approximations. To lessen the multicollinearity problem, we reduce the number of parameters to be estimated as much as possible. For example, distribution dummy variables that were normally included in other studies are excluded. If two categories of distribution variable are included, we have to estimate additional eight parameters in the underwriting model. We test the effect of distribution on cost economies after estimating the model.

Another technique of handling this problem is to increase the sample size. We include all the UK life assurance companies that reported the positive cost defined in this model into our sample. The joint estimation can also be regarded as a way of increasing observations. Jointly estimating the RHTC function and the acquisition share equation, for instance, doubles the number of observations, which was commonly used in the translog model (Hunter and Timme, 1986:157).

5.4 DATA

5.4.1 Data, Sample and Period

The main data source is the DTI Returns. The data are obtained from *1995 SynThesys Life* (Release 2) for the period 1985-1995. All the forms of the Returns used in the models are shown in Appendix *A*. Our sample consists of all the UK life assurance companies which have positive cost defined in the underwriting model. The average size for each year is 167 observations. The data source of UK life distribution is *Companies Profile and Financial Strength Reports*.

6.3. The standard errors of parameters and their significant levels in the other tables are computed by the Robust-White method.

5.4.2 Outputs, Inputs and Input Prices

With regard to measuring outputs in the underwriting model, we use net premium income of the four business lines (Form 41 of the DTI Returns) as a proxy for the outputs of the underwriting function. Since the required minimum margin of solvency (line 41 of Form 9) will be included as one of the counterparts for the outputs, this net premium income can be treated as a new output measurement. The required minimum margin of solvency is employed as a proxy for the riskiness of contracts.

As for measuring costs, we consider the acquisition and maintenance expenses. The acquisition expenses are comprised of 'commission payable in connection with acquisition of business' and 'management expenses in connection with acquisition of business' (line 12 and 14 of Form 41). The maintenance expenses consist of 'other commission payable' and 'other management expenses' (line 13 and 15 of Form 41).[9]

The association between costs and outputs can be achieved by the fact that the acquisition and maintenance expenses are generated by carrying out the underwriting function. Form 41 of the DTI Returns (Analysis of premiums and expenses) is required for each long-term business fund maintained by Regulation 8 of the Insurance Companies (Accounts and Statements) Regulations 1983. Premiums and expenses of each fund should be reported separately. The expenses of each fund in one year can thus be regarded as actual cash outlay to produce premium income in that fund in the same year. Therefore, the sum of all the expenses can be regarded as an appropriate cost measure for producing total premiums of a company.

In order to capture the different cost structure between acquisition and maintenance business, we have divided both inputs and input prices into two categories. The

[9]. A split criterion of the commission and management expenses in Form 41 is dependent on a person who receives a payment. A payment to outsiders is usually regarded as commissions. On the other hand, a payment to a company's employee is regarded as the management expenses. The commission and management expenses are further categorised into expenses arising from acquisition of business and other expenses.

acquisition expense per a new contract is normally greater than the maintenance expense per an existing contract. The average measurement problem in measuring input prices can be solved by employing real values of input prices. The price of acquisition factor is calculated as dividing the acquisition expenses by the number of contracts of new business (Form 44), i.e. the acquisition expense per new contract. The price of maintenance factor is calculated as dividing the maintenance expenses by 'the number of contracts of total business (line 12 of Form 43 + 2×(line 11 of Form 43)) less the number contracts of new business'. The number of contracts of total business includes the number of contracts caused by deaths, maturities, surrenders and forfeitures.

5.5. EMPIRICAL RESULTS

5.5.1 Test for Homogeneity and Curvature

Before estimating the parameters of the model, we check the regularity conditions for the RHTC function. The regularity conditions are the prerequisite for using a cost function that is derived from a production function by the duality theorem. These conditions are linear homogeneity, monotonically increasing and concave function in input prices.

The condition for linear homogeneity is examined as follows. Firstly, we formulate the RHTC function without imposing linear homogeneity and get the two cost share equations and then estimate the unrestricted cost share equations separately. Secondly, we impose the linear homogeneity on the RHTC function and construct eight parameter restrictions. Finally we estimate linear homogeneity restrictions. The results are shown in Table 5.1. The null hypotheses shown in the first row of the table are not rejected at the 0.05 level. So the underwriting model satisfies the linear homogeneity condition and is well behaved.

Table 5.1 Linear Homogeneity in the Underwriting Model
(Standard Errors in Parentheses)

	$\beta_a+\beta_m = 1$	$\gamma_{aa} + \gamma_{am} = 0$	$\gamma_{mm} + \gamma_{am} = 0$	$\gamma_{aR} + \gamma_{mR} = 0$	$\eta_{la} + \eta_{lm} = 0$	$\eta_{ga} + \eta_{gm} = 0$	$\eta_{pa} + \eta_{pm} = 0$	$\eta_{ha} + \eta_{hm} = 0$
1995	.0000 (.131)	.0000 (.015)	.0000 (.016)	.0000 (.018)	.0000 (.001)	.0000 (.000)	.0000 (.000)	.0000 (.001)
1994	.0000 (.104)	.0000 (.014)	.0000 (.012)	.0000 (.014)	.0000 (.004)	.0000 (.001)	.0000 (.002)	.0000 (.001)
1993	.0002 (.127)	.0000 (.022)	.0000 (.011)	.0001 (.015)	.0000 (.003)	.0000 (.001)	.0000 (.001)	.0000 (.001)
1992	.0001 (.141)	.0000 (.017)	.0000 (.012)	.0001 (.019)	.0000 (.002)	.0000 (.001)	.0000 (.001)	.0000 (.001)
1991	-.0004 (.147)	.0000 (.025)	.0000 (.014)	.0001 (.017)	-.0001 (.004)	.0000 (.002)	.0000 (.002)	.0000 (.002)
1990	-.0063 (.130)	.0005 (.023)	-.0004 (.013)	.0008 (.011)	-.0001 (.003)	.0007 (.002)	-.0002 (.002)	-.0005 (.002)
1989	-.0009 (.113)	.0000 (.019)	.0000 (.013)	-.0001 (.015)	-.0001 (.006)	.0000 (.002)	.0000 (.002)	.0000 (.002)
1988	-.0002 (.112)	.0000 (.029)	.0000 (.016)	.0000 (.013)	.0000 (.003)	.0000 (.001)	.0000 (.001)	.0000 (.001)
1987	.0002 (.099)	.0000 (.024)	.0000 (.024)	.0001 (.013)	.0000 (.003)	.0000 (.001)	.0000 (.001)	.0000 (.001)
1986	.0001 (.095)	.0000 (.016)	.0001 (.013)	.0000 (.012)	.0000 (.002)	.0000 (.001)	.0000 (.001)	.0000 (.001)
1985	.0000 (.089)	.0000 (.013)	.0000 (.021)	.0000 (.014)	.0000 (.002)	.0000 (.002)	.0000 (.002)	.0000 (.001)

Note : The subscriptions '*a*', '*m*' and '*R*' denote the price of acquisition factor, the price of maintenance factor and the required minimum margin of solvency, respectively; and the subscriptions '*l*', '*g*', '*p*' and '*h*' denote premium income of life assurance products, general annuities, pensions and permanent health products, respectively.

The regularity condition for monotonicity can be checked by the sign of the first partial derivatives of the cost, C, with respect to each input price. As the cost share equations, S_i, have the same sign as the derivatives[10], they can be used for examining this condition in the underwriting model. In order to satisfy nondecreasing or monotonically increasing function in input prices, it is required that all the fitted values of the cost share equations should be positive. As is shown in Table 5.2, they satisfy the requirement for monotonicity.

[10]. Since $S_i = \dfrac{\partial \ln C}{\partial \ln p_i} = \dfrac{\partial C}{\partial p_i}\dfrac{p_i}{C}$, $p_i > 0$ and $C > 0$, the cost share equations have the same sign as the first partial derivatives.

Table 5.2 The Fitted Values of Acquisition and Maintenance Cost Share Equation in 1995

Cost Share Equation	Mean	Minimum	Maximum
Acquisition fitted share equation (S_a)	0.5624	0.3081	0.7505
Maintenance fitted share equation (S_m)	0.4376	0.2495	0.6919

The regularity condition for concavity in input prices requires that the matrix of C_{ij}, the second partial derivatives of the cost with respect to input prices, is negative semidefinite. The second partial derivative of the cost with respect to the acquisition and the maintenance input prices, for example, is expressed as:

$$C_{am} = \frac{\partial^2 C}{\partial p_a \partial p_m} = \frac{C}{p_a p_m}(\gamma_{am} + S_a S_m)$$

where γ_{am} is the parameter estimate for the acquisition × maintenance input price variable.

This condition can be easily checked by using the Allen partial elasticities of substitution in the underwriting model since the signs of C_{ij} have always the same as those of the Allen partial elasticities of substitution.[11] The condition for concavity requires that the Allen own elasticities of substitution for both the acquisition (σ_{aa}) and the maintenance factor (σ_{mm}) be non-positive at each observation and that the determinant of the *2×2* matrix of the Allen partial elasticities of substitution be non-negative.

This model satisfies the regularity condition for concavity when the elasticities of substitution are calculated by using the overall sample mean values. The substitution matrix is negative semidefinite. All the Allen own elasticities of substitution have negative estimates and are significant at the 0.01 level. This is shown in Table 5.3 including the Allen cross-elasticity of substitution (σ_{am}). The determinant of the *2×2*

[11]. Since $C_a > 0$, $C_m > 0$ and $C > 0$, C_{am} always has the same sign as σ_{am}, where C_a and C_m denote the first partial derivative of the cost with respect to the acquisition and the maintenance factor price, respectively; and σ_{am} is the Allen elasticity of substitution between the two factors.

substitution matrix, for example, which is 0.1868 in 1995, also satisfies the condition for negative semidefinite.

The partial elasticity of substitution between the two factors can tell us the relationship between them: substitutes or complements. They can easily be calculated by using the fitted cost share equations. As can be seen in Table 5.3, the two factors are substitutes for all the years in the underwriting model. This substitutable characteristic is always statistically significant at the 0.01 level. The price elasticities of substitution show the same result as the partial elasticities of substitution. They are shown in Appendix *B*.

Table 5.3 The Partial Elasticities of Substitution of the Underwriting Model (Standard Errors in Parentheses)

	σ_{am}	σ_{aa}	σ_{mm}
1985-1995	0.7501*** (.024)	-0.4455*** (.014)	-2.1045*** (.041)
1995	0.8957*** (.072)	-0.6970*** (.056)	-1.4191*** (.092)
1994	0.7582*** (.065)	-0.5249*** (.045)	-1.7938*** (.094)
1993	0.7265*** (.051)	-0.4580*** (.032)	-2.0202*** (.081)
1992	0.7466*** (.050)	-0.4730*** (.032)	-1.9785*** (.079)
1991	0.7124*** (.060)	-0.4331*** (.036)	-2.1180*** (.099)
1990	0.7002*** (.066)	-0.4082*** (.039)	-2.2294*** (.114)
1989	0.6983*** (.058)	-0.3793*** (.032)	-2.3963*** (.107)
1988	0.7332*** (.093)	-0.3847*** (.049)	-2.4147*** (.178)
1987	0.7662*** (.104)	-0.4034*** (.055)	-2.3433*** (.198)
1986	0.4705*** (.048)	-0.2546*** (.026)	-2.8265*** (.089)
1985	0.6808*** (.063)	-0.3801*** (.035)	-2.3627*** (.113)

*** significant at the 1% level

** significant at the 5% level

* significant at the 10% level

Note : The subscriptions '*a*' and '*m*' denote the price of acquisition factor and the price of maintenance factor, respectively.

In life assurance this substitutable characteristic, for example, means that if the commission rate is increased and the maintenance expense per existing contract is unchanged, life assurance companies endeavour to sustain existing policies in order to keep the same amount of premium income as before. In the opposite situation, they try to increase new contracts. However, the extent of substitution is not very strong and thus the shape of the isoquant between the two inputs is relatively sharp.

According to Table 5.3, the degree of σ_{aa} is some 5 times lower than that of σ_{mm}. This result implies that selling new policies is essential business in the insurance business like necessities in the demand theory. The less responsiveness of σ_{aa} to changes in price may be explained by the fact that life assurance companies can readily transfer the increased acquisition price to the new policyholders, but they have difficulty in transferring the increased maintenance price to the existing policyholders.

5.5.2 Parameter Estimates

The parameter estimates of the underwriting model and the associated standard errors for the pooled year are presented in Table 5.4. We call 1985-1995 the pooled year. This table also shows the value of objective function, R^2, standard error of regression, mean of dependent variable and number of observations. The results of the pooled year are gained by combining the data for each year. The results for each year are shown in Appendix *C*.

The parameter estimates of the pooled year, however, can only be used if they keep stability in the pooled year. This stability can be examined by the Chow test.[12] The F-statistic is 0.5815 and 1.1473, and critical value, 1.1404 and 1.2662 at the 0.05 level for the underwriting model and the acquisition share equation, respectively. Thus the null hypothesis is not rejected and we can obtain parameter stability for the pooled results.

Theory would predict positive marginal costs for increases in each four outputs requiring $\frac{\partial \ln C}{\partial Y_i^*} > 0$. Using the parameter estimates of the pooled year with each

[12]. The test statistic is :

$$F = \frac{S_r - \sum S_u / (p-1)k}{\sum S_u / (n-pk)}$$

variable by each observation, $\frac{\partial \ln C}{\partial Y_l^*}$, $\frac{\partial \ln C}{\partial Y_g^*}$, $\frac{\partial \ln C}{\partial Y_p^*}$ and $\frac{\partial \ln C}{\partial Y_h^*}$ are 0.4511, 0.0084, 0.1301 and 0.0301, respectively. With regard to the significance of parameter estimates, some 60 % of them in the pooled year are significantly different from zero at the 0.05 level.

Table 5.4 Parameter Estimates of the Underwriting Model for the Pooled Year (Asymptotic Standard Errors in Parentheses)

Parameter	Estimate	Parameter	Estimate
α_0	3.1519***(1.072)	γ_{aa}	.0584*** (.006)
α_l	.0571* (.040)	γ_{mm}	.0584*** (.006)
α_g	-.0848* (.044)	γ_{RR}	-.0415 (.043)
α_p	.1830*** (.046)	γ_{am}	-.0584*** (.006)
α_h	.0598 (.051)	γ_{aR}	-.0319*** (.007)
β_a	.5628*** (.045)	γ_{mR}	.0319*** (.007)
β_m	.4372*** (.045)	η_{la}	.0102*** (.002)
β_R	.7518** (.286)	η_{lm}	-.0102*** (.002)
δ_{ll}	.0079** (.004)	η_{lR}	.0046 (.005)
δ_{gg}	-.0009 (.001)	η_{ga}	.0020** (.001)
δ_{pp}	.0029* (.002)	η_{gm}	-.0020** (.001)
δ_{hh}	.0062** (.002)	η_{gR}	.0125* (.006)
δ_{lg}	-.0016 (.001)	η_{pa}	.0019*** (.001)
δ_{lp}	-.0046*** (.001)	η_{pm}	-.0019*** (.001)
δ_{lh}	-.0042*** (.001)	η_{pR}	-.0109** (.006)
δ_{gp}	.00005 (.001)	η_{ha}	-.0011 (.001)
δ_{gh}	-.0001 (.001)	η_{hm}	.0011 (.001)
δ_{ph}	-.0005 (.001)	η_{hR}	-.0001 (.006)
		λ	.0970*** (.022)
The value of objective function	-2620.25		
R^2 (RHTC)	.59		
S.E. of regression	1.34		
Mean of dependent variable	9.35		
Number of observation	1845		

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level

Note : 'α_0' and 'λ' imply the constant term and the parameter of the RBCT, respectively; the subscriptions '*a*', '*m*' and '*R*' denote the price of acquisition factor, the price of maintenance factor and the required minimum margin of solvency, respectively; and the subscriptions '*l*', '*g*', '*p*' and '*h*' denote premium income of life assurance products, general annuities, pensions and permanent health products, respectively.

where S_r, S_u are the sum of squared residuals obtained using the pooled data and each year data, respectively; the constant p is time periods (11 in the underwriting model); k, the number of parameters; and n, total observations.

5.5.3 Scale Economies

All the estimates of scale and scope economies are based on the parameter estimates for each year. With regard to the variables in estimating scale and scope economies, there are three methods: (1) the overall sample mean vector of variables, (2) each variable by each observation, but holding input prices constant at their sample mean and (3) each variable by each observation, i.e. the matrix of variables. We employ the third method that enables us to calculate the extent of cost economies for each company accurately and to use the estimated value for other tests such as comparing scale and scope economies among the divided groups.

The procedure for estimating scale and scope economies is explained as follows. After formulating the measurements for scale and scope economies, we calculate the degree of scale and scope economies by using the parameter estimates of each year with the variable matrix. However, the result of calculation itself does not tell us about the extent of scale and scope significance. In order to find out the degree of significance, we recalculate the standard errors of the degree of scale and scope economies. For example, the standard errors of Overall Scale Economies (OSCE) are derived from the paired t-test when the null-hypothesis is $OSCE = 1$.

The degree of $OSCE$ can be measured by:

$$OSCE = \sum_{i=1}^{4} \frac{\partial \ln C}{\partial Y_i *} = \sum_{i=1}^{4} Y_i (Y_i + \lambda)^{\lambda - 1} \left[\alpha_i + \sum_{j=1}^{4} \delta_{ij} Y_j * + \sum_{j=1}^{2} \eta_{ij} \ln p_j + \eta_{iR} \ln R \right] = \sum_{i=1}^{4} Y_i \omega_i$$

where Y_i* is transformed output by the RBCT,

and $\omega_i = (Y_i + \lambda)^{\lambda - 1} \left[\alpha_i + \sum_{j=1}^{4} \delta_{ij} Y_j * + \sum_{j=1}^{2} \eta_{ij} \ln p_j + \eta_{iR} \ln R \right]$.

If $OSCE < 1$, the marginal costs are less than the average costs, i.e. overall scale economies; if $OSCE > 1$, overall diseconomies of scale; and if $OSCE = 1$, constant returns to scale.

Product-Specific Scale Economies (PSSCE) can be written as:

$$PSSCE = \frac{\partial^2 C}{\partial Y_i^2} = C\left[\frac{\partial^2 \ln C}{\partial Y_i^2} + \frac{\partial \ln C}{\partial Y_i}\frac{\partial \ln C}{\partial Y_i}\right] = C[\delta_{ii}(Y_i+\lambda)^{2\lambda-2} + \omega_i(\frac{\lambda-1}{Y_i+\lambda} + \omega_i)]$$

where $\omega_i = (Y_i + \lambda)^{\lambda-1}\left[\alpha_i + \sum_{j=1}^{4}\delta_{ij}Y_j^* + \sum_{j=1}^{2}\eta_{ij}\ln p_j + \eta_{iR}\ln R\right]$.

If $PSSCE < 0$, the marginal cost of product Y_i is declining, i.e. product-specific increasing returns to scale; if $PSSCE > 0$, product-specific decreasing returns to scale; and if $PSSCE = 0$, constant product-specific scale economies.

The degree of *OSCE* and *PSSCE* are presented in Table 5.5. The standard errors of the estimates are derived from the paired *t*-test when the null-hypothesis is $OSCE = 1$ and $PSSCE = 0$.

It is clear from the table that there are, indeed, statistically significant overall scale economies for the pooled year and each year from 1985 to 1995 at the 0.01 level. The *OSCE* estimates suggest that the degree of scale economies markedly increased from 1991 with the exception of 1993. With regard to product-specific scale economies, we find positive scale economies in life assurance and pensions. Even though the estimates of the two products are not always significant for each year, all the estimates are negative and the estimates for the pooled year are statistically significant. The estimates of permanent health exhibit significant scale economies for 1985, 1990-1991 and the pooled year, whereas those of general annuities show statistically significant diseconomies of scale for 1985-1986,1989 and the pooled year.

Table 5.5 Scale Economies in the Underwriting Model
(Standard Errors in Parentheses)

Year	OSCE	PSSCEl	PSSCEg	PSSCEp	PSSCEh
1985-1995	.6347*** (.007)	-.1434* (.085)	.3440* (.186)	-.5179** (.252)	-.2134* (.109)
1995	.5712*** (.015)	-.0004* (.000)	-.0846 (1.389)	-.0006 (.000)	-.6090 (.583)
1994	.5678*** (.012)	-.0040 (.004)	1.2876 (.815)	-.0023 (.022)	-.1624 (.171)
1993	.6908*** (.024)	-.0042 (.004)	.3377 (.281)	-.4279 (.421)	.2591 (.175)
1992	.5222*** (.028)	-.4125 (.412)	-.0893 (1.074)	-.6421 (.653)	.5371 (.426)
1991	.5229*** (.009)	-.1151 (.155)	.9329 (.598)	-1.2420 (1.047)	-.2853* (.157)
1990	.6297*** (.013)	-.1790 (.133)	.7529 (.470)	-.0005** (.000)	-.5395** (.253)
1989	.6988*** (.001)	-.0026 (.000)	1.1148* (.000)	-.0086 (.003)	.1626 (.001)
1988	.6652*** (.019)	-.0022 (.002)	-.2400 (.492)	-2.3702 (2.254)	.3710 (.323)
1987	.8214*** (.049)	-.0005 (.000)	-.0498 (.072)	-.0679 (.059)	-.3065 (.234)
1986	.6217*** (.027)	-.0001* (.000)	.1893* (.110)	-.2901 (.252)	-.7688 (.567)
1985	.6349*** (.018)	-.8030 (.803)	.5879* (.343)	-.4688 (.324)	-1.3962** (.652)

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level

Note: The lowercases '*l*', '*g*', '*p*' and '*h*' denote life assurance products, general annuities, pensions and permanent health products, respectively.

We now turn to the comparison between composite and non-composite companies in terms of scale economies. Table 5.6 shows the estimates of each group, their standard errors (enclosed in parentheses) and the standard errors of the differences between the two groups (enclosed in brackets) that are calculated by the independent *t*-test.

With regard to *OSCE* the results indicate that both groups display statistically significant overall scale economies at the 0.01 level. The estimate of non-composite companies is slightly lower (i.e. higher scale economies) than that of composite companies for the pooled year. However, composite companies demonstrate higher overall scale economies than non-composite companies in the 1985, 1989-1992, and

1995 samples. The results of each year are shown in Appendix *D*. Moreover, the difference of standard errors between the two groups is not significant. We may therefore say that there is not much difference between the two groups in *OSCE*.

Table 5.6 Scale Economies of Composite and Non-Composite in the Underwriting Model (1985-1995)

OSCE (com) (non-com)	PSSCEl (com) (non-com)	PSSCEg (com) (non-com)	PSSCEp (com) (non-com)	PSSCEh (com) (non-com)
.6474*** .6322*** (.023) (.008) [.024]	-.0003*** -.1751* (.000) (.104) [.104]*	.3508 .3415 (.340) (.222) [.406]	-1.3237* -.3591 (.726) (.226) [.680]	.0526* -.2817** (.032) (.137) [.271]
305 1540	286 1287	225 618	239 1213	177 689

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level
Note 1: Each cell of the third row indicates number of samples for composite and non-composite companies, respectively.
Note 2: Standard errors of each estimate are enclosed in parentheses and those of the differences between two groups are enclosed in brackets.
Note 3: The results for each year are shown in Appendix *D*.
Note 4: The lowercases '*l*', '*g*', '*p*' and '*h*' denote life assurance products, general annuities, pensions and permanent health products, respectively.

With regard to *PSSCE*, composite companies exhibit statistically significant scale economies in pensions; however, non-composite companies are not statistically significant. Composite companies show statistically significant diseconomies of scale in permanent health; yet, non-composite companies display statistically significant scale economies. However, there are no significant differences between the two groups except for *PSSCEl*. We may therefore say that there is not much difference between the two groups in terms of scale economies.

With regard to the comparison between bancassurance and non-bancassurance in terms of scale economies, the results for the pooled year are reported in Table 5.7 and these for each year, in Appendix *E*. It is clear from the table that non-bancassurance companies exhibit much greater scale economies than bancassurance companies. There are statistically significant scale economies in the life assurance, pensions and permanent health products as well as overall scale economies for non-bancassurance companies, whereas only overall scale economies are statistically significant for bancassurance companies. There are also statistically significant differences between the two groups in *OSCE*, *PSSCEl* and *PSSCEh*.

The relatively low scale economies of bancassurance companies may be explained by their low level in producing premiums. Their average level of premium income and the ratio of premiums to costs (166974 and 4.68, respectively) are lower than those of non-bancassurance companies (187187 and 7.49, respectively) for the pooled year. In fact, bancassurance companies have not extended their underwriting business in the area of requiring sophisticated risks and have focused their business on less complicated products and less sophisticated customers (Leach, 1996). This weak position in selling business may be the reason for bancassurers' relatively low scale economies.

Table 5.7 Scale Economies of Bancassurance and Non-Bancassurance in the Underwriting Model (1985-1995)

OSCE		PSSCEl		PSSCEg		PSSCEp		PSSCEh	
(ban)	(non-ban)	(ban)	(non-ban)	(ban)	(non-ban)	(ban)	(non-ban)	(ban)	(non-ban)
.6835*** (.019)	.6292*** (.008)	-.7109 (.711)	-.0764* (.045)	1.2379 (.929)	.2828 (.189)	-.1000 (.081)	-.5650** (.280)	.1578 (.220)	-.2635** (.121)
[.021]***		[.277]**		[.760]		[.292]		[.251]*	
188	1657	166	1407	54	789	147	1305	103	763

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level

Note 1: Each cell of the third row indicates number of samples for bancassurers and non-bancassurance companies, respectively.
Note 2: Standard errors of group estimate are enclosed in parentheses and those of the differences between two groups are enclosed in brackets.
Note 3: The results for each year are shown in Appendix *E*.
Note 4: The lowercases '*l*', '*g*', '*p*' and '*h*' denote life assurance products, general annuities, pensions and permanent health products, respectively.

The results of the comparison between bancassurance and non-bancassurance in the underwriting model differ from those of Bacon & Woodrow (1996). The reasons for the difference may be the different sample size and group categorisations. Bacon & Woodrow studied a sample of 82 UK life assurance companies and compared bancassurers with other distribution channels such as tied agents, DSFs, IFAs and the mixed channels. The low standard deviation of bancassurance for both the level of premium income and the ratio of premiums to cost can make the result vary according to group categorisation of the sample companies.

Now we compare the results of scale economies among the distribution channels. For this comparison, we, firstly, consider three distribution channels: company agents, IFAs and the mixed channel. DSFs and tied agents are included in the category of company agents. A company, which earned over 75 % of its APE through company agents, is classified into the category of company agents. The same rule is applied to the IFA channel. The rest is included as the mixed channel that is applicable to the '*focus and multi-channel*' in Chapter 2. This analysis is restricted in the 1994 and 1995 samples due to data consideration.

Under the category of the three distribution channels, IFAs demonstrate significantly higher overall scale economies than company agents at the 0.05 level. This is reported in Table 5.8. The table shows F ratio, the results of post hoc test (Duncan's multiple range test) and the number of samples.

Table 5.8 Distribution Channels and Scale Economies in the Underwriting Model (1994-1995)[13]

	F Ratio	Post Hoc Test	Number of Samples
OSCE (three groups)	4.9828***	I (.5823)*** I A M A (.6514)*** # M (.6140)***	I (54) A (59) M (32)
OSCE (six groups)	3.4332***	I&D (.5922)*** I&D A&D M&D I&ND A&ND M&ND A&D (.6892)*** # (I&D) # (M&D) # (I&ND) # (A&ND) M&D (.6086)*** I&ND (.5770)*** A&ND(.6123)*** M&ND(.6209)***	I&D (19) A&D (30) M&D (18) I&ND (35) A&ND (29) M&ND(14)

*** significant at the 1% level

Note 1: # indicates significant differences between two groups (Duncan test with significance level 0.05).

Note 2: *I* denotes IFAs; *A*, company agents; *M*, mixed distribution; and *D*, using direct marketing, otherwise *ND* .

Note 3: The degree of scale economies in each distribution is enclosed in parentheses of the third column.

Secondly, we further divide the three groups into six taking into account direct marketing because the effect of different scale economies can be generated by a

[13] . With regard to the comparison among the distribution channels, we only report statistically significant results in both the underwriting and the intermediation model.

combination of one of the three distribution channels and the direct marketing channel. Taking into account direct marketing, we observe that company agents with direct marketing (A&D) display the least scale economies. This A&D distribution method shows statistically significant differences from IFAs with direct marketing (I&D), IFAs without direct marketing (I&ND), the mixed channel with direct marketing (M&D) and company agents without direct marketing (A&ND) at the 0.05 level.

5.5.4 Scope Economies

Pair-Wise Cost Complementarities (PWCC) can be measured by:

$$\text{PWCC} = \frac{\partial^2 C}{\partial Y_i \partial Y_j} = C\left[\frac{\partial^2 \ln C}{\partial Y_i \partial Y_j} + \frac{\partial \ln C}{\partial Y_i}\frac{\partial \ln C}{\partial Y_j}\right]$$

$$= C\,[\delta_{ij}(Y_i+\lambda)^{\lambda-1}(Y_j+\lambda)^{\lambda-1}+\omega_i\omega_j]$$

where $\omega_i = (Y_i+\lambda)^{\lambda-1}\left[\alpha_i + \sum_{j=1}^{4}\delta_{ij}Y_j^* + \sum_{j=1}^{2}\eta_{ij}\ln p_j + \eta_{iR}\ln R\right]$.

If $PWCC < 0$, the joint production of the products Y_i, Y_j reduces the costs of separate production, i.e. scope economies between Y_i and Y_j ; if $PWCC > 0$, diseconomies of scope between Y_i and Y_j ; and if $PWCC = 0$, constant scope economies.

The results of scope economies are reported in Table 5.9. The null hypothesis is not significantly different from constant scope economies, i.e. $PWCC = 0$. There are statistically significant scope economies in *PWCCgh* and *PWCClg* for the pooled year, whereas there are statistically significant scope diseconomies in *PWCClp* for the same year.

It is interesting to observe that all the significant scope economies are observed in the combination of general annuities and one of the other products except for *PWCClh* in 1993. This finding can tell us the important role of general annuities for the product mix strategy in the UK life assurance industry. In particular, when we compare the results of scope economies with those of product-specific scale economies, we can conclude that general annuities contribute to cost economies by means of scope, not scale.

Table 5.9 Scope Economies in the Underwriting Model
(Standard Errors in Parentheses)

Year	PWCClg	PWCClp	PWCClh	PWCCgp	PWCCgh	PWCCph
1985-1995	-.0003* (.000)	.0002*** (.000)	-.0001 (.000)	-.0022 (.002)	-.0045*** (.001)	.0019 (.001)
1995	-.0001 (.000)	.0000 (.000)	.0004 (.000)	-.0004 (.000)	-.0020*** (.001)	.0000 (.000)
1994	-.0004* (.000)	.0001 (.000)	.0001 (.000)	-.0002 (.000)	-.0069* (.004)	-.0001 (.000)
1993	.0000 (.000)	.0001 (.000)	-.0001*** (.000)	-.0001 (.000)	.0030** (.001)	.0000*** (.000)
1992	.0002 (.001)	.0000 (.000)	-.0023 (.002)	-.0009* (.000)	.0032 (.007)	-.0070 (.006)
1991	-.0003** (.000)	.0005 (.000)	-.0008 (.001)	-.0002** (.000)	-.0104 ** (.005)	.0026 (.002)
1990	-.0012 (.001)	.0001 (.000)	.0000 (.000)	-.0035 (.003)	-.0092** (.004)	.0008*** (.000)
1989	-.0007 (.015)	.0006 (.002)	-.0002 (.664)	-.0003 (.006)	-.0030 (.228)	.0014 (.000)
1988	.0003 (.000)	.0005 (.000)	-.0007 (.001)	-.0164 (.015)	-.0146 (.009)	.0116 (.009)
1987	.0000 (.000)	.0001** (.000)	.0004*** (.000)	-.0005 (.000)	.0005 (.001)	.0013** (.001)
1986	-.0002** (.000)	.0001 (.000)	.0012*** (.000)	.0002 (.000)	-.0047** (.002)	.0046* (.003)
1985	-.0006 (.000)	.0001** (.000)	.0011** (.000)	.0001 (.000)	-.0043* (.002)	.0093 (.009)

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level
Note: The lowercases '*l*', '*g*', '*p*' and '*h*' denote life assurance products, general annuities, pensions and permanent health products, respectively.

It is also interesting to compare the scale and scope results in Table 5.5 and 5.9, respectively, with those of the previous UK life assurance productivity studies. The results of *OSCE* in our sample are similar to the results of Kaye (1991) and Hardwick (1994) that showed positive overall scale economies. Kaye examined the degree of scale economies for 43 UK life assurance companies over the period 1980-1986. Hardwick estimated the extent of scale and scope economies for 76 UK life assurance companies from 1989 to 1991.

With regard to comparing our results with Hardwick's in terms of product-specific scale economies and scope economies, the two studies cannot be compared in a straightforward way. This is because he aggregated long-term products into three categories, while we aggregate the products into four categories. He included annuities in the category of pensions. However, taking into account the different group divisions, we may say that the results of product-specific scale economies and scope economies in our study are also nearly consistent with those of Hardwick. The largest scale economies are observed in the permanent health products in his study. In our study, we can observe statistically significant scale economies in permanent health in 1990 and 1991. Positive scope economies in the joint production of pensions and permanent health in his result is shown as statistically significant scope economies in *PWCCgh* in our 1990 and 1991 samples.

Table 5.10 Scope Economies of Composite and Non-Composite in the Underwriting Model (1985-1995)

PWCClg (com) (non-com)	PWCClp (com) (non-com)	PWCClh (com) (non-com)	PWCCgp (com) (non-com)	PWCCgh (com) (non-com)	PWCCph (com) (non-com)
-.0003** -.0003 (.000) (.000) [.000]	.0003* .0002** (.000) (.000) [.000]	.0000 -.0002 (.000) (.000) [.000]	-.0059 -.0008** (.006) (.000) [.003]	-.0029** -.0050*** (.001) (.002) [.003]	.0013 .0020 (.001) (.001) [.002]
231 573	237 968	158 666	213 585	135 401	144 598

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level

Note 1: Each cell of the third row indicates number of samples for composite and non-composite companies, respectively.

Note 2: Standard errors of each estimate are enclosed in parentheses and those of the differences between two groups are enclosed in brackets.

Note 3: The results for each year are shown in Appendix *F*.

Note 4: The lowercases '*l*', '*g*', '*p*' and '*h*' denote life assurance products, general annuities, pensions and permanent health products, respectively.

We now move on to the comparison between composite and non-composite companies in terms of scope economies for the pooled year. This is shown in Table 5.10. The results of each year are shown in Appendix *F*. According to Table 5.10, composite companies show statistically significant scope economies in *PWCClg*, while non-composite companies do not exhibit significant scope economies in the same joint production. On the other hand, there are statistically significant scope economies in *PWCCgp* for non-composite companies, but no significant scope economies for composite companies.

Nevertheless, there are no significant differences between the two groups. All the comparison standard errors, shown in brackets, do not reject the null hypothesis that there is no difference between the two groups. Moreover, the two groups show the same results: statistically significant scope economies in *PWCCgh* and statistically significant diseconomies of scope in *PWCClp*.

With regard to the comparison for scope economies between bancassurance and non-bancassurance, all the non-bancassurance companies show slightly higher scope economies than bancassurers except for *PWCClp*. As can be seen in Table 5.11, non-bancassurance companies show statistically significant scope economies in *PWCClg*, but bancassurers are not statistically significant in the same joint production. The null hypothesis for no difference between the groups is also rejected in *PWCClg* and *PWCCph*.

Table 5.11 Scope Economies of Bancassurance and Non-bancassurance in the Underwriting Model (1985-1995)

PWCClg (ban) (non-ban)	PWCClp (ban) (non-ban)	PWCClh (ban) (non-ban)	PWCCgp (ban) (non-ban)	PWCCgh (ban) (non-ban)	PWCCph (ban) (non-ban)
-.0000 -.0003* (.000) (.000) [.000]*	.0001* .0002*** (.000) (.000) [.000]	.0003 -.0002 (.000) (.000) [.000]	-.0000 -.0023 (.000) (.002) [.002]	-.0006**-.0048*** (.000) (.001) [.005]	.0078 .0011 (.006) (.001) [.004]*
44 760	125 1080	94 730	49 749	38 498	87 655

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level
Note 1: Each cell of the third row indicates number of samples bancassurers and non-bancassurance companies.
Note 2: Standard errors of each estimate are enclosed in parentheses and those of the differences between two groups are enclosed in brackets.
Note 3: The results for each year are shown in Appendix *G*.
Note 4: The lowercases '*l*', '*g*', '*p*' and '*h*' denote life assurance products, general annuities, pensions and permanent health products, respectively.

The reason for the relatively low scope economies of bancassurers may be explained by the fact that they have a narrow range of product mix. Out of 188 bancassurance companies for the pooled year, only 85 bancassurers (45.2 %) operate their business in three kinds of products or more; yet 55.9 % of non-bancassurance companies earned their premium income from the same range.

With regard to comparing the three distribution channels, the null hypothesis, i.e. the three distribution channels are not different with respect to scope economies, is not rejected at the 0.05 level. In the comparison of the six groups, company agents with direct marketing show statistically significant differences from each of the other groups in *PWCCgp* at the 0.05 level. This is shown in Table 5.12. It should be noted here that company agents with direct marketing display the least scale economies. This distribution, however, shows higher *PWCCgp* than other channels.

Table 5.12 Distribution Channels and Scope Economies in the Underwriting Model (1994-1995)

	F Ratio	Post Hoc Test	I&D	A&D	M&D	I&ND	A&ND	M&ND	Number of Samples
PWCCgp (six groups)	1.1932*	I&D (.0000)							I&D (13)
		A&D (-.0002)	#		#	#	#	#	A&D (8)
		M&D (.0000)							M&D (15)
		I&ND (.0000)							I&ND (15)
		A&ND(.0000)							A&ND (21)
		M&ND(.0000)							M&ND(12)

* significant at the 10 % level

Note 1: # indicates significant differences between two groups (Duncan test with significance level 0.05).

Note 2: *I* denotes IFAs; *A*, company agents; *M*, mixed distribution; and *D*, using direct marketing, otherwise *ND* .

Note 3: The lowercases '*g*' and '*p*' denote general annuities and pensions, respectively.

5.5.5 The Company Size and Cost Economies

We now examine the relationship between the company size and cost economies. The results are shown in Table 5.13 and 5.14. We divide the UK life assurance companies into three groups according to their premium income. We take the trisection value of premium income of each year for this division.

With regard to scale economies, three groups exhibit statistically significant *OSCE*, i.e. cost savings in expanding the level of output. The results also show that small companies show higher scale economies than both large and medium-sized companies. The differences between small and large companies are statistically significant in *OSCE*, *PSSCEp* and *PSSCEh* at the 0.05 level. This means that small companies can realise greater cost savings from scale economies than both large and medium-sized companies. Medium-sized companies exhibit higher scale economies than large companies in *OSCE* and the difference between the two groups is statistically significant in *OSCE* at the 0.05 level.

Table 5.13 Company Size and Scale Economies in the Underwriting Model (1985-1995)[14]

	F Ratio	Post Hoc Test				Number of Samples
OSCE	90.0621***	S (.5079)***	S	M	L	S (612)
		M (.6558)***	#			M (622)
		L (.7401)***	#	#		L (611)
PSSCEp	5.1050***	S (-1.8543)**	S	M	L	S (385)
		M (-.0843)	#			M (503)
		L (.0076)	#			L (564)
	4.8562***	S (-.7081)***	S	M	L	S (204)
PSSCEh		M (-.3191)				M (291)
		L (.1415)	#			L (371)

*** significant at the 1% level

** significant at the 5% level

Note 1: # indicates significant differences between two groups (Duncan test with significance level 0.05).

Note 2: *S* denotes small companies; *M*, medium-sized companies; *L*, large companies.

Note 3: The lowercases '*p*' and '*h*' denote pensions and permanent health products, respectively.

Note 4: The degree of scale economies in each size is enclosed in parentheses of the third column.

With regard to scope economies, on the other hand, small companies show statistically significant diseconomies of scale in *PWCClp*. Both large and medium-sized companies are favourable for *PWCClp* and *PWCCph* except for *PWCClg*. The differences between small and large companies, and between small and medium sized companies are statistically significant in *PWCClp* and *PWCCph* at the 0.05 level. Taking into account the fact that over 97 % of premiums in the UK ordinary business

[14]. With regard to the comparison among the company size, we only report statistically significant results in both the underwriting and the intermediation model.

came from the life assurance products and pensions in 1996, we may suggest that large and medium-sized companies are favourable for scope economies in the underwriting activity.

Table 5.14 Company Size and Scope Economies in the Underwriting Model (1985-1995)

	F Ratio	Post Hoc Test		Number of Samples
PWCClg	.8007***	S (-.0015)*** M (-.0003)*** L (.0002)	S M L # #	S (153) M (245) L (406)
PWCClp	11.5525***	S (.0008)*** M (.0000) L (.0000)	S M L # #	S (298) M (387) L (520)
PWCCph	4.4324***	S (.0095) M (.0002) L (.0000)***	S M L # #	S (140) M (238) L (364)

*** significant at the 1% level

Note 1: # indicates significant differences between two groups (Duncan test with significance level 0.05).

Note 2: *S* denotes small companies; *M*, medium-sized companies; *L*, large companies.

Note 3: The lowercases '*l*', '*g*', '*p*' and '*h*' denote life assurance products, general annuities, pensions and permanent health products, respectively.

Note 4: The degree of scope economies in each size is enclosed in parentheses of the third column.

5.6. CONCLUSION

We have estimated the underwriting model and have examined the degree of scale and scope economies in the UK life assurance industry and the divided groups. In estimating the model, the symmetry constraints and linear homogeneity in input prices are imposed. Both the RHTC function and the acquisition cost share equation are estimated to increase the degrees of freedom. A more exact and easy search for λ in the RBCT is executed by using the "CNORM" command in TSP. The iterative generalised technique, LSQ, is employed in estimating the non-linear regression equations. In particular, the LSQ estimator is an effective estimator for handling the singularity problem and the contemporaneous problem.

The underwriting model satisfies the restriction of linear homogeneity, and the requirements of monotonicity and concavity. The requirement for monotonicity is checked by the fitted values of the cost share equations. Concavity in the input prices is inspected by the Allen partial elasticities of substitution.

The findings of the empirical estimation are summarised as follows. Firstly, we find statistically significant overall scale economies and weak scope economies. In particular, scale economies are generated from the production of life assurance, pensions and permanent health insurance: but general annuities show diseconomies of scale. Statistically significant scope economies are observed in the joint production between general annuities and life assurance, and between general annuities and permanent health, but diseconomies of scope otherwise.

Secondly, there is not much difference in the degree of cost economies between composite and non-composite. We do not find significant differences between the two groups for all the degrees of scale and scope economies except for product-specific scale economies in life assurance where non-composite companies show higher scale economies than composite companies.

Thirdly, bancassurance companies exhibit lower scale and scope economies than non-bancassurance companies. This may be explained by the fact that bancassurers have been carrying out their long-term business in a less aggressive way and with a narrow range of product mix. They have focused on less complicated products and their output level has been relatively low.

Fourthly, with regard to the distribution channels, IFAs show significantly higher overall scale economies than company agents. Taking account of direct marketing, IFAs with direct marketing, IFAs without direct marketing and the mixed channel with direct marketing display higher overall scale economies. Company agents with direct marketing exhibit the least overall scale economies, but this distribution shows higher scope economies.

Finally, with regard to the relationship between the company size and cost economies, cost savings in expanding the level of output are observed. We find that small companies can realise greater cost savings from scale economies than both large and medium-sized companies. However, large and the medium companies are favourable for scope economies.

CHAPTER SIX

EMPIRICAL ESTIMATION OF THE INTERMEDIATION MODEL

6.1. INTRODUCTION

The purpose of this chapter is to model and estimate the intermediation function of a life assurance company. A life company ultimately exists to earn a return for its policyholders. A life company in the intermediation function can be viewed as an intermediary whose role is to collect premiums, invest the funds and distribute bonuses to its policyholders.

The bonus payments of a life company depend on not only its underwriting activity, but also its investment activity. The income generated from the underwriting activity is the primary source for distributing bonuses. Since premiums are paid in advance, they can be invested until needed to pay claims and they generate investment income. Thus the income generated from the investment activity is also the source for the intermediation function. It is the relationship between the input generated from the underwriting activity and the bonus payments and between the investment activity and the bonus payments that we shall investigate.

This chapter consists of 5 Sections. We construct the intermediation model and explain the outputs and inputs in Section 2. We discuss the econometric methodology in Section 3. The empirical results are presented in Section 4. Firstly, we investigate three regularity conditions: linear homogeneity, monotonicity and concavity in input prices. Secondly, the estimated parameters of the model are presented. Thirdly, we present the results of scale economies in the industry and for the divided groups.

Finally, we show the relationship between the company size and scale economies. This chapter ends with a brief summary of findings in Section 5.

6.2. MODELLING THE INTERMEDIATION PROCESS

6.2.1 Motivation for the Intermediation Model and the Production Technology

One of the reasons for studying the intermediation function of an insurance company is that, as illustrated in Chapter 1, the production process in the life investment funds is important both for the life assurance companies themselves and the UK economy. Thus the investment activity should be included in modelling the production technology of a life company. A second and the most important reason is that a life company ultimately exists a return for its policyholders. The role of a life company in the intermediation function is how efficiently the income generated from the underwriting activity and the investment activity is distributed for its policyholders. Despite the importance of the intermediation function, none of the existing studies examines the cost structure and efficiency of this activity.

In Chapter 5, we examined the cost structure of the underwriting function of a life assurance company. The purpose of the intermediation function is to generate profits for policyholders by selling products such as life assurance products, annuities, pensions and permanent health products, and investing net income. There are four main questions that we want to answer in relation to the intermediation activity of life companies. These are (1) Is size important in terms of bonuses to policyholders? That is, are larger life companies enjoying scale economies? (2) Does the type of insurance companies, i.e. composite and non-composite, affect bonuses? (3) Does the ownership of insurance companies, i.e. bancassurers and the traditional life insurers, affect bonuses? (4) Does the distribution channel affect the bonus payments?

A life insurance company performs primarily an intermediation role. It raises money from its underwriting activity which is then invested. Payment of bonus is therefore funded by both the underwriting and investment activities.

Let A be the investment income, S the amount of bonuses paid out and p_i the premium earned for a contract from the ith line of business. The exact relationship of premium and investment income and bonuses is not defined a priori. One way to model this relationship is to adopt a production function approach treating bonuses as the output and premium and investment income as inputs. The production can be described in a number of equivalent alternative ways, such as the production function, the cost function and the revenue function.

For the purpose of this study we employ the production specification, i.e.

$$\Omega(S, A, \mathbf{n}) = 0$$

where **n** is the vector of inputs representing the number of contracts.

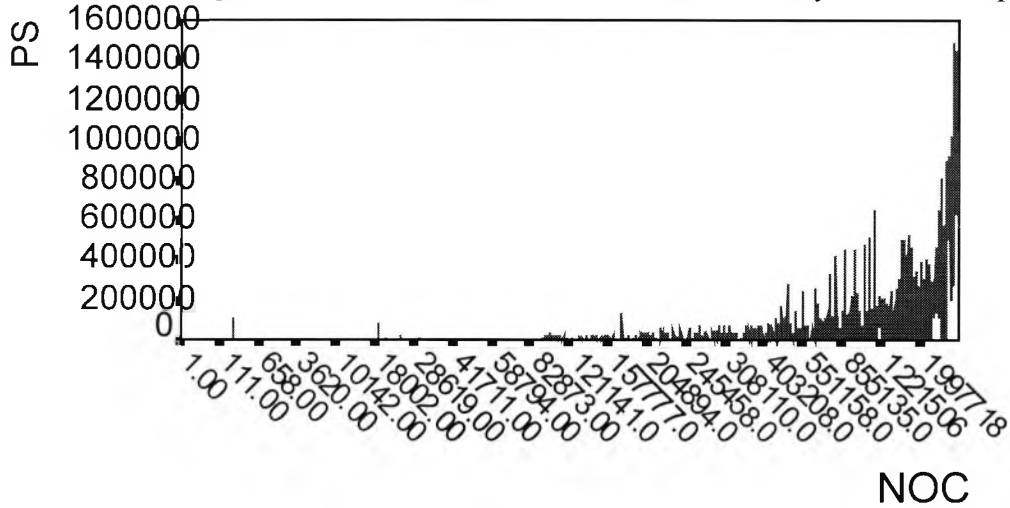
The cost function is described as a solution to the following problem:

$$C(S, A, \mathbf{p}) = \min_{\mathbf{n}} \{\mathbf{p}'\mathbf{n} : \Omega(S, A, \mathbf{n}) \geq 0\}$$

where **p** is the vector of premiums.

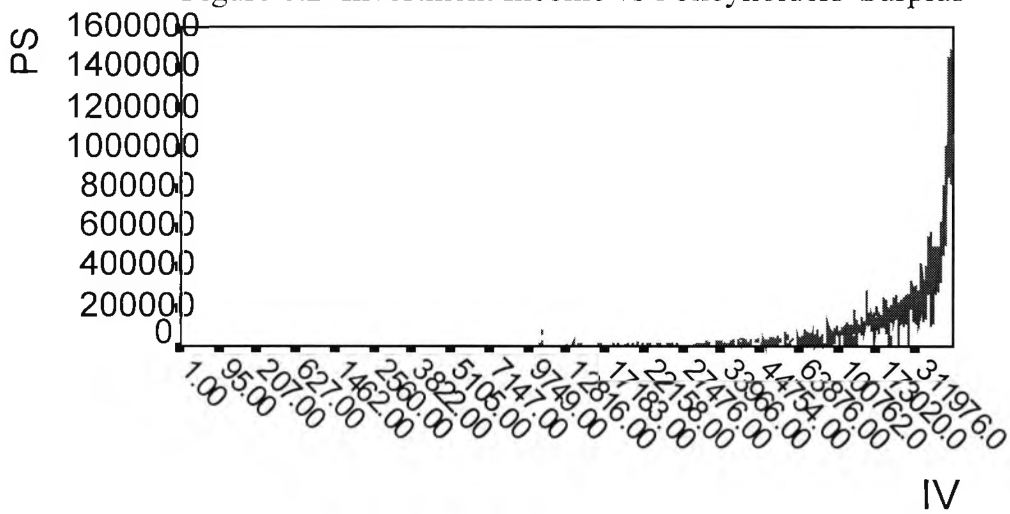
The figures below shows the relationship between **n** and S and between A and S for the period 1985-1995.

Figure 6.1 The Number of Contracts vs Policyholders' Surplus



'NOC' denotes the number of contracts
'PS' denotes policyholders' surplus

Figure 6.2 Investment Income vs Policyholders' Surplus



'IV'denotes investment income
'PS' denotes policyholders' surplus

The formulation so far has assumed that all inputs are perfect substitutes, i.e. $\frac{\partial\Omega}{\partial n_i} = \frac{\partial\Omega}{\partial n_j}$, where i denotes the ith business line. However, the bonus payments may depend on not just the total quantity of policies but also the composition of them. Surplus arises from the sum of mortality savings, the savings from loading and excess interest. Different allocation of mortality charges, expenses and investment income across different lines of insurance can make the bonus payments different according to the lines. For example, the savings from mortality charges are generated when the actual deaths are fewer than the assumed rate for the life assurance products, but more than the assumed rate for annuities. The product structure of life companies, i.e. specialised companies or diversified companies, is one of the factors determining surplus. (Adams and Hardwick, 1999:4). They assumed that more diversified life companies would tend to report higher surplus, which was significant.

We assume four business lines: life assurance, annuities, pensions and permanent health business line. Because of the different risk characteristics of the various liabilities, we can assume that the requirements in terms of real factor are different. So we can assume that $\frac{\partial \Omega}{\partial n_i} \neq \frac{\partial \Omega}{\partial n_j}$. The cost function that captures this effect is:

$$C\,(S,\ A,\ p_l,\ p_g,\ p_p,\ p_h)$$

where p_l, p_g, p_p, p_h are input prices of life assurance, annuities, pensions and permanent health, respectively.

It is true that investment income could be considered as an intermediation output, which is produced by using underwriting income. However, the investment output is ultimately regarded as the input factor for paying bonuses. It is also true that the earnings from investments account for most sources for determining bonuses. Thus investment income is transformed twice in the intermediation function: an output generated from underwriting income and the input factor for determining the level of bonuses.

It should be noted in this model that all the independent variables including the input price variables are transformed by the RBCT. This is because all the independent variables have zero value problem. Since investment income is employed as one of the input factors and also as one of the independent variables, the RHTC function of this model is the restrictive cost function, *g*, which can be expressed as:

$$\ln C = g(S^*, A^*, p_l^*, p_g^*, p_p^*, p_h^*)$$

where the superscript '*' denotes the RBCT.

6.2.2 Outputs, Inputs and Input Prices

The bonus payments are measured by the surplus allocated to policyholders (line 22 of Form 58). The output reflects both the welfare of customers and the productivity of a life assurance company. Policyholders prefer the company that provides greater bonuses given that other contract conditions among companies are almost equal. The amount of policyholders' surplus consists of bonus payments made to policyholders, cash bonuses, reversionary bonuses, other bonuses and premium reductions (line 17 to 21 of Form 58). For example, terminal bonuses are included in the category of other bonuses.

The income generated from the investment activity is measured by investment income (line 2 of Form 40). This consists of investment income from all the assets such as land, securities, debts and linked assets. Ernst & Young (1995:49-56) explained each investment asset as follows:

a) land (line 11 of Form 13) is defined by the Interpretation Act 1978 as including "buildings and other structures, land covered with water and any estate, interest, easement, servitude or right in or over land",

b) securities consist of fixed interest securities (line 12, 13, 14, 15 of Form 13), equity shares[1] (line 21, 22, 23 of Form 13), other variable interest securities (line 16,17,18 of Form 13) and investments in dependants,

c) debts are composed of deposit and current account, insurance debts, and other debts,

[1]. Equity shares mean share capitals that are divided into listed and unlisted. If dealings in investment are affected regularly on a stock exchange in an EEA or a regulated market, these are included in the category of listed.

d) linked assets (line 85, 86 of Form 13) are defined as long term business assets of a company which are, for the time being, identified in the records of the company as being assets by reference to the value of which property linked benefits are determined.

As far as measuring the dependent variable, *C*, is concerned, we employ the underwriting performance and the investment performance as determining the amount of bonus payments. The underwriting performance may be measured by premium income ($Y = \mathbf{p'n}$) less selling and management costs (*X*) less costs which arise from the processing of liabilities (*L*). The investment performance is determined by not only the current underwriting income, but also accumulated funds. Thus the amount of *C* is measured by 'admissible assets plus net premium income less net claims less expenses'. Admissible assets (*AA*) are defined as the excess of the value of a company's assets over the amount of its regulatory liability, i.e. the amount of the required minimum margin of solvency. Admissible assets ((line 21 of Form 9 + line 22 of Form 9 - line 41 of Form 9)) in the preceding year can be considered as total assets that can be invested and then be distributed for bonuses in the current year. Net premium income in the current year, which is assumed to be received at the beginning of the year, can be the supply of funds for paying bonuses as well. We again assume that net claims and expense payments (Form 42 and Form 41, respectively) are discharged through the year. So the calculation of cost, C, is written as:

$$C = [(AA)_{t-1} + (Y)_t] - \frac{(X+L)_t}{(1+i)^{1/2}}$$

where *AA* is admissible assets; *Y* is net premium income; *X* is the acquisition and maintenance expenses; *L* is net claims; and *t* and *i* are time and interest rate, respectively. We use the long-term interest rate of Government Bond in this calculation.

With regard to measuring input prices, we firstly allocate cost to each business line: life assurance, general annuities, pensions and permanent health business. For this allocation[2], we assume that admissible assets are allocated to each business line as the ratio of premium income of each line to total premium income in the previous year. The expense payments are also assumed to be assigned to each business line as the ratio of premium income of each line to total premium income in the current year. Then the cost of each line is divided by the number of contracts in force at the beginning of year (line 1 of Form 43) and new business (Form 44) of each business.

The intermediation model is written as:

$$\ln C = \alpha_0 + \alpha_s S^* + \alpha_I A^* + \sum_{i=1}^{4} \beta_i p_i^* + \frac{1}{2}\delta_{ss}(S^*)^2 + \frac{1}{2}\delta_{II}(A^*)^2 + \delta_{sI} S^* A^* + \frac{1}{2}\sum_{i=1}^{4}\sum_{j=1}^{4}\gamma_{ij} p_i^* p_j^* + \sum_{j=1}^{4}\eta_{sj} S^* p_j^* + \sum_{j=1}^{4}\eta_{Ij} A^* p_j^* + \mu_c$$

where C is cost; S^* and A^* are the RBCT of policyholders' surplus and investment income, respectively[3]; p_1^*, p_2^*, p_3^* and p_4^* are the RBCT input prices of life assurance, general annuities, pensions and permanent health, respectively; and μ_C is a disturbance term. The input price of m business line is calculated as

$$p_m = \frac{[(AA_m)_{t-1} + (Y_m)_t] - [(X_m + L_m)_t / (1+i)^{1/2}]}{\text{the number of contracts in } m \text{ business line}}$$, m is the four business lines.

6.3. DATA AND METHODOLOGY

6.3.1 Data, Sample and Period

The data sources of the intermediation model are the same as those of the underwriting model: *1995 SynThesys Life* (Release 2) and *Companies Profile and*

[2]. The DTI Returns shows the amount of each business line for net premium income and net claims, but does not report it for the admissible assets and the expense payments.

[3]. All the independent variables are transformed by the RBCT because they have zero value problem. The RBCT can be used because of its general property and the sample size can also increase by using this transformation.

Financial Strength Reports for the distribution channel. Our sample consists of all the UK life assurance companies that reported positive cost defined in this model. The average size for each year is 158 observations in this model. The sample period is from 1986 to 1995. Since we assume admissible assets in the preceding year to be invested in the current year, 1985 year is not included in the sample period.

6.3.2 Econometric Methodology

The econometric methodology used in estimating the intermediation model is the same as that in the underwriting model. We use the iterative method, LSQ, in estimating parameters and their standard errors in the intermediation model with the HETERO option. We impose the usual symmetry constraints and linear homogeneity in input prices. The number of parameters estimated reduces from 36 to 22 by the two restrictions. A search for the optimal estimate of the transformation parameter, λ, is executed by using the 'CNORM' command. We estimate just one λ for both the transformed outputs and input prices so as not to decrease the degrees of freedom.

The one difference from the underwriting model is, however, to estimate only the RHTC function. As the input prices are transformed by the RBCT in this model and thus the transformed input prices have the parameter, λ, the optimal cost share equations can not be gained by Shephard's Lemma. The dependent variable in each cost share equation has λ parameter and the invariance to the choice of cost share equations cannot be attained in this model.

6.4. EMPIRICAL RESULTS

6.4.1 Test for Homogeneity and Curvature

Before estimating the parameters of the model, we check the three regularity conditions: linear homogeneity, monotonicity and concavity in input prices. Linear homogeneity is examined by comparing the parameter estimates gained from the RHTC function estimated without imposing linear homogeneity with the parameter restrictions of linear homogeneity. In this examination, we estimate the two RHTC functions directly instead of estimating each cost share equation since the input prices are transformed by the RBCT .

Table 6.1 Linear Homogeneity in the Intermediation Model (Standard Errors in Parentheses)

	$\beta_l+\beta_g+\beta_p+\beta_h=1$	$\gamma_{hh}+\gamma_{lh}+\gamma_{gh}+\gamma_{ph}=0$	$\gamma_{lh}+\gamma_{ll}+\gamma_{lg}+\gamma_{lp}=0$	$\gamma_{gh}+\gamma_{gg}+\gamma_{lg}+\gamma_{gp}=0$	$\gamma_{ph}+\gamma_{pp}+\gamma_{lp}+\gamma_{gp}=0$	$\eta_{ll}+\eta_{lg}+\eta_{lp}+\eta_{lh}=0$	$\eta_{sl}+\eta_{sg}+\eta_{sp}+\eta_{sh}=0$
1995	.4425 (.354)	.0254 (.054)	.0092 (.036)	.0057 (.019)	.0160 (.021)	-.0443 (.035)	-.0017 (.008)
1994	.2453 (.439)	.0486 (.059)	.0289 (.042)	.0052 (.018)	.0237 (.025)	-.0611 (.041)	.0000 (.005)
1993	.2893 (.648)	-.0036 (.075)	-0012 (.039)	-.0181 (.026)	.0097 (.027)	-.0612 (.059)	.0099 (.013)
1992	.5490 (.501)	-.0201 (.034)	-.0056 (.020)	-.0238 (.017)	.0024 (.016)	-.0514 (.047)	.0066 (.007)
1991	-.1427 (.714)	.0587 (.082)	.0211 (.031)	.0277 (.036)	.0197 (.038)	-.0872 (.055)	-.0161 (.017)
1990	.6390*** (.174)	-.0006 (.031)	.0025 (.021)	-.0012 (.008)	.0062 (.017)	-.0325** (.016)	.0081 (.005)
1989	.5841*** (.176)	.0061 (.027)	.0154 (.018)	-.0021 (.011)	.0016 (.015)	-.0374*** (.013)	.0139 (.009)
1988	.5509** (.241)	-.0142 (.031)	.0034 (.017)	-.0037 (.014)	-.0087 (.017)	-.0530** (.024)	.0064 (.006)
1987	.8965*** (.124)	-.0308 (.029)	-.0190 (.019)	.0056 (.009)	-.0235 (.017)	-.0200* (.012)	.0062 (.005)
1986	.6395** (.286)	-.0150 (.039)	-.0036 (.033)	.0123 (.017)	-.0165 (.016)	-.0367 (.025)	.0046 (.007)

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level
Note : The subscriptions '*l*', '*g*', '*p*' and '*h*' denote the input price of each insurance line: life assurance, general annuities, pensions and permanent health business, respectively.

There are seven parameter restrictions in linear homogeneity. The results are presented in Table 6.1. The null hypotheses shown in the first row of the table are not rejected at the 0.05 level except for 1986-1990. One or two of the parameter restrictions are rejected from 1986 to 1990. The reason for this may be explained by the different production structure between before and after 1991[4].

The condition for monotonicity can be examined by the sign of the first partial derivatives of cost with respect to each input price. All the estimates of the first partial derivatives, evaluated using the overall sample mean values for all the variables, should be positive. This is shown in Appendix *H*. This model satisfies the regularity condition for monotonicity.

To check concavity, we can use the second derivative matrix $[C_{ij}]$. In the case of the intermediation model, C_{ij} is calculated as:

$$C_{ij} = C\phi_i\phi_j[(\beta_i + \sum_{j=1}^{4}\gamma_{ij}p_j^{*} + \eta_{si}S^{*} + \eta_{li}A^{*})(\beta_j + \sum_{i=1}^{4}\gamma_{ij}p_i^{*} + \eta_{sj}S^{*} + \eta_{lj}A^{*}) + \gamma_{ij}]$$

where C is cost; ϕ_i is $(p_i+\lambda)^{\lambda-1}$; p_i^*, S^* and A^* are the transformed input prices, policyholders' surplus and investment income, respectively; and γ_{ij} is the parameter estimate for two input prices.

The second derivative matrix, $[C_{ij}]$, is negative semidefinite when evaluated by using the overall sample mean values for all the variables. All the second partial derivatives of cost with respect to own price, C_{ii}, have negative estimates as shown in Appendix *H*. The *2×2(l, g)*, *3×3(l, g, p)* and *4×4(l, g, p, h)* matrix $[C_{ij}]$ are, for example, 628.081, -.00008 and .000002, respectively in 1995, where '*l*', '*g*', '*p*' and '*h*' denote the input price of life assurance, general annuities, pensions and permanent health business, respectively. These results suggest that this model satisfies the regularity condition for concavity in input prices.

With regard to the partial elasticities of substitution, the calculation in this model is slightly more complicated than that in the underwriting model because of the input price transformation. In other words, we cannot use the fitted cost share equations for

4 . For the different production structure between before and after 1991, see "Parameter Estimates" in this section.

the calculation of the elasticities of substitution in the intermediation model. However, we can construct the equation for calculating the elasticities of substitution by the formula, $\sigma_{ij} = \frac{CC_{ij}}{C_i C_j}$. The calculation is written as:

$$\sigma_{ij} = 1 + \frac{\gamma_{ij}}{(\beta_i + \sum_{j=1}^{4} \gamma_{ij} p_j^* + \eta_{si} S^* + \eta_{li} A^*)(\beta_j + \sum_{i=1}^{4} \gamma_{ij} p_i^* + \eta_{sj} S^* + \eta_{lj} A^*)}$$

Even though the partial elasticities of substitution in the intermediation model, reported in Table 6.2, do not suggest a constant result, it can be seen from the table that the life assurance factor is substitutable with both the general annuities and the permanent health factors. The general annuities and the permanent health factors can also be thought of as substitutes. The price elasticities of substitution, which is shown in Appendix *I*, present nearly the same results as the partial elasticities of substitution.

Table 6.2 The Partial Elasticities of Substitution of the Intermediation Model (Standard Errors in Parentheses)

	1991-1995	**1995**	**1994**	**1993**	**1992**	**1991**
σ_{lg}	2.2783** (1.072)	.6486 (.472)	.9761*** (.286)	1.6532** (.693)	5.2380 (7.533)	1.8271 (2.975)
σ_{lp}	-.5298 (.948)	-.1731 (2.447)	.7893*** (.251)	-12.7691 (104.82)	-.7543 (1.878)	-.5199 (1.180)
σ_{lh}	1.1918*** (.099)	1.3650*** (.318)	1.4757*** (.456)	1.1241*** (.162)	1.2472*** (.306)	-3.9907 (6.486
σ_{gp}	2.0684*** (.739)	1.4592 (1.701)	1.1489*** (.331)	5.1388 (31.23)	3.0146 (2.615)	1.7584 (1.571)
σ_{gh}	.6623*** (.425)	1.8005** (.752)	.6039*** (.983)	1.1976*** (.171)	-.8056 (2.968)	-1.6597 (1.427)
σ_{ph}	2.2018** (.635)	2.0867 (1.784)	1.4258*** (.290)	1.8326 (75.209)	1.8142*** (.572)	5.4614* (3.273)
σ_{ll}	-1.7528 (.875)	-2.0301 (1.695)	-.8902 (.808)	-2.0041 (1.816)	2.7488 (3.574)	.3572 (2.194)
σ_{gg}	-4.9086 (3.682)	-2.4523 (4.160)	-2.1499 (2.538)	-3.5946 (3.763)	-6.2832 (11.84)	-11.5333 (19.147)
σ_{pp}	-9.5434** (7.412)	-1.6134 (25.95)	-1.8594 (1.967)	-324.44 (4524)	-4.6295 (4.929)	-1.3440 (1.015)
σ_{hh}	-.9776 (.465)	-1.1581 (1.175)	-2.9147 (2.852)	-.7837 (.646)	-.8539 (.756)	-8.3365 (7.795)

(continued)

	1990	1989	1988	1987	1986
σ_{lg}	1.4511** (.669)	1.0148*** (.277)	1.0604*** (.173)	.9360*** (.291)	1.1202*** (.252)
σ_{lp}	.5348*** (.213)	.4089 (.425)	-18.7880 (403.633)	-.2285 (.852)	-1.9187 (3.053)
σ_{lh}	3.4719 (2.450)	1.6678*** (.299)	1.3185*** (.126)	3.4765 (8.164)	6.9321 (43.924)
σ_{gp}	1.8885 (1.899)	-1.2345 (2.527)	2.2451 (.399.80)	1.0675 (1.058)	1.5946 (1.258)
σ_{gh}	-7.0574 (17.367)	4.4725*** (1.505)	.8987*** (.266)	3.8387 (8.955)	13.2917 (97.715)
σ_{ph}	9.8517 (7.553)	4.3972** (2.180)	25.3989 (498.69)	11.8193 (37.931)	6.2205 (491.64)
σ_{ll}	-.0915 (.163)	-.3084 (.257)	-.6222 (.541)	-.2586 (.216)	-.4611* (.269)
σ_{gg}	-5.9739** (3.001)	-7.2235* (3.904)	-2.3676 (2.638)	-5.0729* (3.095)	-2.2986** (1.095)
σ_{pp}	-3.7416 (2.453)	-6.1878 (5.754)	-1455.4 (56888)	-3.4454 (2.149)	-5.5673 (3.668)
σ_{hh}	-14.7939 (14.456)	-4.0654** (2.024)	-1.1588 (1.114)	-27.4226 (112.62)	-103.82 (859.29)

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level
Note 1: The subscriptions '*l*', '*g*', '*p*' and '*h*' denote the input price of each insurance line: life assurance, general annuities, pensions and permanent health business, respectively.
Note 2: Stability of the parameter estimates for the pooled year is accepted only for the period 1991-1995 by the Chow test.

6.4.2 Parameter Estimates

The estimated parameters and their asymptotic standard errors for the pooled year are shown in Table 6.3. The results for each year are reported in Appendix *J*. The pooled results consist of the 1991-1995 samples, because the F-statistics for 1986-1995 and other combinations are rejected by the Chow test. The F statistic and critical value for the period 1991-1995 are 1.1358 and 1.2214, respectively.

We can observe an important change in the production structure of the UK life assurance industry from both the Chow test and the linear homogeneity condition test in Table 6.1. The results of *OSCE* in Table 5.5 also showed that the degree of scale economies sharply increased from 1991. All these results suggest that there was a new phase of cost structure in the UK life assurance industry from 1991 or 1992. This new phase can reflect 'the cost-cutting undertaken by many financial firms during the UK recession of 1990-1991' (Hardwick, 1997:42). Macmillan and Christophers (1997) also pointed out a different market structure of the 1990s from the 1980s.

Table 6.3 Parameter Estimates of the Intermediation Model for the Pooled Year (1991-1995) (Asymptotic Standard Errors in Parentheses)

Parameter	Estimate	Parameter	Estimate
α_0	7.2047*** (.566)	γ_{lg}	.0400*** (.015)
α_l	.3215*** (.079)	γ_{lp}	-.0264*** (.005)
α_s	.1204*** (.035)	γ_{lh}	.0300** (.014)
β_l	.0892 (.113)	γ_{gp}	.0088 (.007)
β_g	.1556 (.151)	γ_{gh}	-.0252 (.026)
β_p	.5793*** (.071)	γ_{ph}	.0495*** (.010)
β_h	.1758* (.097)	η_{Il}	.0312*** (.007)
δ_{II}	.0206*** (.014)	η_{Ig}	-.0031 (.013)
δ_{ss}	.0156*** (.005)	η_{Ip}	-.0197*** (.006)
δ_{sI}	-.0202*** (.004)	η_{Ih}	-.0083 (.007)
γ_{ll}	-.0436*** (.018)	η_{sl}	.0060 (.006)
γ_{gg}	-.0236** (.015)	η_{sg}	-.0074** (.005)
γ_{pp}	-.0319*** (.003)	η_{sp}	.0023 (.004)
γ_{hh}	.0543* (.033)	η_{sh}	-.0009 (.008)
		λ	.0525*** (.018)
The value of objective function		-1101.19	
R^2		.89	
S.E. of regression		.89	
Mean of dependent variable		12.41	
Number of observation		775	

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level

Note : 'α_0' and 'λ' imply the constant term and the parameter of the RBCT, respectively; the subscriptions '*l*', '*g*', '*p*' and '*h*' denote the input price of each insurance line: life assurance, general annuities, pensions and permanent health business, respectively; and the subscriptions '*I*' and '*s*' denote investment income and policyholders' surplus, respectively.

Most of the parameters are significantly different from the zero at the 0.05 level. To satisfy positive marginal cost for increase in each output, $\frac{\partial \ln C}{\partial S^*} > 0$ is required. Using the parameter estimates in the table with each variable by each observation, $\frac{\partial \ln C}{\partial S^*}$ is 0.0297.

6.4.3 Scale Economies

The measurements for scale economies in this model are the same as those in the underwriting model except for using p_j* instead of p_j because of the input price transformation. The degree of scale economies in investments (SE_s) can be measured by:

$$SE_s = \frac{\partial^2 C}{\partial S^2} = C\left[\frac{\partial^2 \ln C}{\partial S^2} + \frac{\partial \ln C}{\partial S}\frac{\partial \ln C}{\partial S}\right] = C[\delta_{SS}(S+\lambda)^{2\lambda-2} + \omega(\frac{\lambda-1}{S+\lambda} + \omega)]$$

where $\omega = (S+\lambda)^{\lambda-1}\left[\alpha_s + \delta_{ss}S^* + \delta_{sA}A^* + \sum_{j=1}^{4}\eta_{sj}\ln p_j^*\right]$

If $SE_S < 0$, the marginal cost of product A is declining, i.e. product-specific increasing returns to scale; if $SE_S > 0$, product-specific decreasing returns to scale; and if $SE_S =$ 0, constant product-specific scale economies.

The pooled results are obtained from the 1986-1995 samples, not 1991-1995 samples. As we calculate the degree of scale economies for the period 1986-1995 by using the parameter estimates of each year, the parameter's stability for this pooled year is not required. The results of scale economies are reported in Table 6.4. The standard errors in the table are calculated by the same method that we employed in the underwriting model.

As can be seen in Table 6.4, we observe weak diseconomies of scale. The results show statistically significant diseconomies of scale for the pooled year and 1990-1992. Significant diseconomies of scale from 1990 to 1992 imply that the UK life companies did not distribute enough bonuses to their policyholders in those years. This may be one of the reasons for lessening of the policyholders' confidence in insurance at the beginning 1990s.

Table 6.4 Scale Economies in the Intermediation Model (Standard Errors in Parentheses)

Year	SE_s
1986-1995	.0947** (.038)
1995	-.0455 (.057)
1994	.0258 (.044)
1993	-.2087 (.159)
1992	.3220* (.175)
1991	.1998* (.114)
1990	.0668* (.034)
1989	.1215 (.086)
1988	.2143 (.159)
1987	.0340 (.101)
1986	.1737 (.148)

** significant at the 5% level
* significant at the 10% level
Note: The subscription '*s*' denotes policyholders' surplus.

With regard to the comparison between composite and non-composite companies, the degree of scale economies and the difference between the two groups are reported in Table 6.5. Non-composite companies show statistically significant diseconomies of scale, while composite companies have minus value. In fact, composite companies provide larger policyholder's surplus than non-composite companies. The ratio of policyholder's surplus to total premium income is 2.9355 and 0.3838 for composite and non-composite companies, respectively, for the period 1985-1995 and the difference is also statistically significant at the 0.01 level. This may suggest that composite companies are more efficient than non-composite companies in the intermediation activity.

Table 6.5 Scale Economies of Composite and Non-Composite in the Intermediation Model (1986-1995)

SE_s (com)	SE_s (non-com)
-.0006 (.001)	.1248** (.050)
[.089]	
161	508

** significant at the 5% level

Note 1: The third row indicates number of samples for composite and non-composite companies, respectively.
Note 2: Standard errors of each estimate are enclosed in parentheses and those of the difference between two groups are enclosed in brackets.
Note 3: The results for each year are shown in Appendix *K*.
Note 4: The subscription '*s*' denotes policyholders' surplus.

With regard to the comparison between bancassurance and non-bancassurance, the results are shown in Table 6.6. The two groups have statistically significant diseconomies of scale. However, non-bancassurance companies show lower diseconomies of scale than bancassurers and the difference between two groups is also statistically significant.

Table 6.6 Scale Economies of Bancassurance and Non-Bancassurance in the Intermediation Model (1986-1995)

SE_s	
(ban)	(non-ban)
.3035***(.091)	.0748* (.041)
[.100]**	
58	611

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level

Note 1: The third row indicates number of samples for bancassurers and non-bancassurance companies, respectively.

Note 2: Standard errors of each estimate are enclosed in parentheses and those of the difference between two groups are enclosed in brackets.

Note 3: The results for each year are shown in Appendix *L*.

Note 4: The subscription '*s*' denotes policyholders' surplus.

We can answer the question about the cross-industry regulation raised in Chapter 3 with this table and the comparison results of two groups in the underwriting model. The main concern of the regulators is to protect the policyholders and to co-ordinate the cross-industry activities to improve efficiency in the market. All the results show that bancassurance companies are less efficient than non- bancassurance companies. It may be very difficult to justify the entry into the life assurance sector by banks and building societies in terms of market efficiency. So we may suggest that the cross-industry penetration by banks and building societies should be restricted.

As far as distribution is concerned, the division method for the channels in this model is the same as that in the underwriting model. Table 6.7 shows that company agents with direct marketing (A&D) exhibit the highest diseconomies of scale and the differences between this channel and one of the other groups are statistically significant at the 0.05 level.

Table 6.7 Distribution Channels and Scale Economies in the Intermediation Model (1994-1995)

	F Ratio	Post Hoc Test	Number of Samples
SE_S (six groups)	4.7133***	I&D (-.0006) A&D (.5456) M&D (.0000) I&ND (.0037) A&ND(.0000) M&ND(.0000) I&D A&D M&D I&ND A&ND M&ND # # # # #	I&D (14) A&D (7) M&D (12) I&ND (10) A&ND (24) M&ND (8)

*** significant at the 1% level

Note 1: # indicates significant differences between two groups (Duncan test with significance level .05).

Note 2: *I* denotes IFAs; *A*, company agents; *M*, mixed distribution; and *D*, using direct marketing, otherwise *ND* .

Note 3: The subscription '*s*' denotes policyholders' surplus.

6.4.5 The Company Size and Scale Economies

We now examine the relationship between the company size and cost economies in the intermediation model. The results are shown in Table 6.8. We take the trisection value of premium income of each year for the size division. Both large and medium-sized companies show statistically significant diseconomies of scale and the differences between medium-sized companies and small companies, and between medium-sized companies and large companies are statistically significant at the 0.05 level.

It is interesting to compare the result of this model to that of the underwriting model in terms of the company size and scale economies. Cost savings in expanding the level of output are observed in the underwriting model. Weak diseconomies of scale are, however, observed in the intermediation model. This contrasting result may be explained by three factors: the high bonus payment strategy of small companies, flexibility of small companies in investments and symmetry in investment information.

Table 6.8 Company Size and Scale Economies in the Intermediation Model (1986-1995)

	F Ratio	Post Hoc Test		Number of Samples
SE_s	3.2872**	S (-.0230) M (.2350)*** L (.0571)***	S M L # #	S (137) M (203) L (329)

*** significant at the 1% level
** significant at the 5% level
Note 1: # indicates significant differences between two groups (Duncan test with significance level 0.05).
Note 2: *S* denotes small companies; *M*, medium-sized companies; *L*, large companies.
Note 3: The subscription '*s*' denotes policyholders' surplus.
Note 4: The degree of scale economies in each size is enclosed in parentheses of the third column

In order to offset the cost disadvantages in the underwriting activity and to compete with large companies who realise scale economies in the underwriting activity, small companies may have decided to pay higher rates of bonuses to attract new business. The bonus payments of a life company depend on not only its underwriting activity, but also its investment activity. In fact, the earnings from investments account for most profits of a life company. Small companies may have the flexibility advantage in investments, which enables them to achieve the investment activity efficiently.[5] In the competitive market, small companies can also share the same investment information as large companies. We may not expect that the disadvantages caused by the information asymmetry problem exist in the competitive UK insurance market. This symmetry in investment information may be one of the reasons for achieving scale economies of small companies in investments.

6.5. CONCLUSION

We have estimated the intermediation model. The symmetry constraints and linear homogeneity in input prices are imposed in the estimation. All the independent

[5]. The empirical result shows that small companies exhibit statistically significant scale economies at the 0.01 level when we treat investment income as output in the intermediation model. However, both large and medium-sized companies show statistically significant diseconomies of scale. This may be caused by inflexibility of them in investments.

variables including the input price variables in this model are transformed by the RBCT. Due to the transformation of input prices, only the RHTC function is estimated.

The model satisfies the condition for monotonicity and concavity in input prices for the period 1986-1995 and for linear homogeneity for 1991-1995, respectively. We have examined linear homogeneity by comparing the parameters estimated with imposing the linear homogeneity restrictions with the parameters estimated without the restrictions. Monotonicity in the intermediation model is examined by the sign of the first partial derivatives of cost with respect to each input price. Concavity in input prices is inspected by the second derivative matrix.

The findings of the empirical estimation are summarised as follows. Firstly, we find weak diseconomies of scale in distributing bonuses. Significant diseconomies of scale are observed in 1990-1992 and the pooled year. This result may be one of the reasons for lessening of the policyholders' confidence in insurance at the beginning 1990s.

Secondly, with regard to the comparison between composite and non-composite companies, non-composite companies exhibit statistically significant diseconomies of scale, while composite companies have minus value. Composite companies also provide larger bonuses than non-composite companies. The effect on providing policyholders' surplus is tested by the ratio of policyholders' surplus to total premium income. The ratio is statistically significant at the 0.01 level.

Thirdly, bancassurance companies show higher diseconomies of scale than non-bancassurance companies and the difference between the two groups is also statistically significant. This may suggest that the cross-industry activity should be restricted in order to improve efficiency in the life market.

Fourthly, with regard to the distribution channels, company agents with direct marketing show the highest diseconomies of scale and the differences between this channel and one of the other groups are statistically significant at the 0.05 level. The results may suggest that this channel is not suitable for achieving scale economies in the intermediation activity.

Finally, with regard to the relationship between the company size and scale economies, small companies are favourable for scale economies. This result may be explained by the fact that small companies who would pay higher rates of bonuses to offset the cost disadvantages in selling life products and to compete with large companies. With regard to the bonus payments from the investment performance, flexibility of small companies in their investment activity is one of the reasons for this result. This is also explained by the fact that symmetry in investment information is facing large and small life companies.

There is some independent market evidence to suggest that small life companies have eaten into their capital bases to pay out their high bonuses. Over time this has encouraged small companies to demutualise or to agree to be taken over as their capital bases cannot sustain future bonuses growth. Hence, these findings of weak diseconomies of scale in the intermediation model may be sound.

CHAPTER SEVEN
SUMMARY AND CONCLUSIONS

7.1. INTRODUCTION

The purpose of this chapter is to summarise this thesis and to make policy recommendations based on the findings. This chapter is organised as follows. In Section 2, we summarise the main discussions and the results of previous chapters. In Section 3, we suggest policy recommendations to the UK regulators as well as to the life assurance companies. The limitations of this study are outlined and further research is suggested in Section 4.

7.2. SUMMARY OF THIS THESIS

The main objective of this thesis is to estimate scale and scope economies in the UK life assurance industry. After determining the objectives of this thesis and describing the motivation for the study in Chapter 1, we examined the market structure of UK life insurance industry in Chapter 2. The market has experienced dynamic changes that require life assurers to be competitive in order to survive. For a study of productivity, this competitive market structure suggests that a cost function is a more appropriate functional form than a production function. In a competitive industry, output prices rather than inputs are regarded as exogenous variables since output prices might be determined in the market by supply and demand. This exogeneity of outputs makes the cost function preferable.

We also discussed the distribution channels of the UK life assurance industry in Chapter 2. We examined each distribution in terms of market share, cost efficiency, the main products and customers. The primary condition for survival may be to realise cost economies in the production process, especially in the area of distribution. The choice of distribution channel or channels is a matter of significance to a life company. When a life company plans distribution strategy, its cost efficiency is a primary concern. To discover the cost efficiency of each distribution channel, we tested the cost differences among distribution channels. The results of this test can be used as useful inputs to life companies when they choose a distribution channel or channels.

In Chapter 3, we examined the regulatory factors such as authorisation, the statutes and rules governing the UK life business, the solvency margin and the business-border regulation. These factors have a great influence on the products and the production process of life assurance. They should be considered in a study of life assurance productivity. The requirements in the new disclosure scheme have forced life companies to increase their costs in providing services to their policyholders and require them to improve productivity for survival and growth. The required minimum margin of solvency is employed as a proxy for the riskiness of insurance contracts and to solve the double-counting problem in using premium income itself as output. In the examination of the business-border regulation, we explained the current regulation over composite and bancassurance companies.

In Chapter 4, we modelled the production structure of a life assurance company. We, firstly, provided a general description of technology. Secondly, the production technology of a life company was modelled. We consider the underwriting activity and the investment activity in modelling the production technology of a life company. The underwriting model is focused on the cost structure of the underwriting activity, while the intermediation model is constructed with the two activities. The income generated from the two activities can be treated as the source for the intermediation function and the bonus payments as the intermediation output.

In Chapter 5, we suggested the criteria for selecting a functional form and developed the Revised Hybrid Translog Cost (RHTC) function. The cost function preference is supported by the economic convenience of this function as well as the high competition in the UK life assurance market. Of the existing cost functions, the Hybrid Translog Cost (HTC) function can be regarded as a suitable functional form in terms of the three criteria: flexibility in measuring returns to scale and the elasticity of substitution, parsimony and multiple observations including zero values. However, the HTC function using the traditional Box-Cox transformation has the econometric problem: the limitation of estimating the asymptotic covariance matrix of the parameter estimates. This problem is solved by developing the Revised Box-Cox transformation in our models. The RHTC function is employed in estimating cost economies in the UK life assurance industry.

In the remaining part of Chapter 5, we estimated the underwriting model. The intermediation model was estimated in Chapter 6. The variables employed in each model well reflect the activities for providing services to policyholders and the costs are appropriately associated with the defined outputs. The acquisition and maintenance expenses and the cost factor caused by the riskiness of insurance contracts are well matched with the premium income outputs. The cost defined in the intermediation model is also matched with the output of the intermediation activity, namely the bonus payments. The output and cost variables employed in both models also solve the controversial problem of using premium income itself as a proxy for output.

The main findings of this study are summarised in the following paragraphs. Firstly, we find statistically significant overall scale economies and weak scope economies in the underwriting model. However, weak diseconomies of scale are observed in the intermediation model. With regard to product-specific economies of scale in the underwriting model, there are statistically positive scale economies in life assurance, pensions and permanent health. The joint production between general annuities and life assurance and between general annuities and permanent health exhibits statistically positive scope economies.

Secondly, there are no significant differences between composite and non-composite companies in terms of scale and scope economies in the underwriting model.

However, composite companies provide larger bonuses than non-composite companies, which is statistically significant at the 0.01 level.

Thirdly, with regard to bancassurance companies, they exhibit lower scale and scope economies than non-bancassurance companies in the underwriting model and they also show higher diseconomies of scale in the intermediation model. Lower cost economies of bancassurers can be explained by the fact that they have focused their insurance product strategy on less complicated products and a narrow range of product mix. The entry barriers of bancassurance such as the switching costs and the cost disadvantages in the area of insurance product technology can also account for their lower cost economies.

Fourthly, with regard to distribution, both IFAs (with and without direct marketing) and the mixed channel with direct marketing show higher scale economies in the underwriting model. Company agents with direct marketing exhibit the least scale economies, but this channel displays higher scope economies in the underwriting model. This channel shows the highest diseconomies of scale in the intermediation model.

Finally, we find cost savings in expanding the level of output in the underwriting model. Small companies can realise greater cost savings than both large and medium-sized companies in terms of scale economies. Both large and medium-sized companies are favourable for scope economies in the underwriting activity. However, small companies are favourable for scale economies in the intermediation model. This contrasting result in two models may be explained by the high bonus payment strategy of small companies, flexibility of small companies in the investment activity and symmetry in investment information facing large and small companies.

7.3. POLICY RECOMMENDATION

Based on our findings in the empirical analysis, we can suggest useful policy recommendations for life assurance companies as well as regulators as follows:

Firstly, we can give life companies useful insights about the expansion strategy. There are cost savings in expanding the level of underwriting output. A large company is also favourable for scope economies. Under this circumstance, the expansion strategy by M&A with increasing the range of products is desirable.

Secondly, we may recommend the optimal product mix and distribution strategy to life assurance companies based on the empirical results. The life assurance products, pensions and permanent health products can be recommended for scale economies. To gain scope economies, the mix of general annuities with one of the other outputs can be recommended. Of the various distribution methods, IFAs and the mixed channel with direct marketing can be advised in order to realise scale economies in the underwriting business. Company agents with direct marketing may be suggested for scope economies in the underwriting business.

Finally, we may suggest that the cross-industry penetration by banks and building societies should be restricted. The main role of regulators is to protect the policyholders, to co-ordinate the cross-industry activities and to improve market efficiency. Based on the comparison results between bancassurance and non-bancassurance companies, the regulators should reconfigure the cross-industry activities.

7.4. THE LIMITATIONS OF THIS THESIS AND SUGGESTIONS FOR FURTHER RESEARCH

Every research has its own limitations and our research in not outside this boundary. As most empirical studies face the problem of availability of data, we employed unit cost instead of input price. It is very difficult to gain the prices of labour and capital which differ from company to company according to different grades. In addition to this problem, because of data consideration our study could not cover all the issues related to our topic. We could not directly test the effect of M&A on cost economies. The examination of this effect is a very interesting subject to the regulators as well as insurance companies. However, the number of companies, who merged with other companies in *1995 SynThesys Life* (User Guide), is not enough for the empirical test.

We may suggest further research in the following areas for the development of UK insurance industry and the insurance industry as a whole.

Our models may be used for other countries' life assurance industries for similar tests. In this case, researchers should, first of all, check the countries' market structure and the regulations that affect the insurance products and the production process.

Moreover, if anybody can obtain the data, they may examine the effects of life companies' intra-industry activity, namely M&A, on cost economies. If the UK sample is too small, they might take EC countries as the EC is implementing similar accounting standard and procedures for the Members.

APPENDIX A

The Forms of the DTI Returns

Statement of Solvency **Form 9**

L11	Gen -Available assets	
L12	Gen - Required minimum margin	
L13	Gen - Excess (11 - 12)	
L14	Gen - Implicit items	
L21	LT - Admissible assets	#
L22	LT - Other	#
L23	LT - Total mathematical reserves	
L24	LT - Other liabilities	
L25	LT - Available assets (21 + 22 - 23 - 24)	
L31	LT - Future profits	
L32	LT - Zillmerising	
L33	LT - Hidden reserves	
L34	LT - Total available assets & implicit items (25 + 31 + 32 + 33)	
L41	LT - Required minimum margin	*, #
L42	LT - Explicit required minimum margin	
L43	LT - Excess of available assets (25 - 42)	
L44	LT - Excess of available assets & implicit items (34 - 41)	
L51	OLT - Assets not allocated towards Gen. required min. margin	
L52	OLT - Assets not allocated towards LTB required min. margin	
L53	OLT - Net assets (51 + 52)	
L60	Contingent Liabilities: in respect of OLT business	
L61	Contingent Liabilities: in respect of LT business	

* Denotes that the line is used for measuring variables in the underwriting model.

# Denotes that the line is used for measuring variables in the intermediation model.

Long Term business: Revenue Account **Form 40**

F40 OB	L1	Premiums receivable (less rebates and refunds)	
F40 OB	L2	Investment income receivable before deduction of tax	#
F40 OB	L3	Increase (decrease) in the value of non linked assets	
F40 OB	L4	Increase (decrease) in the value of linked assets	
F40 OB	L5	Other income	
F40 OB	L6	Total income (1 to 5)	
F40 OB	L7	Claims payable	
F40 OB	L8	Expenses payable	
F40 OB	L9	Interest payable before tax	
F40 OB	L10	Taxation	
F40 OB	L11	Other expenditure	
F40 OB	L12	Transfer to (from) statement of other income and expenditure	
F40 OB	L13	Total expenditure (7 to 12)	
F40 OB	L14	Increase (decrease) in fund in financial year	
F40 OB	L15	Fund brought forward	
F40 OB	L16	Fund carried forward (14 + 15)	

# Denotes that the line is used for measuring variables in the intermediation model.

Long Term business: Analysis of premiums and expenses **Form 41**

F41 OB	L1 Net	Premiums receivable - Life: single premium	
F41 OB	L2 Net	Premiums receivable - Life: regular premiums	
F41 OB	L3 Net	Premiums receivable - General annuity: single premium	*,#
F41 OB	L4 Net	Premiums receivable - General annuity: regular premiums	*,#
F41 OB	L5 Net	Premiums receivable - Pensions: single premium	*,#
F41 OB	L6 Net	Premiums receivable - Pensions: regular premiums	*,#
F41 OB	L7 Net	Premiums receivable - Permanent health	*,#
F41 OB	L8 Net	Premiums receivable - Capital redemption	
F41 OB	L9 Net	Premiums receivable - Total (1 to 8)	
F41 OB	L10 Net	Premiums receivable - Total: UK contracts	
F41 OB	L11 Net	Premiums receivable - Total: Overseas contracts	
F41 OB	L12 Net	Expenses - Commission re. acquisition of business	*,#
F41 OB	L13 Net	Expenses - Other commission	*,#
F41 OB	L14 Net	Expenses - Management expenses re. acquisition of business	*,#
F41 OB	L15 Net	Expenses - Other management expenses	*,#
F41 OB	L16 Net	Expenses - Total (12 to 15)	
F41 OB	L17 Net	Expenses - Total: UK contracts	
F41 OB	L18 Net	Expenses - Total: Overseas contracts	

* Denotes that the line is used for measuring variables in the underwriting model.

# Denotes that the line is used for measuring variables in the intermediation model.

Long Term business: Analysis of Claims **From 42**

F42 OB	L1 Net	Life Assurance - On death	
F42 OB	L2 Net	Life Assurance - On maturity	
F42 OB	L3 Net	Life Assurance - On surrender	
F42 OB	L4 Net	Life Assurance - Total claims (1 to 3)	#
F42 OB	L5 Net	General Annuity - On death	
F42 OB	L6 Net	General Annuity - Lump sums on maturity	
F42 OB	L7 Net	General Annuity - Periodical payments	
F42 OB	L8 Net	General Annuity - On surrender	
F42 OB	L9 Net	General Annuity - Total claims (5 to 8)	#
F42 OB	L10 Net	Pension Business - On death	
F42 OB	L11 Net	Pension Business - Lump sums on maturity	
F42 OB	L12 Net	Pension Business - Periodical payments	
F42 OB	L13 Net	Pension Business - On surrender	
F42 OB	L14 Net	Pension Business - Total claims (10 to 13)	#
F42 OB	L15 Net	Permanent Health - Lump sums	
F42 OB	L16 Net	Permanent Health - Periodical payments	
F42 OB	L17 Net	Permanent Health - Total claims (15 + 16)	#
F42 OB	L18 Net	Capital Redemption - Lump sums	
F42 OB	L19 Net	Capital Redemption - Periodical payments	
F42 OB	L20 Net	Capital Redemption - Total claims (18 + 19)	
F42 OB	L21 Net	Total claims (4 + 9 +14 + 17 + 20)	
F42 OB	L22 Net	Total claims: UK contracts	
F42 OB	L23 Net	Total claims: Overseas contracts	

# Denotes that the line is used for measuring variables in the intermediation model.

Long Term business:

Summary of changes in ordinary long term business **Form 43**

F43 UK_LKD	L1 LA No.	In force at beginning of year	#
F43 UK_LKD	L2 LA No.	New business	*,#
F43 UK_LKD	L3 LA No.	Net transfers & other alterations 'on'	
F43 UK_LKD	L4 LA No.	Total 'on' (2 + 3)	
F43 UK_LKD	L5 LA No.	Deaths	
F43 UK_LKD	L6 LA No.	Maturities	
F43 UK_LKD	L7 LA No.	Surrenders	
F43 UK_LKD	L8 LA No.	Forfeitures	
F43 UK_LKD	L9 LA No.	Conversions to paid-up policies	
F43 UK_LKD	L10 LA No.	Net transfers etc 'off'	
F43 UK_LKD	L11 LA No.	Total 'off' (5 to 10)	*
F43 UK_LKD	L12 LA No.	In force at year end (1 + 4 - 11)	*

* Denotes that the line is used for measuring variables in the underwriting model.

# Denotes that the line is used for measuring variables in the intermediation model.

Valuation Result and Distribution of Surplus **Form 58**

F58 OB	L1	Valuation result: fund carried forward	
F58 OB	L2	Valuation result: bonus payments made to policyholders	
F58 OB	L3	Valuation result: net transfer to/from other income & expenditure	
F58 OB	L4	Valuation result: net transfer to/from other funds	
F58 OB	L5	Valuation result: net transfer out of fund (3+4)	
F58 OB	L6	Valuation result: Total (1+2+5)	
F58 OB	L7	Valuation result: mathematical reserves for non-linked contracts	
F58 OB	L8	Valuation result: mathematical reserves for linked contracts	
F58 OB	L9	Valuation result: Total (7+8)	
F58 OB	L10	Valuation result: surplus held towards solvency margin (6-9)	
F58 OB	L11	Composition of surplus: balance of surplus b/f from last valuation	
F58 OB	L12	Composition of surplus: net transfer from/to other income & expenditure	
F58 OB	L13	Composition of surplus: net transfer from/to other funds	
F58 OB	L14	Composition of surplus: net transfer into fund (12+13)	
F58 OB	L15	Composition of surplus: surplus arising since last valuation	
F58 OB	L16	Composition of surplus: Total (11+14+15)	
F58 OB	L17	Distribution of surplus: bonus payments made to policyholders	
F58 OB	L18	Distribution of surplus: allocated by way of cash bonuses	
F58 OB	L19	Distribution of surplus: allocated by way of reversionary bonuses	
F58 OB	L20	Distribution of surplus: allocated by way of other bonuses	
F58 OB	L21	Distribution of surplus: allocated by way of premium reductions	
F58 OB	L22	Distribution of surplus: total allocated to policyholders (17 to 21)	#
F58 OB	L23	Distribution of surplus: net transfer out of fund	
F58 OB	L24	Distribution of surplus: Total (22+23)	
F58 OB	L25	Distribution of surplus: balance of surplus c/f unappropriated	
F58 OB	L26	Distribution of surplus: Total (24+25)	
F58 OB	L27	Percentage of distributed surplus allocated to policyholders	

# Denotes that the line is used for measuring variables in the intermediation model.

APPENDIX B

The Price Elasticities of Substitution in the Underwriting Model

(Standard Errors in Parentheses)

	P_{am}	P_{ma}	P_{aa}	P_{mm}
1985-1995	0.2795*** (.009)	0.4706*** (.000)	-0.2795***(.009)	-0.7842***(.015)
1995	0.3920*** (.031)	0.5038*** (.000)	-0.3920***(.031)	-0.6210***(.040)
1994	0.3102*** (.027)	0.4481*** (.000)	-0.3102***(.027)	-0.7338***(.039)
1993	0.2809*** (.020)	0.4456*** (.000)	-0.2809***(.020)	-0.7811***(.031)
1992	0.2895*** (.019)	0.4570*** (.000)	-0.2895***(.019)	-0.7673***(.031)
1991	0.2693*** (.023)	0.4430*** (.000)	-0.2693***(.023)	-0.8008***(.037)
1990	0.2579*** (.024)	0.4423*** (.000)	-0.2579***(.024)	-0.8211***(.042)
1989	0.2458*** (.020)	0.4525*** (.000)	-0.2458***(.020)	-0.8435***(.038)
1988	0.2523*** (.032)	0.4809*** (.000)	-0.2523***(.032)	-0.8309***(.061)
1987	0.2643*** (.036)	0.5019*** (.000)	-0.2643***(.036)	-0.8083***(.068)
1986	0.1652*** (.017)	0.3053*** (.000)	-0.1652***(.017)	-0.9924***(.031)
1985	0.2439*** (.023)	0.4368*** (.000)	-0.2439***(.023)	-0.8466***(.040)

*** significant at the 1% level

Note : The subscriptions '*a*' and '*m*' denote the price of acquisition factor and the price of maintenance factor, respectively,

APPENDIX C

Parameter Estimates of the Underwriting Model

(Asymptotic Standard Errors in Parentheses)

Year	1995	1994	1993	1992
Parameter	Estimate	Estimate	Estimate	Estimate
α_0	4.7198 (3.309)	1.5399 (3.948)	.4083 (4.961)	-11.6750**(5.845)
α_l	.0718 (.096)	.0095 (.133)	.0137 (.028)	-.3245** (.185)
α_g	-.2527 (.178)	-.0923 (.136)	-.0038 (.072)	-.4975** (.166)
α_p	.2980** (.134)	.3275** (.177)	.0495 (.047)	.0219 (.151)
α_h	.0522 (.138)	-.0319 (.158)	.0091 (.096)	-.2002 (.185)
β_a	.4299*** (.150)	.3700*** (.141)	.5180*** (.138)	.4527*** (.143)
β_m	.5701*** (.150)	.6300*** (.141)	.4820*** (.138)	.5473*** (.143)
β_R	.1786 (.712)	.9042 (.871)	1.5038 (1.265)	4.8850*** (1.567)
δ_{ll}	.0404 (.025)	.0222 (.032)	-.0003 (.000)	.0058 (.012)
δ_{gg}	-.005 (.009)	.0059 (.006)	-.0003 (.000)	-.0111 (.007)
δ_{pp}	.0135 (.012)	.0021 (.011)	.0002 (.000)	.0037 (.006)
δ_{hh}	.0113 (.009)	.0053 (.008)	.0005 (.001)	.0059 (.007)
δ_{lg}	-.0043 (.003)	-.0023 (.003)	.0004 (.000)	-.0107* (.005)
δ_{lp}	-.0041 (.005)	-.0086 (.006)	-.0003 (.000)	-.0085 (.004)
δ_{lh}	-.0004 (.003)	-.0001 (.003)	.0000 (.000)	-.0155** (.006)
δ_{gp}	-.0004 (.004)	.0004 (.004)	.0001 (.001)	-.0038 (.004)
δ_{gh}	-.0009 (.003)	-.0025 (.003)	.0003 (.001)	-.0019 (.003)
δ_{ph}	-.0033 (.004)	-.0021 (.004)	-.0001 (.000)	-.0021 (.004)
γ_{aa}	.0257** (.018)	.0584*** (.016)	.0649*** (.012)	.0602*** (.012)
γ_{mm}	.0257** (.018)	.0584*** (.016)	.0649*** (.012)	.0602*** (.012)
γ_{RR}	.0487 (.074)	-.0383 (.108)	-.1176 (.168)	-.6276*** (.232)
γ_{am}	-.0257** (.018)	-.0584*** (.016)	-.0649*** (.012)	-.0602*** (.012)
γ_{Ar}	.0007 (.019)	-.0127 (.017)	-.0377** (.017)	-.0235 (.020)
γ_{mR}	-.0007 (.019)	.0127 (.017)	.0377** (.017)	.0235 (.020)
η_{la}	.0106*** (.004)	.0136*** (.006)	.0049* (.003)	.0110*** (.004)
η_{lm}	-.0106*** (.004)	-.0136*** (.006)	-.0049* (.003)	-.0110*** (.004)
η_{lR}	-.0132 (.015)	.0056 (.015)	.0039 (.004)	.0617*** (.026)
η_{ga}	.0032 (.005)	.0018 (.003)	-.0004 (.001)	.0002 (.003)
η_{gm}	-.0032 (.005)	-.0018 (.003)	.0004 (.001)	-.0002 (.003)
η_{gR}	.0286 (.022)	.0092 (.018)	-.0028 (.010)	.0778** (.024)
η_{pa}	-.0077** (.004)	.0001 (.003)	.0007 (.001)	.0040* (.002)
η_{pm}	.0077** (.004)	-.0001 (.003)	-.0007 (.001)	-.0040* (.002)
η_{pR}	-.0270 (.017)	-.0205 (.025)	-.0028 (.005)	.0148 (.020)
η_{ha}	.0001 (.004)	-.0003 (.003)	-.0013 (.001)	-.0012 (.003)
η_{hm}	-.0001 (.004)	.0003 (.003)	.0013 (.001)	.0012 (.003)
η_{hR}	-.0040 (.015)	.0048 (.017)	-.0019 (.011)	.0461* (.023)
λ	.0196 (.039)	.0479 (.070)	.2384*** (.056)	.0780* (.046)
The value of objective function	-208.226	-200.436	-231.758	-224.20
R^2 (RHTC)	.72	.65	.58	.58
S.E. of regression	1.06	1.21	1.34	1.35
Mean of dependent variable	9.75	9.77	9.71	9.63
Number of observation	148	149	163	157

Parameter Estimates of the Underwriting Model

(continued)

Year	1991	1990	1989	1988
Parameter	Estimate	Estimate	Estimate	Estimate
α_0	4.5927 (3.578)	2.5272 (3.606)	5.8707 (3.262)	6.1001 (4.712)
α_l	-.0996 (.178)	.0208 (.202)	-.1658 (.293)	.0208 (.219)
α_g	-.0302 (.137)	-.0452 (.135)	.0595 (.112)	.1683 (.153)
α_p	.3650*** (.144)	.3249** (.131)	.2921** (.170)	.1998 (.147)
α_h	-.0223 (.154)	.0322 (.137)	.0350 (.114)	.1052 (.171)
β_a	.4339*** (.124)	.4598*** (.122)	.4097*** (.109)	.4360*** (.113)
β_m	.5661*** (.124)	.5402*** (.122)	.5903*** (.109)	.5640*** (.113)
β_R	.3326 (.817)	.6082 (.848)	.0994 (.769)	-.1512 (1.085)
δ_{ll}	.0277** (.022)	.0359** (.021)	.0668*** (.030)	.0774*** (.023)
δ_{gg}	-.0054 (.007)	-.0072 (.008)	.0017 (.006)	.0141 (.011)
δ_{pp}	.0270** (.016)	.0345** (.020)	.0084 (.010)	-.0036 (.011)
δ_{hh}	.0120 (.012)	.0123 (.012)	.0036 (.009)	.0098 (.010)
δ_{lg}	-.0036 (.006)	-.0038 (.005)	-.0034 (.004)	-.0014 (.003)
δ_{lp}	-.0042 (.007)	-.0034 (.007)	-.0062 (.009)	-.0036 (.007)
δ_{lh}	-.0091 (.012)	-.0055 (.008)	-.0079 (.009)	-.0056 (.006)
δ_{gp}	-.0021 (.005)	.0019 (.003)	.0001 (.002)	-.0035 (.004)
δ_{gh}	-.0019 (.004)	-.0024 (.005)	-.0012 (.003)	-.0033 (.005)
δ_{ph}	.0012 (.004)	.0038 (.006)	.0021 (.004)	.0025 (.003)
γ_{aa}	.0676*** (.014)	.0697*** (.015)	.0688*** (.013)	.0602*** (.021)
γ_{mm}	.0676*** (.014)	.0697*** (.015)	.0688*** (.013)	.0602*** (.021)
γ_{RR}	.0241 (.095)	.0015 (.100)	.0249 (.098)	.0787 (.127)
γ_{am}	-.0676*** (.014)	-.0697*** (.015)	-.0688*** (.013)	-.0602*** (.021)
γ_{aR}	-.0186 (.019)	-.0170 (.015)	-.0118 (.014)	-.0014 (.012)
γ_{mR}	.0186 (.019)	.0170 (.015)	.0118 (.014)	.0014 (.012)
η_{la}	.0154*** (.009)	.0117** (.007)	.0138*** (.006)	.0081** (.004)
η_{lm}	-.0154*** (.009)	-.0117** (.007)	-.0138*** (.006)	-.0081** (.004)
η_{lR}	.0160 (.021)	.0001 (.022)	.0162 (.019)	-.0100 (.021)
η_{ga}	-.0005 (.003)	-.0029 (.003)	-.0021 (.003)	-.0016 (.003)
η_{gm}	.0005 (.003)	.0029 (.003)	.0021 (.003)	.0016 (.003)
η_{gR}	.0074 (.021)	.0043 (.019)	-.0044 (.014)	-.0169 (.018)
η_{pa}	.0036 (.003)	.0053* (.004)	.0060** (.004)	.0020 (.003)
η_{pm}	-.0036 (.003)	-.0053* (.004)	-.0060** (.004)	-.0020 (.003)
η_{pR}	-.0387** (.021)	-.0342 (.023)	-.0233 (.018)	-.0150 (.016)
η_{ha}	.0022 (.003)	.0020 (.003)	.0001 (.002)	-.0006 (.002)
η_{hm}	-.0022 (.003)	-.0020 (.003)	-.0001 (.002)	.0006 (.002)
η_{hR}	.0099 (.019)	-.0010 (.014)	.0030 (.013)	-.0066 (.019)
λ	.0010 (.009)	.0010 (.009)	.0010 (.008)	.0013 (.007)
The value of objective function	-229.210	-229.894	-211.595	-137.685
R^2 (RHTC)	.60	.60	.65	.62
S.E. of regression	1.29	1.31	1.16	1.23
Mean of dependent variable	9.58	9.47	9.42	9.15
Number of observation	172	175	172	178

Parameter Estimates of the Underwriting Model

(continued)

Year	1987	1986	1985
Parameter	Estimate	Estimate	Estimate
α_0	2.6533 (3.025)	6.6829** (2.711)	6.1646 (3.200)
α_l	.0165 (.010)	.0434 (.026)	.1752* (.098)
α_g	-.0080 (.033)	-.1158 (.085)	.0151 (.164)
α_p	.0199 (.010)	.0629 (.038)	.0734 (.065)
α_h	.1145* (.042)	.2688** (.082)	.1565 (.118)
β_a	.6419*** (.105)	.5515*** (.092)	.5958*** (.091)
β_m	.3581*** (.105)	.4485*** (.092)	.4042*** (.091)
β_R	.9964 (.836)	.0350 (.790)	-.2646 (.918)
δ_{ll}	-.0001 (.000)	.0003 (.001)	.0014 (.003)
δ_{gg}	.0000 (.000)	-.0005 (.001)	.0013 (.003)
δ_{pp}	.0000 (.000)	.0000 (.000)	.0005 (.002)
δ_{hh}	.0003 (.000)	.0021 (.002)	.0045 (.004)
δ_{lg}	.0000 (.000)	-.0001 (.000)	-.0001 (.001)
δ_{lp}	.0000 (.000)	-.0004 (.000)	-.0017 (.002)
δ_{lh}	.0001 (.000)	.0009 (.001)	.0010 (.001)
δ_{gp}	.0000 (.000)	.0001 (.001)	.0007 (.002)
δ_{gh}	-.0001 (.000)	.0000 (.000)	-.0004 (.001)
δ_{ph}	.0001 (.000)	.0006 (.001)	-.0005 (.002)
γ_{aa}	.0528*** (.024)	.1206*** (.011)	.0734*** (.014)
γ_{mm}	.0528*** (.024)	.1206*** (.011)	.0734*** (.014)
γ_{RR}	-.0599 (.117)	.0750 (.111)	.1295 (.134)
γ_{am}	-.0528*** (.023)	-.1206*** (.011)	-.0734*** (.014)
γ_{aR}	-.0241* (.014)	-.0462*** (.013)	-.0339** (.015)
γ_{mR}	.0241* (.014)	.0462*** (.013)	.0339** (.015)
η_{la}	.0007 (.000)	.0045** (.002)	.0039 (.002)
η_{lm}	-.0007 (.000)	-.0045** (.002)	-.0039 (.002)
η_{lR}	.0004 (.001)	-.0012 (.004)	-.0116 (.011)
η_{ga}	.0002 (.000)	.0005 (.001)	-.0032 (.002)
η_{gm}	-.0002 (.000)	-.0005 (.001)	.0032 (.002)
η_{gR}	.0008 (.004)	.0120 (.012)	-.0042 (.024)
η_{pa}	-.0002 (.000)	.0001 (.001)	.0048* (.003)
η_{pm}	.0002 (.000)	-.0001 (.001)	-.0048* (.003)
η_{pR}	-.0017 (.001)	-.0046 (.004)	-.0034 (.007)
η_{ha}	-.0003 (.000)	.0000 (.001)	.0004 (.002)
η_{hm}	.0003 (.000)	.0000 (.001)	-.0004 (.002)
η_{hR}	-.0147* (.006)	-.0353** (.011)	-.0196 (.017)
λ	.3968*** (.046)	.2396*** (.050)	.1768** (.061)
The value of objective function	-243.786	-153.888	-229.576
R^2 (RHTC)	.54	.67	.58
S.E. of regression	1.32	1.04	1.29
Mean of dependent variable	9.02	8.91	8.51
Number of observation	181	175	175

*** significant at the 1% level

** significant at the 5% level

* significant at the 10% level

Note : 'α_0' and 'λ' imply the constant term and the parameter of the RBCT, respectively; the subscriptions '*a*', '*m*' and '*R*' denote the price of acquisition factor, the price of maintenance factor and the required minimum margin of solvency, respectively; and the subscriptions '*l*', '*g*', '*p*' and '*h*' denote premium income of life assurance products, general annuities, pensions and permanent health products, respectively.

APPENDIX D

Degree of Scale Economies of Composite and Non-Composite in the Underwriting Model

(Standard Errors in Parentheses)

Year	1985-1995	1995	1994	1993	1992	1991
OSCE (com)	.6474***	.5630***	.5683***	.6994***	.4727***	.4705***
	(.023)	(.034)	(.025)	(.072)	(.050)	(.023)
(non-com)	.6322***	.5728***	.5676***	.6891***	.5325***	.5336***
	(.008)	(.017)	(.013)	(.025)	(.032)	(.010)
	[.024]	[.033]	[.029]	[.065]	[.059]	[.025]*
PSSCEl (com)	-.0003***	-.0002	-.0003	-.0002	-.0004	-.0006
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
(non-com)	-.1751**	-.0004*	-.0049	-.0051	-.5061	-.1895
	(.104)	(.000)	(.005)	(.005)	(.506)	(.189)
	[.104]*	[.000]	[.005]	[.005]	[.506]	[.189]
PSSCEg (com)	.3508	.3058	1.4213*	.0684	-2.1699	.1644
	(.340)	(.224)	(.746)	(.183)	(3.450)	(.129)
(non-com)	.3415	-1.6849	1.2157	.4455	.7343	1.2263
	(.222)	(1.986)	(1.195)	(.387)	(.638)	(.824)
	[.406]	[.1.999]	[1.409]	[.428]	[2.375]	[.834]
PSSCEp (com)	-1.3237*	-.0002	-.0001	-2.6686	-3.9322	-7.3961
	(.726)	(.000)	(.000)	(2.625)	(3.881)	(6.190)
(non-com)	-.3591	-.0007	-.0027	-.0001**	.0223	-.0004*
	(.266)	(.000)	(.027)	(.000)	(.023)	(.000)
	[.680]	[.000]	[.027]	[1.128]**	[1.716]**	[2.740]***
PSSCEh (com)	.0526*	.0190	.0367	.0854	.1155	.1474
	(.032)	(.021)	(.023)	(.059)	(.070)	(.210)
(non-com)	-.2817**	-.7660	-.2179	.3025	.6503	-.4028**
	(.137)	(.729)	(.218)	(.218)	(.540)	(.189)
	[.271]	[.729]	[.219]	[.226]	[1.046]	[.283]*

(continued)

Year	1990	1989	1988	1987	1986	1985
OSCE (com) (non-com)	.5870*** (.034) .6835*** (.013) [.037]	.6696*** (.037) .7049*** (.016) [.041]	.6799*** (.033) .6623*** (.022) [.039]	1.0999. (.183) .7704*** (.046) [.132]**	.7003*** (.079) .6073*** (.029) [.084]	.6007*** (.049) .6411*** (.020) [.054]
PSSCEl (com) (non-com)	-.0001 (.000) -.2201 (.163) [.163]	-.0002* (.000) -.0031 (.022) [.022]	-.0005 (.000) -.0025 (.002) [.002]	-.0001 (.000) -.0006 (.000) [.000]	-.0001 (.000) -.0001* (.000) [.000]	-.0002 (.000) -.9756 (.975) [.975]
PSSCEg (com) (non-com)	.2907 (.268) .9232 (.635) [.690]	.9179 (.916) 1.1883 (.849) [.1.249]	.9159 (.716) -.6502 (.610) [.941]	.0128 (.031) -.0671 (.091) [.096]	.2059 (.305) .1845 (.113) [.325]	1.3751 (1.198) .3374 (.245) [.797]
PSSCEp (com) (non-com)	-.0004 (.000) -.0005* (.000) [.000]	-.0003* (.000) -.0103 (.007) [.007]	-.3294 (.329) -2.7680 (2.693) [2.713]	-.0001 (.000) -.0800 (.069) [.069]	-.0005 (.000) -.3469 (.301) [.301]	-.0011 (.001) -.5633 (.389) [.389]
PSSCEh (com) (non-com)	-.0760* (.039) -.6520** (.313)* [.315]	-.0060** (.003) .2067 (.288) [.566]	.0020 (.021) .4746 (.413) [.784]	.3185 (.235) -.4549 (.281) [.367]**	-.0636 (.074) -.9386 (.702) [1.439]	-.0248 (.027) -1.7254** (.803) [1.650]

*** significant at the 1% level

** significant at the 5% level

* significant at the 10% level

Note1: Standard errors of each value are enclosed in parentheses, and those of the difference between two groups are enclosed in brackets.

Note2: The lowercases '*l*', '*g*', '*p*' and '*h*' denote life assurance products, general annuities, pensions and permanent health products, respectively.

APPENDIX E

Degree of Scale Economies of Bancassurance and Non- Bancassurance in the Underwriting Model

(Standard Errors in Parentheses)

Year	1985-1995	1995	1994	1993	1992	1991
OSCE (ban)	.6835***	.6437***	.6119***	.6498***	.7290**	.5774***
	(.019)	(.052)	(.038)	(.048)	(.098)	(.029)
(non-ban)	.6292***	.5611***	.5621***	.6972***	.4971***	.5170***
	(.008)	(.016)	(.012)	(.027)	(.028)	(.010)
	[.021]***	[.044]*	[.040]	[.055]	[.102]**	[.030]*
PSSCEl (ban)	-.7109	-.0002	.0000	.0000**	.0000	-.0001
	(.711)	(.000)	(.000)	(.000)	(.000)	(.000)
(non-ban)	-.0764*	-.0004*	-.0045	-.0049	-.4640	-.1725
	(.045)	(.000)	(.004)	(.005)	(.464)	(.172)
	[.277]**	[.000]	[.004]	[.005]	[.464]	[.172]
PSSCEg (ban)	1.2379	.0011	23.3110	3.8701	.0031	.0002
	(.929)	(.000)	(23.31)	(3.870)	(.003)	(.000)
(non-ban)	.2828	-1.1388	.5282*	.0660	-.0921	.9847
	(.189)	(1.458)	(.281)	(.060)	(1.108)	(.631)
	[.760]	[1.458]	[3.468]***	[.998]***	[1.108]	[.631]
PSSCEp (ban)	-.1000	-.0041	-.1476	-.0003	-.0003	-.0001
	(.081)	(.003)	(.146)	(.000)	(.000)	(.000)
(non-ban)	-.5650**	-.0001**	.0166	-.4960	-.7230	-1.3722
	(.280)	(.000)	(.017)	(.488)	(.735)	(1.157)
	[.292]	[.001]***	[.069]**	[.488]	[.735]	[1.157]
PSSCEh (ban)	.1578	-.1478	.0381	.0828**	2.7314	-.3767*
	(.220)	(.215)	(.045)	(.034)	(1.801)	(.186)
(non-ban)	-.2635**	-.6675	-.1853	.2889	.2109	-.2737
	(.121)	(.657)	(.190)	(.204)	(.403)	(.175)
	[.251]*	[.691]	[.195]	[.207]	[.1.245]**	[.256]

(continued)

Year	1990	1989	1988	1987	1986	1985
OSCE (ban)	.6904***	.7536***	.7480***	.6863**	.7266***	.7239***
	(.030)	(.039)	(.056)	(.117)	(.088)	(.079)
(non-ban)	.6227***	.6924***	.6570***	.8336***	.6118***	.6265***
	(.013)	(.016)	(.020)	(.052)	(.029)	(.019)
	[.041]*	[.042]	[.060]	[.128]	[.092]	[.081]
PSSCEl (ban)	.0000*	.0000**	.0000**	.0000	.0000*	-9.0771
	(.000)	(.000)	(.000)	(.000)	(.000)	(9.077)
(non-ban)	-.2004	-.0029	-.0024	-.0006	-.0001*	-.0003
	(.149)	(.002)	(.002)	(.000)	(.000)	(.000)
	[.149]	[.002]	[.002]	[.000]	[.000]*	[2.735]***
PSSCEg (ban)	.0035	.2385	-.0890	-.0523	.0029	.0107
	(.002)	(.237)	(.089)	(.041)	(.009)	(.011)
(non-ban)	.8153	1.1977	-.2516	-.0496	.2052*	.6231*
	(.508)	(.726)	(.530)	(.078)	(.119)	(.363)
	[.508]	[.764]	[.537]	[.088]	[.120]*	[.000]
PSSCEp (ban)	-.0026	-.0312	-.0301	.0000	-1.0637	.0000
	(.002)	(.026)	(.030)	(.000)	(1.064)	(.000)
(non-ban)	-.0003**	-.0058	-2.5879	-.0731	-.2209	-.5076
	(.000)	(.006)	(2.463)	(.063)	(.258)	(.351)
	[.001]***	[.018]	[2.463]	[.063]	[1.094]	[.351]
PSSCEh (ban)	-.6997*	-.1023	-.3143	-.0179	.4478	-.2992
	(.380)	(.110)	(.203)	(.177)	(.697)	(.284)
(non-ban)	-.5138*	-.2036	.4437	-.3421	-.9338	-1.5138**
	(.287)	(.263)	(.356)	(.262)	(.635)	(.720)
	[.476]	[.285]	[.410]*	[.316]	[.942]	[.774]

*** significant at the 1% level

** significant at the 5% level

* significant at the 10% level

Note1: Standard errors of each value are enclosed in parentheses, and those of the difference between two groups are enclosed in brackets.

Note2: The lowercases '*l*', '*g*', '*p*' and '*h*' denote life assurance products, general annuities, pensions and permanent health products, respectively.

APPENDIX F

Degree of Scope Economies of Composite and Non-Composite in the Underwriting Model

(Standard Errors in Parentheses)

Year	1985-1995	1995	1994	1993	1992	1991
PWCClg (com) (non-com)	-.0003** (.000) -.0003 (.000) [.000]	-.0004 (.000) .0000 (.000) [.000]	-.0004 (.000) -.0004 (.000) [.000]	.0001 (.000) -.0001 (.000) [.000]	-.0007 (.001) .0005 (.002) [.002]	-.0003 (.000) -.0002** (.000) [.000]
PWCClp (com) (non-com)	.0003* (.000) .0002** (.000) [.000]	.0000 (.000) .0000 (.000) [.000]	.0000 (.000) .0001 (.000) [.000]	.0004 (.000) .0001 (.000) [.000]	.0005 (.001) -.0001 (.000) [.000]*	.0024 (.002) .0001 (.000) [.001]***
PWCClh (com) (non-com)	.0000 (.000) -.0002 (.000) [.000]	.0000** (.000) .0005 (.000) [.000]	.0000 (.000) .0001 (.000) [.000]	.0000** (.000) -.0001*** (.000) [.000]	-.0002*** (.000) -.0029 (.002) [.002]	-.0002 (.000) -.0009 (.001) [.001]
PWCCgp (com) (non-com)	-.0059 (.006) -.0008** (.000) [.003]	-.0009 (.001) -.0001* (.000) [.001]	-.0007 (.001) .0000* (.000) [.000]	-.0001 (.000) .0000 (.000) [.000]	-.0008 (.001) -.0009 (.001) [.001]	-.0002* (.000) -.0002** (.000) [.000]
PWCCgh (com) (non-com)	-.0029** (.001) -.0050*** (.002) [.003]	-.0009* (.000) -.0024** (.001) [.001]	-.0086 (.006) .0060 (.005) [.007]	.0030 (.002) .0030** (.001) [.002]	-.0001 (.003) .0045 (.010) [.010]	-.0036* (.002) -.0129* (.006) [.007]
PWCCph (com) (non-com)	.0013 (.001) .0020 (.002) [.002]	.0000** (.000) .0000 (.000) [.000]	.0000** (.000) -.0001 (.000) [.000]	.0000 (.000) .0000*** (.000) [.000]	-.0004 (.000) -.0085 (.008) [.008]	.0119 (.012) .0003** (.000) [.006]**

(continued)

Year	1990	1989	1988	1987	1986	1985
PWCClg (com)	-.0006	-.0004	.0002	.0000***	-.0001	-.0003
	(.000)	(.000)	(.001)	(.000)	(.000)	(.000)
(non-com)	-.0014	-.0008	.0003	-.0001	-.0002**	-.0007
	(.001)	(.001)	(.000)	(.000)	(.000)	(.001)
	[.001]	[.001]	[.001]	[.000]	[.000]	[.001]
PWCClp (com)	.0000*	.0000*	.0001	.0000*	.0000	.0000
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
(non-com)	.0001	.0007	.0006	.0001*	.0001	.0001*
	(.000)	(.001)	(.000)	(.000)	(.000)	(.000)
	[.000]	[.001]	[.000]	[.000]	[.000]	[.000]
PWCClh (com)	.0000**	.0000	.0000**	.0001	.0002	.0001
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
(non-com)	.0000	-.0003	-.0008	.0005***	.0014***	.0013**
	(.000)	(.000)	(.001)	(.000)	(.001)	(.001)
	[.000]	[.000]	[.001]	[.000]	[.001]	[.001]
PWCCgp (com)	-.0007	.0000	-.0549	.0000	.0000	.0003
	(.000)	(.000)	(.055)	(.000)	(.000)	(.000)
(non-com)	-.0046	-.0004	-.0015*	-.0006	.0002	.0000
	(.004)	(.000)	(.001)	(.001)	(.000)	(.000)
	[.004]	[.000]	[.034]	[.001]	[.000]	[.000]**
PWCCgh (com)	-.0030**	-.0006**	-.0114	-.0030	-.0002	-.0020
	(.001)	(.000)	(.010)	(.002)	(.000)	(.001)
(non-com)	-.0110*	-.0038	-.0157	.0017	-.0059**	-.0049*
	(.005)	(.004)	(.011)	(.001)	(.002)	(.003)
	[.006]	[.004]	[.015]	[.002]*	[.005]	[.003]
PWCCph (com)	.0002**	.0000*	.0001*	.0004**	.0003*	.0000
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
(non-com)	.0009**	.0017	.0148	.0015**	.0055*	.0116
	(.000)	(.001)	(.011)	(.001)	(.003)	(.011)
	[.001]	[.001]	[.011]	[.001]*	[.003]*	[.011]

*** significant at the 1% level

** significant at the 5% level

* significant at the 10% level

Note1: Standard errors of each value are enclosed in parentheses, and those of the difference between two groups are enclosed in brackets.

Note2: The lowercases '*l*', '*g*', '*p*' and '*h*' denote life assurance products, general annuities, pensions and permanent health products, respectively.

APPENDIX G

Degree of Scope Economies of Bancassurance and Non- Bancassurance in the Underwriting Model

(Standard Errors in Parentheses)

Year	1985-1995	1995	1994	1993	1992	1991
PWCClg (ban) (non-ban)	.0000 (.000) -.0003* (.000) [.000]*	.0000 (.000) -.0001 (.000) [.000]	.0000 (.000) -.0005 (.000) [.002]	.0000 (.000) .0000 (.000) [.000]	.0000 (.000) .0002 (.001) [.012]	.0000** (.000) -.0003 (.000) [.000]
PWCClp (ban) (non-ban)	.0001* (.000) .0002*** (.000) [.000]	.0000 (.000) .0000 (.000) [.000]	.0003 (.000) .0000 (.000)** [.000]	.0000 (.000) .0001 (.000) [.000]	.0000 (.000) .0000 (.000) [.000]	.0000 (.000) .0006 (.000) [.000]
PWCClh (ban) (non-ban)	.0003 (.000) -.0002 (.000) [.000]	.0022 (.002) .0002 (.000) [.001]**	.0000 (.000) .0001 (.000) [.000]	-.0001** (.000) -.0001*** (.000) [.000]	-.0008 (.000) -.0025 (.002) [.002]	.0002 (.000) -.0009 (.001) [.001]
PWCCgp (ban) (non-ban)	.0000 (.000) -.0023 (.002) [.002]	-.0004 (.000) -.0004 (.000) [.001]	.0001 (.000) -.0002 (.000) [.000]	-.0002 (.000) .0000 (.000) [.000]	.0000* (.000) -.0009 (.001) [.001]	.0000** (.000) -.0002 (.000) [.000]
PWCCgh (ban) (non-ban)	-.0006** (.000) -.0048*** (.001) [.005]	-.0020 (.002) -.0020** (.001) [.002]	-.0018 (.000) -.0070* (.004) [.024]	.0013** (.000) .0032** (.000) [.001]	-.0010 (.000) .0033 (.007) [.051]	-.0005** (.000) -.0110 (.005) [.005]
PWCCph (ban) (non-ban)	.0078 (.006) .0011 (.001) [.004]*	.0000 (.000) .0000 (.000) [.000]	.0000 (.000) -.0001 (.000) [.000]	.0000** (.001) .0000*** (.000) [.000]	-.0006 (.000) -.0079 (.007) [.007]	.0006 (.001) .0028 (.003) [.003]

(continued)

Year	1990	1989	1988	1987	1986	1985
PWCClg (ban) (non-ban)	.0000 (.000) -.0012 (.001) [.001]	.0000 (.000) -.0007 (.000) [.000]	.0000 (.000) .0003 (.000) [.000]	.0000* (.000) .0000 (.000) [.000]	.0000* (.000) -.0002 (.000) [.000]	.0000 (.000) -.0007 (.000) [.000]
PWCClp (ban) (non-ban)	.0000** (.000) .0001 (.000) [.000]	.0001 (.000) .0006 (.001) [.001]	.0001 (.000) .0005 (.000) [.000]	.0000 (.000) .0001* (.000) [.000]**	.0005*** (.001) .0000 (.000) [.000]	.0001 (.000) .0001 (.000) [.000]
PWCClh (ban) (non-ban)	.0002 (.000) .0000 (.000) [.000]	.0000 (.000) -.0003 (.000) [.000]	.0010 (.001) -.0008 (.001) [.003]	.0002 (.000) .0005*** (.000) [.000]	.0002** (.000) .0013 (.000) [.001]	.0003* (.000) .0012 (.000) [.000]
PWCCgp (ban) (non-ban)	.0000 (.000) -.0038 (.003) [.003]	.0000 (.000) -.0003 (.000) [.000]	.0000 (.000) -.0175 (.016) [.016]	.0000 (.000) -.0005 (.000) [.000]	.0000 (.000) .0002 (.000) [.000]	.0000 (.000) .0001 (.000) [.000]
PWCCgh (ban) (non-ban)	-.0024 (.001) -.0099** (.005) [.005]	-.0003 (.000) -.0033 (.003) [.003]	-.0002 (.000) -.0159 (.010) [.010]	.0000 (.001) .0006 (.001) [.002]	-.0011* (.001) -.0051 (.002) [.002]	-.0003* (.000) -.0046 (.002) [.002]
PWCCph (ban) (non-ban)	.0024 (.002) .0005** (.000)** [.001]	.0092 (.009) .0003** (.000) [.003]*	.0798 (.080) .0034 (.003) [.027]***	.0004* (.000) .0014** (.001) [.001]*	.0014 (.001) .0050 (.033) [.033]	.0000 (.000) .0101 (.010) [.010]

*** significant at the 1% level

** significant at the 5% level

* significant at the 10% level

Note1: Standard errors of each value are enclosed in parentheses, and those of the difference between two groups are enclosed in brackets.

Note2: The lowercases '*l*', '*g*', '*p*' and '*h*' denote life assurance products, general annuities, pensions and permanent health products, respectively.

APPENDIX H

The First and Second Partial Derivatives of Cost with respect to Each Own Price in the Intermediation Model

(Standard Errors in Parentheses)

Year	1991-1995	1995	1994	1993	1992	1991
C_l	.0885*** (.026)	.0488* (.026)	.1103*** (.045)	.0700* (.041)	.0735 (.059)	.1736 (.132)
C_g	.0491* (.029)	.1059 (.100)	.0954 (.060)	.0717 (.052)	.0320 (.057)	.0220 (.034)
C_p	.0002* (.000)	.0001 (.000)	.0003* (.000)	.00002 (.000)	.0004 (.000)	.0722*** (.030)
C_h	.0667*** (.015)	.1122* (.057)	.0489 (.035)	.0810*** (.028)	.0537*** (.021)	.0093 (.007)
C_{lg}	.0056*** (.002)	-.0018 (.002)	-.0003 (.003)	.0033 (.002)	.0010*** (.003)	.0032 (.009)
C_{lp}	-.00002*** (.000)	-.000006 (.000)	-.000008 (.000)	-.00002** (.000)	-.00003** (.000)	-.0191*** (.006)
C_{lh}	.0011** (.001)	.0020 (.001)	.0026 (.002)	.0007 (.001)	.0010 (.001)	-.0081** (.004)
C_{gp}	.00001 (.000)	.000005 (.000)	.000005 (.000)	.000006 (.000)	.00002 (.000)	.0012 (.002)
C_{gh}	-.0011 (.001)	.0095* (.005)	.0075*** (.003)	.0011 (.001)	-.0031*** (.001)	-.0005 (.001)
C_{ph}	.00001*** (.000)	.00001 (.000)	.000007 (.000)	.00001** (.000)	.00002** (.000)	.0030** (.001)
C_{ll}	-.0216*** (.006)	-.0072** (.004)	-.0230*** (.009)	-.0147* (.009)	-.0202 (.013)	-.0194 (.095)
C_{gg}	-24638.2* (13735)	-86989 (60809.4)	-63391** (29635.5)	-36091 (22983.2)	-10884 (21369.0)	-7831 (12833.0)
C_{pp}	-.0000004*** (.000)	-.0000001 (.000)	-.0000003* (.000)	-.0000001 (.000)	-0000007* (.000)	-.0122*** (.005)
C_{hh}	-.0088*** (.002)	-.0272** (.013)	-.0093 (.006)	-.0117*** (.004)	-.0053*** (.002)	-.0008 (.001)

(continued)

Year	1990	1989	1988	1987	1986
C_l	.4301*** (.078)	.3012*** (.062)	.0220*** (.007)	.4033*** (.090)	.4372*** (.118)
C_g	.0279 (.018)	.0315*** (.013)	.0956 (.080)	.0225 (.014)	.1512** (.054)
C_p	.0420** (.019)	.0308 (.024)	.00001 (.000)	.0257 (.017)	.0139 (.017)
C_h	.0139 (.013)	.0497*** (.018)	.0159* (.008)	.0050 (.020)	.0025 (.020)
C_{lg}	.0054 (.006)	.0001 (.003)	.0001 (.000)	-.0006 (.003)	.0079 (.016)
C_{lp}	-.0084** (.004)	-.0055** (.003)	-.000005*** (.000)	-.0127*** (.004)	-.0178*** (.004)
C_{lh}	.0148 (.010)	.0100* (.005)	.0001** (.000)	.0050 (.006)	.0064 (.013)
C_{gp}	.0010 (.002)	-.0022 (.001)	.00002 (.000)	.00004 (.001)	.0013 (.002)
C_{gh}	-.0031 (.004)	.0054*** (.002)	-.0002 (.000)	.0003 (.001)	.0046 (.005)
C_{ph}	.0052* (.003)	.0052** (.002)	.000004** (.000)	.0014 (.001)	.0020 (.001)
C_{ll}	-.2019*** (.048)	-.1187*** (.028)	-.0008*** (.000)	-.2048*** (.061)	-.2792*** (.109)
C_{gg}	-6971 (7691.4)	-7992*** (2935.4)	-25253 (.22437.0)	-2443 (1977.6)	-52647*** (20506.3)
C_{pp}	-.0084** (.004)	-.0068 (.005)	-.0000002 (.000)	-.0029 (.003)	-.0013 (.003)
C_{hh}	-.0031 (.003)	-.0125*** (.004)	-.0005** (.000)	-.0007 (.003)	-.0006 (.005)

*** significant at the 1% level

** significant at the 5% level

* significant at the 10% level

Note : The subscriptions '*l*', '*g*', '*p*' and '*h*' denote the input price of each insurance line: life assurance, general annuities, pensions and permanent health business, respectively.

APPENDIX I
The Price Elasticities of Substitution in the Intermediation Model

(Standard Errors in Parentheses)

Year	1991-1995	1995	1994	1993	1992	1991
P_{lg}	.4159*** (.144)	.2325 (.312)	.3980* (.212)	.4297* (.240)	.6368 (.564)	.1409 (.138)
P_{lp}	-.0714 (.111)	-.0217 (.278)	.2863 (.226)	-.2007 (.238)	-.1699 (.425)	-.2466 (.604)
P_{lh}	.5668*** (.148)	.5886** (.295)	.3418* (.195)	.6043** (.255)	.6272* (.342)	-.3919 (.554)
P_{gl}	.8812** (.415)	.2095 (.212)	.5100* (.269)	.5611 (.346)	1.6189 (2.399)	.5304 (1.065)
P_{gp}	.2786*** (.095)	.1832 (.217)	.4167** (.208)	.0808 (.157)	.6790 (.494)	.8341 (.632)
P_{gh}	.3150 (.205)	.7764 (.616)	.6032 (.375)	.6439*** (.238)	-.4051 (1.528)	-.1630 (.926)
P_{pl}	-.2049 (.346)	-.0559 (.784)	.4124 (.264)	-4.3338 (36.085)	-.2331 (.458)	-.1509 (.245)
P_{pg}	.3776 (.277)	.5230 (1.064)	.4684 (.412)	1.3356 (8.062)	.3665 (.437)	.1356 (.153)
P_{ph}	1.0472*** (.381)	.8998 (.999)	.3303 (.250)	5.8240 (41.199)	.9124** (.433)	.5363*** (.180)
P_{hl}	.4610*** (.117)	.4410** (.208)	.7710** (.365)	.3815* (.204)	.3855 (.255)	-1.1585 (1.469)
P_{hg}	.1209 (.132)	.6453 (.404)	1.0617 (.719)	.3113 (.216)	-.0979 (.201)	-.1280 (.630)
P_{hp}	.2966*** (.074)	.2620 (.200)	.5171** (.240)	.1702 (.117)	.4087*** (.164)	2.5906** (1.145)
P_{ll}	-.6780*** (.147)	-.6558*** (.209)	-.4651** (.236)	-.6802*** (.222)	-.8496** (.427)	.1037 (.560)
P_{gg}	-.8960*** (.166)	-.8789 (.662)	-.8765* (.484)	-.9342*** (.306)	-.7639*** (.241)	-.8893*** (.282)
P_{pp}	-1.2855*** (.326)	-1.3325 (1.157)	-.6743** (.306)	-5.099 (32.297)	-1.0428*** (.385)	-.6375*** (.225)
P_{hh}	-.4650*** (.119)	-.4995** (.253)	-.6752*** (.187)	-.4213** (.204)	-.4294** (.213)	-.8186*** (.113)

(continued)

Year	1990	1989	1988	1987	1986
P_{lg}	.1547** (.070)	.1718** (.075)	.3025 (.259)	.1552 (.102)	.3650*** (.145)
P_{lp}	.1357 (.096)	.0637 (.105)	-.1252 (.140)	-.0420 (.135)	-.1795* (.108)
P_{lh}	.1901* (.099)	.2994*** (.108)	.5792** (.283)	.1139 (.198)	.0608 (.151)
P_{gl}	1.2449* (.725)	.7563** (.325)	.6811*** (.218)	.6508** (.286)	.6447*** (.215)
P_{gp}	.4792 (.411)	-.1923 (.301)	.1349 (.138)	.1962 (.217)	.1492 (.127)
P_{gh}	-.3864 (.765)	.8030*** (.261)	.3948 (.249)	.1258 (.317)	.1167 (.134)
P_{pl}	.4588** (.207)	.3047 (.312)	-12.0671 (266.1)	-.1589 (.594)	-1.1042 (1.897)
P_{pg}	.2013 (.188)	-.2089 (.412)	5.7749 (114.7)	.1770 (.216)	.5196 (.493)
P_{ph}	.5394** (.235)	.7895* (.436)	11.1575 (219.2)	.3872 (.352)	.5286 (.458)
P_{hl}	2.9785 (2.453)	1.2429*** (.360)	.8468*** (.248)	2.4174 (5.904)	3.9893 (.25.719)
P_{hg}	-.7524 (1.548)	.7570*** (.247)	.2564 (.256)	.6366 (1.611)	4.3312 (32.354)
P_{hp}	2.5000 (1.765)	.6849* (.359)	.1692 (.157)	2.1722 (7.329)	5.6346 (43.777)
P_{ll}	-.0785 (.128)	-.2298 (.148)	-.3997* (.226)	-.1798 (.115)	-.2653*** (.099)
P_{gg}	-.6369** (.331)	-1.2226*** (.207)	-.6754*** (.200)	-.8413*** (.230)	-.7490*** (.107)
P_{pp}	-.9495*** (.221)	-.9638*** (.228)	-9.6953 (.180.0)	-.6332*** (.159)	-.5209 (.473)
P_{hh}	-.8101*** (.067)	-.7299*** (.100)	-.5090** (.229)	-.8983*** (.163)	-.9113*** (.084)

*** significant at the 1% level

** significant at the 5% level

* significant at the 10% level

Note : The subscriptions '*l*', '*g*', '*p*' and '*h*' denote the input price of each insurance line: life assurance, general annuities, pensions and permanent health business, respectively.

APPENDIX J

Parameter Estimates of the Intermediation Model

(Asymptotic Standard Errors in Parentheses)

Year	1995	1994	1993	1992
Parameter	Estimate	Estimate	Estimate	Estimate
α_0	6.6619*** (.813)	6.1415*** (.490)	7.4610*** (.980)	7.1216***(1.123)
α_I	.5211*** (.114)	.4904*** (.077)	.2714** (.164)	.3224*** (.154)
α_s	.0366 (.068)	.0573 (.055)	.1928*** (.082)	.1130** (.076)
β_l	-.1997 (.196)	.0796 (.182)	.0425 (.209)	.0789 (.198)
β_g	.3504 (.357)	.3326 (.250)	-.0924 (.348)	.3890 (.316)
β_p	.4472*** (.247)	.4101*** (.129)	.7243*** (.149)	.4807*** (.120)
β_h	.4021** (.217)	.1777 (.113)	.3256* (.204)	.0514 (.234)
δ_{II}	-.0017 (.015)	.0010 (.009)	.0407** (.028)	.0135 (.021)
δ_{ss}	.0140 (.010)	.0140** (.007)	.0098 (.012)	.0194** (.008)
δ_{sI}	-.0140** (.010)	-.0157** (.008)	-.0275*** (.009)	-.0185*** (.008)
γ_{ll}	-.0113 (.023)	-.0341 (.026)	-.0192 (.026)	-.0622*** (.021)
γ_{gg}	-.0995*** (.037)	-.1273*** (.030)	-.0578*** (.022)	.0040 (.026)
γ_{pp}	-.0294*** (.009)	-.0140** (.006)	-.0402*** (.007)	-.0337*** (.007)
γ_{hh}	.1911*** (.070)	.1887*** (.048)	.1065*** (.040)	-.0048 (.057)
γ_{lg}	-.0175 (.024)	-.0021 (.025)	.0264 (.017)	.0691*** (.020)
γ_{lp}	-.0146* (.008)	-.0104 (.008)	-.0274*** (.009)	-.0382*** (.011)
γ_{lh}	.0434** (.027)	.0465** (.030)	.0202 (.025)	.0313 (.031)
γ_{gp}	.0066 (.026)	.0058 (.015)	.0064 (.013)	.0174 (.014)
γ_{gh}	.1104*** (.051)	.1236*** (.037)	.0250 (.022)	-.0905*** (.030)
γ_{ph}	.0373* (.024)	.0186 (.016)	.0613*** (.019)	.0545** (.020)
η_{ll}	.0281** (.015)	.0133 (.011)	.0298** (.015)	.0424*** (.017)
η_{lg}	-.0138 (.029)	-.0071 (.018)	.0158 (.029)	-.0202 (.027)
η_{lp}	-.0106 (.017)	-.0145** (.008)	-.0336*** (.013)	-.0100 (.009)
η_{lh}	-.0037 (.016)	.0084 (.008)	-.0120 (.017)	-.0123 (.019)
η_{sl}	.0181* (.011)	.0181** (.009)	.0150 (.009)	-.0046 (.007)
η_{sg}	.0095 (.012)	.0036 (.008)	-.0027 (.008)	-.0135 (.010)
η_{sp}	.0036 (.010)	.0108 (.007)	.0015 (.006)	.0025 (.007)
η_{sh}	-.0313** (.013)	-.0326*** (.011)	-.0138 (.009)	.0156** (.010)
λ	.0558** (.041)	.0782** (.037)	.0359** (.023)	.0615*** (.029)
The value of objective function	-157.444	-172.971	-192.444	-216.842
R^2	.93	.93	.90	.88
S.E. of regression	.79	.81	.90	.97
Mean of dependent variable	12.63	12.57	12.39	12.32
Number of Observation	143	153	156	165

Parameter Estimates of the Intermediation Model
(continued)

Year	1991	1990	1989	1988
Parameter	Estimate	Estimate	Estimate	Estimate
α_0	7.2236*** (1.129)	6.4586*** (.446)	6.1418*** (.681)	6.0164*** (.677)
α_I	.3281*** (.118)	.3369*** (.057)	.4325*** (.072)	.4069*** (.111)
α_s	-.0686 (.068)	.0143 (.034)	.0683* (.053)	.0543 (.059)
β_I	-.9129*** (.272)	-.2089 (.179)	-.2129 (.244)	.2047 (.165)
β_g	.7241*** (.281)	.3639** (.180)	.3710** (.245)	.6781*** (.199)
β_p	1.0517*** (.191)	.9002*** (.151)	.6259*** (.167)	.4771*** (.103)
β_h	.1371 (.198)	-.0551 (.154)	.2159 (.174)	-.3600** (.206)
δ_{II}	.0075 (.019)	.0010 (.005)	.0075 (.015)	.0235 (.017)
δ_{ss}	.0119* (.008)	.0068* (.003)	.0171*** (.007)	.0162** (.010)
δ_{sI}	-.0053 (.005)	-.0058* (.003)	-.0167*** (.008)	-.0189*** (.006)
γ_{II}	.2030*** (.071)	-.0762 (.070)	-.0508 (.052)	-.0430*** (.019)
γ_{gg}	-.0042 (.022)	.0101 (.027)	-.0648*** (.025)	-.0069 (.027)
γ_{pp}	-.0723*** (.033)	-.0581*** (.029)	-.0259 (.028)	-.0308*** (.007)
γ_{hh}	.0173 (.085)	.1530*** (.089)	.2471*** (.059)	.0982*** (.042)
γ_{Ig}	.0086 (.023)	.0177 (.021)	.0008 (.015)	.0045 (.013)
γ_{Ip}	-.0918*** (.023)	-.0410*** (.017)	-.0297*** (.014)	-.0260*** (.008)
γ_{Ih}	-.1198*** (.054)	.0994** (.064)	.0798*** (.041)	.0645*** (.024)
γ_{gp}	.0112 (.015)	.0088 (.016)	-.0238** (.015)	.0128 (.014)
γ_{gh}	-.0157 (.032)	-.0366* (.043)	.0878*** (.033)	-.0104 (.023)
γ_{ph}	.1528*** (.015)	.0902*** (.047)	.0795*** (.034)	.0440*** (.021)
η_{II}	.0791*** (.030)	.0429*** (.014)	.0454*** (.020)	.0244* (.013)
η_{Ig}	-.0398** (.025)	-.0232* (.011)	-.0121 (.020)	-.0610*** (.017)
η_{Ip}	-.0418*** (.015)	-.0271*** (.010)	-.0329*** (.012)	-.0151* (.008)
η_{Ih}	.0025 (.013)	.0075 (.010)	-.0004 (.013)	.0516*** (.015)
η_{sI}	.0181** (.010)	.0048 (.008)	.0122* (.008)	.0214*** (.008)
η_{sg}	.0036 (.009)	.0111** (.005)	.0040 (.007)	.0216*** (.006)
η_{sp}	-.0029 (.007)	-.0029 (.006)	.0096 (.006)	-.0014 (.007)
η_{sh}	-.0188** (.012)	-.0130** (.012)	-.0258*** (.009)	-.0416*** (.009)
λ	.0766*** (.044)	.1108*** (.031)	.0723*** (.039)	.0500** (.020)
The value of objective function	-181.938	-162.501	-166.949	-191.445
R^2	.91	.93	.93	.90
S.E. of regression	.82	.71	.72	.84
Mean of dependent variable	12.28	12.28	11.92	11.82
Number of Observation	158	162	164	163

Parameter Estimates of the Intermediation Model

(continued)

Year	1987	1986
Parameter	Estimate	Estimate
α_0	7.1635*** (.954)	7.3636*** (.790)
α_I	.2974*** (.144)	.2563*** (.116)
α_s	.0083 (.062)	.0087 (.049)
β_l	-.5240*** (.179)	-.6428*** (.189)
β_g	.1214 (.284)	.7856*** (.293)
β_p	1.1921*** (.138)	.7673*** (.112)
β_h	.2105 (.249)	.0898 (.241)
δ_{II}	.0236 (.030)	.0263 (.021)
δ_{ss}	.0016 (.008)	.0087 (.006)
δ_{sI}	-.0077** (.005)	-.0110*** (.004)
γ_{ll}	.0227 (.052)	.0319 (.060)
γ_{gg}	-.0099 (.039)	-.0515 (.035)
γ_{pp}	.0169 (.023)	.0234 (.020)
γ_{hh}	.1157*** (.075)	.1019** (.074)
γ_{lg}	-.0033 (.015)	.0113 (.023)
γ_{lp}	-.0702*** (.017)	-.0721*** (.016)
γ_{lh}	.0508* (.055)	.0289 (.060)
γ_{gp}	.0008 (.013)	.0079 (.012)
γ_{gh}	.0124 (.035)	.0323 (.035)
γ_{ph}	.0525** (.033)	.0408 (.027)
η_{Il}	.0854*** (.020)	.0976*** (.019)
η_{Ig}	-.0114 (.024)	-.0556*** (.025)
η_{Ip}	-.0804*** (.014)	-.0545*** (.009)
η_{Ih}	.0064 (.021)	.0125 (.016)
η_{sl}	.0079 (.011)	-.0034 (.008)
η_{sg}	.0137** (.007)	.0242*** (.006)
η_{sp}	.0093 (.007)	.0062 (.007)
η_{sh}	-.0309*** (.013)	-.0270*** (.007)
λ	.0603*** (.040)	.0635*** (.027)
The value of objective function	-181.954	-152.80
R^2	.91	.93
S.E. of regression	.79	.70
Mean of dependent variable	11.86	11.67
Number of Observation	164	152

*** significant at the 1% level

** significant at the 5% level

* significant at the 10% level

Note : 'α_0' and 'λ' imply the constant term and the parameter of the RBCT, respectively; the subscriptions '*l*', '*g*', '*p*' and '*h*', denote the input price of each insurance line: life assurance, general annuities, pensions and permanent health business, respectively; and the subscriptions '*I*' and '*s*' denote investment income and policyholder's surpluses, respectively.

APPENDIX K

Degree of Scale Economies of Composite and Non-Composite in the Intermediation Model

(Standard Errors in Parentheses)

Year	1986-1995	1995	1994	1993	1992	1991
SE_S (com)	-.0006	-.0043	-.0008	-.0028	-.0044	.0000
	(.001)	(.004)	(.001)	(.003)	(.004)	(.000)
(non-com)	.1248**	-.0634	.0356	-.2746	.4267*	.2664*
	(.050)	(.083)	(.061)	(.210)	(.229)	(.151)
	[.089]	[.083]	[.061]	[.373]	[.407]	[.263]
Year	1990	1989	1988	1987	1986	
SE_S (com)	-.0001	-.0016	-.0003	.0002	.0092	
	(.000)	(.001)	(.000)	(.000)	(.009)	
(non-com)	.0890*	.1596	.2710	.0422	.2211	
	(.045)	(.112)	(.201)	(.125)	(.191)	
	[.079]	[.203]	[.201]	[.125]	[.191]	

** significant at the 5% level

* significant at the 10% level

Note 1: Standard errors of each value are enclosed in parentheses and those of the difference between two groups are enclosed in brackets.

Note 2: The subscription '*s*' denotes policyholders' surplus.

APPENDIX L

Degree of Scale Economies of Bancassurance and Non-Bancassurance in the Intermediation Model

(Standard Errors in Parentheses)

Year	1986-1995	1995	1994	1993	1992	1991
SE_S (ban)	.3035***	.0138	.6570***	.6825	.6089	.1888
	(.091)	(.614)	(.604)	(.676)	(.579)	(.180)
(non-ban)	.0748*	-.0699	-.0201	-.2512	.2999	.2011
	(.041)	(.054)	(.015)	(.163)	(.184)	(.126)
	[.100]**	[.298]**	[.153]***	[.695]	[.608]	[.219]
Year	1990	1989	1988	1987	1986	
SE_S (ban)	.2301	.1209	.0520	.4270	.1239	
	(.155)	(.089)	(.044)	(.344)	(.102)	
(non-ban)	.0463	.1216	.2332	.0151	-.1786	
	(.033)	(.096)	(.177)	(.104)	(.163)	
	[.107]*	[.131]	[.183]	[.359]	[.192]	

*** significant at the 1% level

** significant at the 5% level

* significant at the 10% level

Note 1: Standard errors of each value are enclosed in parentheses, and those of the difference between two groups are enclosed in brackets.

Note 2: The subscription '*s*' denotes policyholders' surplus.

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