Thünen-Series of Applied Economic Theory

Thünen-Reihe Angewandter Volkswirtschaftstheorie

Working Paper No. 81

Single- versus Multi-Channel Distribution Strategies in the German Life Insurance Market: A Cost and Profit Efficiency Analysis

by

Lucinda Trigo Gamarra

Universität Rostock

Wirtschafts- und Sozialwissenschaftliche Fakultät

Institut für Volkswirtschaftslehre

2007

Single- versus Multi-Channel Distribution Strategies in the German Life Insurance Market: A Cost and Profit Efficiency Analysis

Lucinda Trigo Gamarra*

Abstract

Until its liberalisation in 1994 exclusive agents dominated the distribution of products in the German life insurance industry. Since then, their importance has been declining for the benefit of both distribution via direct distribution channel and independent agents. However, the market shares of specialized direct and independent agent insurers have remained small, while multi-channel insurers increasingly incorporate direct and independent distribution channels, and represent the dominant distribution strategy.

The aim of this paper is twofold: First, it analyses the performance of single and multi-channel distribution firms in the German life insurance. Thus, we are able to explain the development and the coexistence of the industries' distribution systems. Our study contributes to research on coexistence of different distribution systems in insurance industry which had been limited to the comparison of exclusive versus independent agent insurers so far. Second, our paper gives insight into cost and profit efficiency levels of German life insurance firms for the period 1997-2005, and delivers information about scale economies in the German life insurance industry.

Applying an empirical framework developed by Berger et al. (1997) we estimate cost and profit efficiency for three groups of life insurance firms differing in their distribution systems: multichannel insurers, direct insurers, and independent agent insurers. Non-parametric DEA is used to estimate efficiencies for a sample of German life insurers for the years 1997-2005. Testing a set of hypothesis, we find economic evidence for the coexistence of the different distribution systems which is the absence of comparative performance advantages of specialised insurers. Further, we find evidence for scale economies in the German life insurance industry.

Keywords: insurance markets, distribution systems, efficiency analysis

JEL-Classification: G 22, L 15, L 22

---

* Lucinda Trigo Gamarra, University of Rostock, Institute of Economics, Ulmenstraße 69, 18057 Rostock, Germany, Tel.: ++49-381-498-4349, E-mail: lucinda.trigo-gamarra@uni-rostock.de

Thanks are due to Christian Growitsch, Doris Neuberger, and the participants of the X European Workshop on Efficiency and Producitivity Analysis for helpful comments and suggestions.

1 Introduction

Following the liberalisation of the European insurance markets in 1994, German insurance markets have been deregulated. Insurance companies have been allowed to freely choose their prices (premium levels), which has led to an increasing price competition in the German insurance sector. Insurers are further no longer obliged to authorize the design of their products by the regulatory agency which has led to a greater variety of products in the market. Both effects are intensified by the introduction of the European Single Market enabling European insurance firms to operate throughout the EU under a single license. Further, new insurance products have been created in the life insurance industry due to the promotion of private old-age provision by the German government.

These developments are supposed to have a strong impact on the structure of the distribution systems of German life insurance firms which had been dominated by the distribution via exclusive, firm-own agents before: One the one hand, the increased price competition is supposed to lead to a rise of direct distribution channels, which are expected to incur lower costs compared to agent-based distribution systems (e.g. Muth, 1993). This development is backed by technological progress which permits to sell insurance products via the internet (e.g. Cattani et al., 2004). On the other hand, the increased product variety has led to the hypothesis that distribution by independent insurance brokers would become more important in the German market, as these agents are able to compare a higher number of insurance products and, by this, deliver higher service quality to their customers (e.g. Finsinger/Schmid, 1993). The increasing importance of private aging provision in the German market should back this development, as customer's need for counselling is increasing and best met by independent agents (Eckardt, 2007 and Trigo Gamarra, 2007).

Both expected changes are actually reflected in the development of the German life insurance distribution since the liberalisation: direct distribution and distribution via independent agents have gained importance, whereas distribution via exclusive agents is decreasing. Interestingly enough, specialized insurance firms using only direct distribution or independent agents, resp., show only a small increase in their market shares. In contrast, most German life insurance firms which have traditionally distributed their products by dependent agents, use a multi-channel distribution strategy by aditionally incoporating direct channels and the distribution via independent channels, now.

The aim of this paper is to analyze the reasons for the development of the market shares of specialized insurers compared to multi-channel distribution channels in the German life insurance market by comparing the performance of both distribution systems. According to previous studies on the relative superiority of specialised suppliers, these should be superior to multi-channel insurers, if they are able to realize either cost advantages (direct insurers), or if they are able to realize an advantage in terms of provided quality (distribution via independent agents).

Methodologically, these hypotheses can be tested by analysing the cost and profit efficiency of the examined insurance firms. For it, we separate insurance companies into three groups: multi-channel insurers which use at least two different distribution channels to distribute their products, direct insurers which do not use any intermediaries at all but only direct channels like the internet, mail, and telephone, and a third group which uses only independent insurance agents and brokers for the distribution of its products. Our data set contains information about German life insurance firms which was taken from periodically published industry reports for the period of 1997-2005. Company specific efficiency scores are estimated by using efficiency-frontier estimation to obtain a relative measure of cost and profit efficiency levels. Thereby, it is possible to analyse multidimensional input-output technologies. As the a priori specification of any functional form of the production function is arguable per se, the non-parametric Data Envelopment Analysis (DEA) is employed (Charnes et al., 1978). Here, the production function is calculated implicitly out of all existing input-output- observations.

Our paper provides a twofold contribution to the literature on insurance organisation and market economics: First, research on the coexistence of different distribution systems in life insurance industry is broadened by our study, as, to our knowledge, we are the first comparing direct and multi-channel distribution insurers. While previous research was limited on the comparison of exclusive and independent agency insurers (e.g. Berger et al., 1997 and Klumpes, 2004), our paper adds a new facet to the discussion about the coexistence of distribution channels in insurance markets. This paper also contributes to the explanation of the structure of the German insurance market. Up to now, analyses of differences in the structure of German insurance firms have focused on the influence of ownership structure (Ubl and Diboky, 2007), but the question of the influence of distribution systems on the performance of German insurance industry has not been adressed until today. Our study is further able to give an insight into the situation of the German life insurance industry after the liberalisation of the German insurance industry in 1994 by analyzing cost and profit efficiency, and tackles the question if scale economies prevail in the German insurance industry. Fenn et. al (2007) investigate cost and profit efficiency of European insurance firms and report country results, however, without differentiating between life insurance firms, property-liabiltiy insurance firms, and health insurance firms on country levels. Ubl and Diboky (2007) analyze cost efficiency of German life insurers from 2002 to 2005, but do not provide profit efficiency levels, nor results for scale economies.

The paper is organized as follows: section 2 provides an overview of the German life insurance industry and its distribution structure. In section 3, we present the hypotheses and give an overview of earlier studies. Section 4 illustrates the methodology and our modelling approach. In section 5, the data and the estimation model are described. Section 6 presents the results of our efficiency estimations. Conclusions are drawn in section 7.

2 Structure of the German Life Insurance Industry

2.1 The German Life Insurance Industry

This section provides an overview of the German life insurance industry as a background for the following efficiency analysis. The German life insurance market ranks fifth in the world and fourth in Europe with a premium volume of 72,600m € in 2005. While the US market remains the biggest market on country level, in Europe, UK, France, and Italy show larger life insurance premium incomes than Germany (SwissRe, 2006). Total invested assets in the German life insurance industry sum up to 642,812m € in 2005 and represent 27.6 percent of GDP. German life insurance premium income represents 48 percent of total premium income in the German insurance industry (GDV, 2006), and 3.06 percent of BIP. The number of life insurance firms which are active in the German market declined during our observation period from 119 in 1997 to 115 in 2005 (Bafin, 2006).[1] The decline can mostly be explained by mergers and acquisitions as a consequence of the liberalisation of the German insurance market in 1994.

With regard to ownership, different organisational forms of life insurance firms can be found in the German industry: stock companies, mutuals, and public owned firms. Most insurance firms are stock companies, followed by mutual insurance firms and insurers under public law (Maurer and Somowa, 2007).

The insurance products in Germany differ in the following way: individual endowment policies represent the most important products. In total, they accounted for 63.4 percent of

[1] We only consider life insurance firms which are active in the retail insurance market. Apart from that, are pension funds and friendly societies can be found in the German market. The majority of these companies provides occupational retirement benefits for employees (see Maurer/Somowa (2007) for more details).

total life insurance premium income in 2005. Within this group, the predominant products are cash-value life insurance policies which account for 51.2 percent of total life insurance premium income. Index- and unit-linked endowment policies still play a subordinated role in the German market with only a share of ca. 7.4 percent of total premium income. The second important group within the life insurance products are life annuities. They have a market share of 30.1 percent of the total premium income with unit-/index-linked annuities accounting for 6.1 percent of total premium income. As a third group, pure term life policies account for 4.8 percent of total premium income. Apart from that, life insurers also offer so-called supplementary policies where life insurance policies are sold in addition to disability or private accident policies, for example. They represent 28 percent of all insurance policies which were sold by life insurance firms in 2005, but account only for a small part of the premium income (GDV, 2006).

Endowment policies, and especially participating policies, play a very important role in the German market as a private old-age provision instrument. The number of endowment policies in the German market amounts up to ca. 55 million policies, the total number of life insurance policies (excluding supplementary policies) exceeds 94 million policies. The high attractiveness of these products can be mainly traced back to the fact that (under certain requirements) increases in the cash-values of cash-value policies were free from income-taxation until the end of 2004. Although this tax-deductiveness was abolished in 2005, there are several governmental programs which are likely to foster the demand for private life insurance products. First, tax inducements for occupational pension provisions were established. Second, the so-called Riester pension reform (established in 2002), and the Rürup pension plans (established in 2004) are thought to encourage private old-age provison. Thereby, individuals are able to invest part of their income into individual pension accounts. The investment occurs on a pre-tax basis and is subsidized by the government. These programs are thought to compensate for the cut in the benefits from the public pension systems (see for more details Maurer and Somova, 2007).

2.2 Distribution channels in the German life insurance industry

This paper analyses the influence of distribution strategies on the efficiency of life insurance firms. Thus, in the following the structure of distribution channels in the German insurance market is reported. A distribution system can be defined as

> *"the network of people, institutions or agencies involved in the flow of a product to the customer, together with the informational, financial, promotional and other services*

associated with making the product convenient and attractive to buy and rebuy" (O' Shaughnessy, 1988).

German insurers are not obligated to reveal the structure of their distribution system in detail. Thus, detailed figures about the contribution of single distribution channels to the insurance business are not available. Even so, insurance firms deliver information about the distribution channels in their annual financial statements enabling us to derive the structure of their distribution system.

In the whole German insurance sector, and especially in the life insurance sector, the distribution via exclusive agents has been the dominant distribution channel in the past. Exclusive (or tied) agents are only allowed to sell the insurance products of determined insurance firms or groups, although they are self-employed in most cases. The reason for the dominance of this distribution channel lies in the strict regulation of the German insurance sector before 1994, which among other aspects, consisted in prescribed minimum premium levels. Thus, insurers were interested in maximizing sales which could be best achieved by a large own sales force (e.g. Finsinger and Schmidt, 1993).

Besides the distribution via exclusive agents, the majority of German life insurers at the same time use independent insurance agents and insurance brokers to distribute their products. Both independent insurance agents and insurance brokers are free to choose the products they sell and the companies they work with, whereas insurance brokers act predominantly on behalf of the customer.

A third distribution channel is the distribution of life insurance products via a bank branch network. This distribution channel has been mainly used by German public insurance companies in the past (e.g. Provinzial Lebensversicherung which distributes its products via German savings banks, or R+V Lebensversicherung which uses the branch offices of German cooperative banks), but is increasingly being also used by many private life insurance firms; e.g. Allianz Lebensversicherung which acquired Dresdner Bank in 2001 and since then sells its products via the offices of Dresdner Bank.

Further, life insurers are also using direct distribution channels to sell their products. Direct distribution encompasses all distribution channels where insurance products are sold to the customer without any direct contact to a salesperson. The internet has become the main direct distribution channel, but insurance products may also be sold via telephone, television or mail.[2]

In total, the premium income of German life insurers was distributed as follows in 2005 (Tillinghast, 2006)[3]: Exclusive agents accounted for 27.1 percent of premium income, independent agents and insurance brokers for 32.4 percent, the distribution via banks for 24.8 percent, and the distribution via direct channels for 5.5 percent of the premium income. According to Tillinghast, the distribution via independent agents outperformed the exclusive distribution channel in the German life insurance market in 2005 for the first time. This result has to be treated carefully, as the so-called multi-level-marketing (Strukturvertrieb) accounts for 7.0 percent of the premium income and was recorded separately. If the distribution via multi-level-marketing is treated as a special form of exclusive selling, exclusive and independent agents show very similar levels of premium income (Tillinghast, 2006).

Nevertheless, it can be stated that the distribution via exclusive agents is decreasing. In 2002, the exclusive agents still showed a premium income share of 40 percent, while independent agents only accounted for 24 percent. The distribution via bank offices has remained stable, whereas the distribution via direct channels increased from 2.2 percent in 2002 to 5.5 percent in 2005 (Tillinghast, 2004).

Most life insurance firms in Germany (approx. 85 percent in 2005) use a multi-channel approach combining at least two of the presented channels, mainly exclusive and independent agents or insurance brokers. But an increasing number of life insurers is also incorporating direct distribution channels and the distribution via bank offices into their distribution systems.

In contrast to the multi-channel approach, there are also specialized life insurance firms in the German market which only make use of a single distribution channel. Mainly, two single-distribution approaches can be found:

---

[2] It is important to distinguish *direct distribution* from the broader concept of *direct marketing,* as the latter term decribes "*any communication (advertising or direct mail) that invites the potential customer to communicate directly (via mail or telephone) with the company*" (Easingwood and Storey, 2003), whereas direct distribution means that the policies must also be sold without the use of any salesperson.

[3] The numbers are based on a survey conducted by the international consultancy Tillinghast Towers Perrin. 51 German life insurers participated in the survey, representing approx. 75 percent of the German life insurance market. Information about the missing firms was complemented by Tillinghast based on information from annual statements and "*based on own market knowledge*" (Tillinghast, 2006). Premium income is measured by the Annual Premium Equivalent (APE) which represents the sum of the current premium payments and 10 percent of the single premiums in a year.

On the one hand, there are direct insurers which exclusively distribute their products without the use of salespeople. The number of direct insurers has remained stable over the observation period. In 1997, 8 direct life insurers could be found in the German life insurance market, and in 2005, there were 9 firms.

The second single-distribution approach in the German life insurance market are insurers working solely with independent agents and insurance brokers (independent agency insurers). Some of them have been on the market for many years, whereas others are rather young life insurers. In 1997, 10 independent agency insurers were on the market; in 2005 the number had slightly decreased to 9.

The survey by Tillinghast only reports aggregate market shares for the single distribution channels. It is not stated if the reported premium income by the different channels was generated by multi-channel distribution insurers, direct insurance firms or life insurers working only with insurance brokers. Our own data set (which will be described in section 5.1) yields the following information about the total net premium income for the different types of insurance firms:

Premium income by direct insurers amounted to 3.3 percent in 1997 and has increased to 4.3 percent in 2005. In case of independent agency insurers, the premium income was 4.5 percent in 1997 and has only increased to 5.0 percent in 2005. The remaining premium income is generated by multi-channel-insurance firms. This shows the large dominance of multi-channel distribution compared to insurers using specialized distribution systems.

3 Single-Channel versus Multi-Channel Distribution Systems — Hypotheses and Previous Evidence

3.1 Hypotheses

The aim of this paper is to analyze the reasons for the development of the market shares of specialized insurers and multi-channel distribution channels in the German life insurance market by comparing the performance of both distribution systems.We start with a discussion of possible advantages and disadvantages of multi-channel distribution systems. In the following, we discuss the main advantages and disadvantages of the two different single distribution channel systems. Finally, we derive the hypotheses to be tested in this study.

Multi-channel insurers: There are various benefits which can result from the use of multiple channels: First, insurance firms can reach an extended coverage of the market by employing various distribution channels (Coelho and Easingwood, 2004). As has been shown, the German life insurance market is characterized by an increasing number of different products as a consequence of the liberalisation of the industry and the increasing demand for private old-age provision. Further, knowledge and information about customers can be shared by different channels (Easingwood and Coelho, 2003). An insurer which uses different channels is also able to target different customer segments or to reach new customer segments by this way. Moreover, the use of multi-channel distribution may be suitable to meet the needs of existing customers in a better way (Tsay and Agrawal, 2004). Existing customers are able to purchase insurance products of an insurance firm via different channels, depending on the characteristics of the product and their preferences. Thus, particularly firms with broad product lines will benefit from the distribution via multiple channels (Webb, 2002). They may further save search costs or transaction costs by holding a relationship with a single insurance firm. Finally, the use of multiple channels makes it possible for the insurance firm to reduce risks which arise if a single-channel distribution strategy is pursued: Multi-channel insurers are better able to react to a changing environment, e.g. due to changing consumer preferences or rising competition. The use of additional channels may be a strategy of incumbents to prevent the loss of market shares to new rivals which enter the market with specialized channels at low prices.

There are also potential disadvantages with regards to the use of multiple channels by life insurers. Cost disadvantages can arise due to high investment costs necessary to establish an additional distribution channel, or due to high coordination costs which arise between the channels (Easingwood and Storey, 1996). Further, the insurer runs the risk that newly established distribution channels are not accepted by the customers, or that customers make only use of new distribution channels (e.g.. direct marketing channels) to inform themselves, but go on using the established channels (e.g. exclusive agents) to purchase the product. This problem is also known as channel cannibalization: instead of increasing turnover and profits, the establishment of additional channels only redirects turnover from one channel to another (e.g. Dzienziol et. al, 2002).

Direct insurers: Direct distribution insurers have the main advantage that they are able to provide their services at lower costs compared to insurance firms which use agents, bank branches etc. for the distribution of their products. The main cost advantage results from the fact that direct insurers avoid commission costs for insurance agents which leads to reduced operating expenditures. Moreover, they save the large fixed costs of a distribution network by own branches or bank branches.[4] Due to this cost advantage, these companies try to attract their customers mainly by lower premiums. A potential disadvantage of this distribution system consists in the fact that counselling-intensive and complex insurance products are more difficult to sell without personal advice by an intermediary or a staff member of a branch office. As life insurance products can be mainly characterized as complex, growth of direct life insurance firms could be limited due to the missing personal contact between insurance firm and customers (e.g. SwissRe, 2000). Further, direct insurers which enter the market must incur high marketing costs for customer acquisition and the creation of a well-known brand (e.g. Ennew and Waite, 2007).

Limited growth in a highly competititve market combined with high investments for the establishment of the firm can lead to the fact that the insurance firm is not able to realize possible economies of scale. Accounting for scale effects is of major importance in insurance industry studies. First, insurers face relatively large fixed costs due to investments in computer systems and financial capital, for example. Second, the industry operates on the basis of the law of large numbers. The larger the policy portolio of similar risks, the better the insurance firm is able to assess the risks and the lower is the risk volatility (e.g. Cummins and Rubio-Misas 2006).

Independent agency insurers: The distribution by independent agents is known to incur highest costs compared to the distribution via exclusive agents, branch offices or the direct distribution. (e. g. Zweifel and Ghermi, 1990 and Dahmen, 2004). The higher expenses of independent agents can be explained by differences in the property rights structure of the relationship between the insurance company and the different types of agents: In contrast to exclusive agents or branch office staff, independent agents own an individual client list, and thus have the right to policy renewal. This means that independent agents directly contact the customer at the end of the contract period and decide which of the insurers in their portfolio will receive the renewal business. In case of exclusive agents it is the insurance company which decides on the renewal of an insurance policy. Therefore, typical independent agent renewal commissions are higher than the commission level in exclusive distribution systems, as the insurer must ensure that an independent agent acts in its sense and does not move the client to another insurer. Thus, insurers incur higher monitoring costs in case of dealing with independent agents (Barrese and Nelson, 1992). According to the literature, insurance brokers

[4] For a formal analysis see the model of direct banking by Neuberger (2007), which can be applied to the case of direct insurers.

are able to compensate these higher costs by a higher level of service quality. The higher level of service quality can be analysed from the insurers', as well as from the customers' point of view.

From the insurers' perspective, the use of independent agents enables insurers to reduce transaction costs, and to write more profitable business (Anderson et al., 1998). The lower transaction costs of independent agents in comparison with exclusive agents result from the fact that independent agents show higher incentives to undertake detailed risk analyses (for more details see Regan and Tennyson, 1996, and Regan, 1997).

From a customers' point of view, the higher quality consists in a reduction of customer's search costs (Posey and Tennyson, 1998), a better market overview for the customer, and a better monitoring of the insurer by independent agents (Regan, 1997). Important monitoring functions are screening different insurers for appropriate coverages, low prices, and financial stability, for example. Mayers and Smith (1981) and Barrese and Nelson (1992) also state that independent agents are better capable to deal with conflicts between insurers and policy holders, as they threat with moving the customer to another insurer. Due to the higher costs and the higher service quality, independent agency insurers focus on complex, counselling-intensive insurance products. It is stated that independent insurers should be able to compensate their disadvantage in terms of costs by higher revenues which result from higher service quality (e.g. Berger et al., 1997). Thus a potential disadvantage of this single-distribution channel system would arise if independent insurers were not able to compensate their higher costs by corresponding higher revenues.

The aim of this paper is to explain the distribution structure in the German life insurance industry by comparing the performance of two different single-distribution channels with the multi-channel distribution approach. Insurers' performance is measured both in terms of cost and revenues. The implementation of revenues into performance measurement thereby allows us to incorporate service quality aspects into our analysis. Our approach avoids that an insurance firm is classified as inefficient due to higher costs, and that possible higher revenues due to higher service quality are neglected, as it would be the case if only costs were taken into account.

According to our theoretical considerations, we are able to derive the following hypotheses:

H_1: Direct insurers show a higher level of cost efficiency compared to multi-channel insurers. The higher level of cost efficiency translates into a higher level of profit efficiency, if both distribution systems do not differ in their revenue efficiency, i.e. in their provided service quality.

H_2: Compared to multi-channel insurers, independent agency insurers show lower cost efficiency due to the higher costs of the independent agency system. The disadvantage in terms of cost efficiency is recouped by higher revenues due to high service quality which leads to similar or higher levels of profit efficiency for independent agency insurers.

If we find evidence for both hypotheses, specialized single-distribution strategies are superior to broader multi-channel distribution systems. By focussing either on a cost or on a service quality advantage, direct and independent agency insurers would outperform multi-channel distribution insurers. In contrast, if we must reject both hypotheses, the advantages of a multi-channel distribution system outweigh its disadvantages. A broad multi-distribution strategy would then be superior to single-channel distribution strategies which would explain why specialized single-distribution channel insurers have not gained a larger market share until today.

3.2 Previous evidence

The coexistence of different distribution systems has been the subject of various empirical studies in the past. However, most of these studies focus on the comparison of exclusive agency insurers versus independent agency insurers. Joskow (1973) finds that American insurers working with independent agents incur much higher costs than insurers using exclusive agents. Cummins and Vanderhei (1979) and Barrese and Nelson (1992) also find support for higher underwriting costs of independent agency insurers compared to an exclusive distribution system. However, all three studies lack a comparison of revenue levels of both systems. Barrese, Doerpinghaus, and Nelson (1995) incorporate a quality dimension into their analysis by using private passenger automobile insurance complaint data as a proxy for service quality. According to their study, American independent agency insurers in the private passenger automobile insurance line provide higher service quality compared to exclusive agency insurers. Berger et al. (1997) analyse a sample of 472 US insurers and conclude that exclusive-agency insurers show a higher cost efficiency, but this performance advantage disappears when revenues are taken into account. Brockett et al. (2005) also find US property-liability independent agent insurers being more efficient than a second group of exclusive agent and direct insurers. Finally, Klumpes (2004) analyses a sample of UK life insurance firms and estimated cost and profit efficiency levels. In contrast to Berger et al. (1997) he finds independent agency insurers being both less cost efficient, and less profit efficient compared to dependent agency insurers. To our knowledge, there is only one study which has included the performance of direct insurers up to now: Cummins (1999) analyses the performance of different distribution systems in the US life insurance industry for the period 1988-1995. Compared to agent-based insurers, direct insurers show lower cost and revenue efficiency, but higher technical efficiency scores. As far a we know, there is no study which compares the performance of single- and multi-channel insurers.[5]

4 Methodology

4.1 Frontier efficiency concepts

We apply modern frontier efficiency analysis to estimate cost and profit efficiency in the German life insurance industry. The method allows for the analysis of multiple input-output technologies. The performance of each firm is measured by comparing it to the efficient frontier of the industry which is composed by the efficient firms in the reference set (e.g. the industry). Thus the efficiency scores are obtained relative to a "best practice" frontier. The measurement of productive efficiency goes back to Koopmans (1951), Debreu (1951), and Farrell (1957) who introduced the concept of technical efficiency. Technical efficiency is defined as a firm's ability to produce a given output with a minimum of its inputs (input-oriented approach) or to maximize its output with a given level of inputs (output-oriented approach). Figure 1 illustrates the concept of technical efficency for the one input (x)-one output (y) case. Under constant returns to scale (CRS), Firm A's technical efficiency is defined as the ratio 0E/0A.[6] The CRS assumption assumes that all firms are operating at optimal scale, i.e. at the point where average costs show their minimum. For the calculation of efficiency scores, the assumption of CRS implies that all firms are compared to each other. Thus an inefficient firm can be benchmarked against smaller or larger firms (e.g. Coelli et al., 2005). In figure 1, the CRS frontier is represented by the straight line 0CH.

[Figure 1 about here]

[5] The success of multiple distribution channels has been analysed for the financial sector by Easingwood and Storey (1996). On the basis of a questionnaire which is sent to managers of financial products in the UK market, they conclude that the simultaneous combination of a high number of channels seems to be associated with higher overall success of the firm. However, their analysis does not focus on insurance firms and their results rely solely on the analysis of correlations between qualitative indexes. They fail to analyse cost and revenue structures of the firms. Futher, the study does not compare multi- and single distribution channel strategies, but only analyses the effect of an increasing number of channels within multi-distribution firms.

[6] For the purpose of simplification, technical efficiency is only illustrated in an input-oriented way in this figure. Under CRS, input- and output-oriented technical efficency scores do not differ, whereas under VRS different efficency scores are obtained depending on the orientation of the model.

However, in reality firms may not operate at optimal scale, but deploy increasing (IRS) or decreasing returns to scale (DRS). Under IRS, a firm experiences diminishing average costs, whereas under DRS, a firm is operating under increasing average costs. The variable returns to scale (VRS) frontier accounts for the possibility of IRS and DRS. In figure 1, the VRS frontier is displayed by the line FBCD. From F to C, the production technology is assumed to display IRS, whereas from C to D, firms are assumed to exhibit DRS. In point C, firms are assumed to operate under CRS, consequently point C belongs to both the CRS and VRS frontier. The resulting VRS frontier envelops the observed firms closer than the CRS frontier, thus the efficiency will be at least equal to those under the assumption of CRS. The VRS assumption implies that an inefficient firm is only compared to firms of comparable size (e.g. Banker (1984)). In figure 1, firm A's technical efficiency under VRS is measured by IG/IA. If there are firms in the industry which are not operating at optimal scale, efficiency measurement under CRS leads to the result that technical efficiency is confounded by scale efficiency (SE). The concept of SE allows to decompose the technical efficiency of a firm into pure technical efficiency and SE. SE is defined as the amount by which a firm's efficiency could be improved by moving to its optimal scale (e.g. Coelli et al., 2005 and Ray, 2004). It is calculated by dividing the CRS efficiency score by the VRS efficiency score. In figure 1, firm A's scale efficiency is defined by the ratio IE/IG.

To obtain qualitative information about returns to scale for individual observations, two additional assumptions on the underlying production technology can be added to the concept of CRS and VRS: Under the concept of non-increasing returns to scale (NIRS), a production technology is assumed to exhibit constant returns on the first segment of the frontier and decreasing returns to scale on the second segment, as can be seen in figure 1, where the NIRS frontier is represented by the line 0CD. The term results from the assumption that firms do not exhibit increasing returns to scale at any point of the frontier. Concerning the calculation of efficiency, an inefficient firm is not benchmarked to larger firms, but may be compared with smaller ones. The assumption of NIRS puts emphasis on larger firms, as these are assumed to operate under decreasing returns to scale (e.g. Cooper et al., 2006). In contrast, smaller firms are assumed to operate under constant returns to scale which means that it is not accounted for possible scale effects when calculating their technical efficency. The opposite is supposed if non-decreasing returns to scale (NDRS) are assumed for the production technology. Under NDRS, the production technology exhibits increasing returns to scale in the first segment, and constant returns to scale in the second segment of the frontier, as can be seen in figure 1 by the line FCH which represents the NDRS frontier. Under NDRS, firms do not exhibt decreasing returns to scale at any point of the frontier. Thus, a production process can be scaled up, but not scaled down proportionally. Hence, the NDRS frontier puts emphasis on smaller firms, as these are assumed to operate under increasing returns to scale whereas larger firms are not allowed to exhibit scale ineffiencies.

Summarizing, it can be stated that efficiency scores will be lowest in case of CRS compared to all other models, as the CRS frontier envelops the data least closely of all (e.g. Ferrier and Lovell, 1990). Further the following is stated by Ray (2004):

> *"Note that in this discussion of SE, VRS is the maintained assumption. The CRS and NIRS frontiers are mere artifacts that permit us to examine different points on the VRS frontier."*

The calculation of efficiency scores under NIRS and NDRS can be taken to determine the nature of returns to scale under which a single firm is operating as shown by Briec et al (2000) Let $DF_i(x,y \mid CRS), DF_i(x,y \mid VRS), DF_i(x,y \mid NIRS)$ and $DF_i(x,y \mid NDRS)$ indicate technical input efficiency measures computed under CRS, VRS, NIRS, and NDRS. It is shown that a convex technology exhibits locally the following nature of returns to scale:

- Increasing Returns to Scale (IRS) if the following holds:

$$DF_i(x,y \mid NDRS) = \max\left\{DF_i(x,y \mid NIRS), DF_i(x,y \mid NDRS)\right\}$$

- CRS if the following holds:

$$DF_i(x,y \mid NDRS) = DF_i(x,y \mid NIRS) = \max\left\{DF_i(x,y \mid NIRS), DF_i(x,y \mid NDRS)\right\},$$

- Decreasing Returns to Scale (DRS) if the following holds:

$$DF_i(x,y \mid NIRS) = \max\left\{DF_i(x,y \mid NIRS), DF_i(x,y \mid NDRS)\right\}$$

Thus, if at any local point the technical input efficiency score under NDRS is larger than under NIRS, the technology shows IRS. In contrast, DRS are found if technical efficiency under NIRS is larger than under NDRS. Finally, a local point exhibits CRS if the efficiency scores under NIRS and NDRS do not differ. [7]

---

[7] The main advantage of the method presented by Briec et al. (2000) consists in the fact that only two models (under the assumptions of NIRS and NDRS) must be computed to estimate the nature of returns to scale for every single observation point. However, the nature of returns to scale can also be obtained by other approaches, as has been shown by Färe et al (1983), Banker et al. (1984) and Keerstens/Vanden Eeckaut (1999), among others.

The concept of technical efficiency was extended to a concept of allocative efficiency by Farrell (1957). A firm is allocative efficient if it is able to choose the cost-minimizing combination of inputs given the factor prices. It is further allocative efficient if it chooses the revenue-maximizing ouput combination given the output prices, and finally, a firm is called allocative efficient if it chooses both profit-maximising output and input combination.

Taking into account input price information only, it is possible to determine a firm's cost efficiency (CE). A firm is fully cost efficient, if it is able to produce a given output y_0 at minimum costs.

If the production possibility set is defined as $T = \{(x; y) : x \text{ can produce } y)\}$ where x and y represent input and output vectors, and the corresponding input requirement set for the given ouput y_0 is defined as $V(y_0) = \{(x : x \text{ can produce } y_0)\}$, then the cost minimization problem of the firm can be expressed as

$$\min C = \min w'x \text{ subject to } x \in V(y_0)$$

with $w' = (w_1, w_2, \ldots, w_n)$ representing a vector of input prices.

The firm is assumed to take input prices as given, thus it minimizes its costs by adjusting the input quantities.[8] The CE of a firm is defined by the ratio of minimum costs to actual costs for a given output vector. It ranges from 0 to 1, with a score of 1 representing a fully cost efficient firm. Cost efficiency displays the product of allocative (AE) and technical (TE) efficiency, thus a firm can only be cost efficienct if it is both allocative and technical efficient. (e.g. Ray, 2004). Figure 2 illustrates the concept of cost efficiency for the two input (x_1 and x_2)-one output (y) case under the assumption of CRS. The production frontier represents all technically efficient firms, whereas the isocost line represents a given cost level. Firm B's CE can be determined by the product of TE (0Q/0B) and AE (0R/0Q), and equals 0R/0B. AE accounts for the fact that firm B could move from the technically efficient, but allocative inefficient point Q to point P which is both technically and allocatively efficient.

[Figure 2 about here]

If not only input, but also output quantities are regarded as choice variables, profit efficiency (PE) can be calculated.[9] Therefore, information about both input and output prices are needed.

---

[8] This implies that cost efficiency is always determined under the assumption of an input-oriented model.

[9] It is also possible to calculate revenue efficiency by taking into consideration, output quantities, output prices, and input quantities. In the case of revenue efficiency, firms try to maximize revenues by choosing the optimal

The firm's objective is to choose the profit-maximizing input and output quantities given the input and output prices. It thereby faces the constraint that the chosen input-output combination must represent a feasible production plan. The profit-maximizing problem of a firm can be expressed by

$\max \Pi = p'y - w'x$ subject to $(x,y) \in T$

with $p' = (p_1, p_2, \ldots p_m)$ representing the vector of output prices.

PE is then defined as the ratio between a firm's actual profits and the maximum attainable profits given the input and output prices. A fully profit efficient firm shows a PE score of 1. As profits can turn negative, profit efficiency is not bounded below by 0, but can turn negative (zero) if actual profits are negative (zero). [10] Further the measure would be undefined if the maximum attainable profit in an industry was negative (e.g. Banker and Maindiratta, 1988; Cooper et al., 2006). Figure 3 illustrates the concept of ratio-based profit efficiency for the one input (x)-one output (y) case under the assumption of VRS. Both the efficient production frontier and different isoprofit lines (Π) are illustrated. Each isoprofit line represents an identical profit level with Π* corresponding to the highest and Π corresponding to the lowest illustrated profit level. The overall profit efficiency of firm C is given by Π/ Π*, and can be decomposed into technical profit efficiency (Π/ Π') and allocative profit efficiency. Π' represents the profit at the technically efficient production point D, whereas Π* represents the maximum attainable profit. The allocative profit efficiency would then be Π'/ Π*. Overall profit efficiency represents the product of technical and allocative profit efficiency.

[Figure 3 about here]

---

output quantities given the input prices and input quantities. Thus revenue efficiency is calculated based on an output-oriented approach (see e.g. Ray (2004), Coelli et al. (2005)).

[10] Different solutions for the problem of negative profit efficiency can be found in the literature: Some authors (e.g. Banker/Maindiratta, 1988) suggest eliminating firms which exhibit negative profits before calculating efficiency scores. Others (e.g. De Young and Hasan, 1998) add a small positive number to a firm's actual profits to ensure profits which at least equal zero. We decided not to remove firms from the sample which exhibit negative profits, as it is possible that firms incur short-term losses, but are able to establish in the market in the long-run. This is especially true for young firms which enter the market and incur high initial investments. Our sample contains a number of young firms which entered the market after the liberalisation of the German insurance market in 1994. We neither added a small positive number to negative profits, as we are not so much interested in the PE scores of single firms but rather in the average PE for different groups of insurers. As we only found very few firms showing only small negative PE scores with none of these firms showing negative PE scores over the whole observation period, the impact on the average PE efficency scores is rather small.

4.1 Estimation Methodology

We estimate fim-specific efficiency using non-parametric Data Envelopment Analysis (DEA). Using DEA, an a priori specification of the underlying production function is not needed, the efficient best practice frontier is estimated by solving linear programming models (Charnes et al., 1978). An alternative to DEA would be an econometric approach which makes it necessary to specify a functional form for the cost, profit or production frontiers. It is hypothesized that the function error term consists of an inefficiency component and a purely random component. Thus, efficiency is measured by separating the efficiency component from the overall error term. In contrast to an econometric approach, DEA measures all deviations from the frontier efficiency as inefficiency. Thus, a deviation from the efficiency frontier due to purely random shocks would not be detected by DEA (for an overview see e.g. Kumbakar and Lovell, 2000).

The main advantage of the non-parametric DEA approach consists in the fact that the assumption of a specific functional form of the underlying technology is not necessary. This makes DEA especially useful when dealing with service industries, as knowledge about the underlying production technology is usually limited in case of service firms. Instead, DEA uses linear programming approaches to envelope the observed data as tightly as possible without requiring any functional assumptions on the production technology. It only requires convexity of the production possibility set and disposability of the inputs and outputs.

Standard cost efficiency is estimated as follows: We have data on N inputs and M outputs for each of the I firms. The I-th firm uses a N x 1 input vector $x_i = (x_1\ x_2, \ldots, x_n) \in R^n_+$ to produce a M x 1 output vector $y = (y_1, y_2, \ldots, y_m) \in R^m_+$ where X is a N x I input matrix and Y a M x I output matrix that represent data for all I sample firms. First, the following linear programming problem (LP) is solved:

$$\min_{\lambda, x_i^*} \quad w_i' x_i^*$$

$$\text{subject to} \quad Y\lambda \geq y_i$$
$$X \leq x_i^*$$
$$\lambda \geq 0$$

Further, w_i is a N x 1 input price vector for the i-th firm which corresponds to the input vector x_i, and x_i^* is the cost-minimizing input vector for the i-th firm which is obtained by the LP (e.g. Färe et al., 1994). Second, the cost efficiency of the i-th firm (CE) is calculated as the ratio of minimum cost to observed cost:

$$CE = \frac{w_i' x_i^*}{w_i' x_i}$$

The measure of CE is bounded between 0 and 1. A CE of 1 represents a fully cost efficient firm; 1-CE represents the amount by which the firm could reduce its costs and still produce at least the same amount of output.

The presented LP approach calculates cost efficiency under the assumption of CRS (CE^{CRS}). To calculate cost efficiency under VRS (CE^{VRS}), the convexity constraint $I1'\lambda = 1$ is added, where I1 is an $I \times 1$ vector of ones (Banker et al., 1984). Färe and Grosskopf (1985) showed that SE can also be determined in line with CE: Analogous to the calculation of SE in case of TE, scale efficiency in the model of CE is also determined by dividing CE^{CRS}/CE^{VRS} given that all firms face identical input prices. Accounting for possible economies of scale is of major importance in insurance industry studies, as has been noted in section 2.

To determine the nature of returns to scale, cost efficiency is also estimated under NIRS and NDRS following the approach by Briec et al. (2000). To calculate NIRS, the constraint $I1'\lambda \leq 1$ must be added to the LP problem, whereas NDRS are assumed by adding $I1'\lambda \geq 1$ (e.g. Zhu, 2003 and Ray, 2004).

In the insurance sector, input and output quantities are typically reported in monetary dimension. Further, the definition and calculation of input and output prices is rather difficult and subject of controverse discussion in the literature (see section 4 for a more detailed discussion of this problem). We therefore follow Tone (2002) and Cooper et al. (2006) and calculate cost efficiency by replacing the input vector $x_i = (x_1\ x_2, \ldots, x_n) \in R^n{}_+$ in the above LP by a vector $\bar{x}_i = (\bar{x}_1, \bar{x}_2, \ldots, \bar{x}_n) \in R^n{}_+$ with $\bar{x}_i = (\bar{x}_1, \bar{x}_2, \ldots, \bar{x}_n)$ representing the monetary input quantities, i.e. costs. This approach further allows us to model input prices w_i being equal to unity for all selected inputs. [11]

---

[11] This approach was already suggested by Färe and Grosskopf (1994) who showed that cost efficiency can be determined using DEA by minimizing costs given output quantities without differentiating between input quantities and input prices. Tone (2002) and Cooper et al. (2006) call their approach *new cost efficiency*. Their focus differs from ours, as they wish to account for different input prices faced by the firms by considering $\bar{x}_i$. Notwithstanding, in our opinion this approach may also be used if input prices are not or only hardly available, but information about costs is present, as in our case. Although technically allocative efficiency can be derived by dividing cost and technical efficiency scores, the resulting score should only reflect input slacks which are not accounted for in case of technical efficiency (e.g. Ferrier/Lovell (1990)). In reality, the resulting efficiency scores contain both technical and allocative inefficiencies, as the firm's decision about the optimal use of input factors depending on the given input prices is already contained in the cost information. The fact that allocative and technical inefficiencies cannot be differentiated does not represent a major shortcoming here, as the

As a second step, profit efficiency is estimated. The profit maximisation LP is solved as follows:

$$\max_{\lambda, y_i^*, x_i^*} \quad p_i' y^* - w_i' x_i^*$$

$$\text{subject to} \quad Y\lambda \geq y_i^*$$
$$X \leq x_i^*$$
$$I1'\lambda = 1$$

Further, p_i is a M x 1 vector of input prices for the i-th firm and q_i^* is the revenue-maximizing vector of output quantities for the i-th firm. Given input and and output prices, x_i^* and q_i^* are calculated by the LP (e.g. Zhu, 2003 and Ray, 2004).

A measure of profit efficiency (PE) can be obtained by calculating the ratio of observed profit to maximum (potential) profit.

$$PE = \frac{p_i' y - w_i' x_i}{p_i' y^* - w_i' x_i^*},$$

$-\infty \leq PE \leq 1$ describes the maximum amount by which profits of an inefficent firm could be increased until achieving full profit efficiency. PE is estimated under the assumption of VRS (PE^{VRS}), as under the assumption of CRS maximum profit would be zero or undefined (e.g. Ray, 2004 and Färe et al., 1994). Thus SE is only calculated in case of CE, but we are still able to determine the nature of returns to scale of a profit-inefficient firm. To calculate NIRS, the constraint $I1'\lambda \leq 1$ is added to the LP problem, whereas NDRS are assumed by adding $I1'\lambda \geq 1$ (e.g. Zhu, 2003).

Again, we follow Cooper et al (2006) and calculate the 'new' profit efficiency as data about output prices is not available, but information about revenues is available which represent the product of output quantities and prices (again see section 4 for a more detailed discussion). For it, the output vector y = $(y_1, y_2, \ldots, y_m) \in R^m_+$ is replaced by the following vector $\overline{y}_i = (\overline{y}_1, \overline{y}_2, \ldots, \overline{y}_m) \in R^m_+$ where $\overline{y}_i$ represents the revenues of firm i. This allows us to model output prices which equal 1. Also, the input vector $x_i = (x_1\ x_2, \ldots, x_n) \in R^n_+$ is again replaced

differentiation between allocative and technical efficiency is only of minor importance for the purpose of our study.

by a vector $\overline{x}_i = (\overline{x}_1, \overline{x}_2, \ldots, \overline{x}_n) \in R^n{}_+$ with $\overline{x}_i = (\overline{x}_1, \overline{x}_2, \ldots, \overline{x}_n)$ representing the monetary input quantities, i.e. the costs. Finally, input prices are also again assumed to equal 1.[12]

5 Dataset, Outputs, Revenues, and Inputs

5.1 Dataset

The data used in this study is taken from periodically published insurance industry reports and insurers' income statements for the years 1997-2005 (Hoppenstedt 1999-2007). However, Hoppenstedt registers every licensed insurance firm in Germany, and thus the data base contained information about firms that do not actively participate in the insurance market. We eliminated firms which had not delivered any information at all, or which showed negative obervations for inputs or outputs. In addition, we removed firms operating only in very specialized product niches, either because they only offer products to a very specialized customer base (e.g. civil cervants, doctors) or because they exclusively offer single, specialized insurance products (e.g. firms offering exclusively term-life insurance).[13] These firms are not representative for the industry as a whole. Finally, our data set accounts for approx. 90 percent of the total premium income of the industry. The German life insurance industry is characterized by a large heterogenity between the single firms. We therefore additionally corrected for outliers in the sample by applying the outlier correction model suggested by Wilson (1993). We found that in each year firms being among the largest in the sample were detected as outliers.[14]

[12] The fact that PE cannot be calculated under the assumption of CRS leads to the assumption of imperfect markets, as perfect competition would lead to a situation where all firms operate under CRS. Although technically, all firms face the same input and output prices of 1, our PE model allows for imperfect competition which would be reflected in different output prices due to product differentiation among firms. The different output prices would be already contained in the revenues. Further, the result of this approach, again, is that the resulting efficiency scores cannot be differentiated in regard to allocative and technical inefficiencies.

[13] There is also one life insurer in the German market which solely distributes its products via bank offices (CiV which belongs to Citi Bank and only uses the bank's offices for the distribution of its products). Further, the Aachener und Münchener Lebensversicherung decided in 2005 to sell its products solely via exclusive agents. We excluded CiV from the sample as it represents the only insurer using only bank offices for distribution. Aachener und Münchener Lebensversicherung had already been removed from the sample for 2005, as it was detected as an outlier by the outlier correction we conducted.

[14] The results of the efficiency estimations differ only slightly if the detected outliers are excluded from the sample, though, and all of the qualitative results of the study remain unchanged.

5.2 Outputs, Costs, and Revenues

To use DEA, it is necessary to identify the relevant inputs and outputs of an insurance firm. However, a review of the literature does not show clear consensus on a single input/output specification (e.g. Cummins/Weiss, 2000).

While the efficiency of manufacturing firms can be calculated easily, as these firms use physical resources to produce physical completed products as outputs, the selection of variables to represent inputs and outputs is rather difficult for service firms, as input prices are often implicit, and many outputs are intangible.

The output of insurance firms has been measured according to three main approaches: the asset (intermediation) approach, the user-cost approach, and the value-added approach (see e.g. Berger and Humphrey, 1992).

The asset approach treats insurance firms as pure financial intermediaries. According to it, insurance firms act like other financial intermediaries, e.g. banks, and borrow funds from their customers which are invested, and thus transformed into assets. Interest payments are paid out to cover the time value of the funds used. Applying the asset approach would mean that only the intermediation services provided by life insurance firms are taken into account. By this, important functions of life insurers like risk-pooling and risk-bearing would be disregarded. Thus, the asset approach seems not to be appropriate to measure the real output services by life insurance firms.

The user-cost approach was developed by Hancock (1985). It determines whether a financial product is an input or an output by analyzing if its net contribution to the revenues of an insurance firm is positive or negative. According to that, a product is considered an output, if its financial return exceeds the opportunity costs of funds or if the financial costs of a liability are lower than the opportunity costs. Otherwise, the financial product would be classified as an input. This method would require precise information on product revenues and opportunity costs. Such data is nearly impossible to obtain in for an entire industry.

The value-added approach differs from the asset approach and the user-cost approach as it considers all asset and liability categories to have some output characteristics. Those categories which have substantial value added, are then used as the important outputs. The remaining categories are treated as rather unimportant outputs, intermediate products, or inputs. An important advantage compared to the user-cost approach consists in the fact that the value-added approach uses operating cost data rather than determining the costs implicitly or using opportunity costs. The value added approach is considered to be the most appropriate method to measuring output of financial firms and is widely used in recent insurance studies.

To use the value added approach, the main services provided by insurers have to be defined before choosing suitable output proxies:

The services provided by insurers can be split up in three major groups:

- Risk bearing/risk pooling services: Life insurers collect premiums and annuity considerations from their customers and distribute a certain share/ a part of the premiums to those policyholders who incur a loss. Thus, insurers provide a mechanism which makes it possible for consumers and businesses exposed to possible losses to engage in risk reduction through pooling. In life insurance, the main risks are the risk of death (endowment insurance) and the risk of longevity (annuities). The actuarial, underwriting, and related expenses incurred in operating the risk pool represent the major components of value added.
- "Real" financial services related to insured losses: In life insurance, the main real services provided by insurers are financial planning and counselling for individuals, as well as pension and benefit plan administration for businesses.
- Intermediation services: Intermediation services are of special importance in life insurance, as in most cases asset accumulation products are sold. Funds (premiums) are collected in advance of paying benefits. These funds are held in reserves until claims are paid, and the insurer uses them to purchase a portfolio of assets. The net interest margin between the rate of return earned on assets and the rate credited to policyholders represents the value added from the intermediation function.

Some efficiency studies have used premiums to measure output. This is inappropriate as premiums represent revenues of an insurance firm instead of output (Yuengert, 1993).[15]

Following the value added approach, the output of a life insurance company is therefore defined as follows in our study:

We approximate the risk-bearing function by the *incurred benefits net of reinsurance*. Incurred benefits represent payments received by policyholders in the current year and can be seen as proxies for the risk bearing/risk pooling function, as they measure the amount of funds

[15] Another approach would be to use physical output measures such as number of policies. Unfortunately, there is only limited data availability regarding physical measures.

which was distributed to the policyholders as compensation for occurred losses. The funds received by insurers that are not needed for benefit payments and expenses are added to policyholder reserves. *Additions to reserves* thus represent a suitable proxy for the intermediation function of the insurer. Finally, we include *bonuses and rebates* into our output measure as these funds benefit the policyholders besides the incurred benefits. By choosing incurred benefits net of reinsurance and the additions to reserves as output proxies, we follow the majority of the life insurance studies (e.g. Cummins et al. 1999, Cummins and Zi, 1998, Meador et al., 1997). Bonuses and rebates are also added by Fenn et al. (2007), for example.[16] All three output measures are correlated with real services provided by life insurers. Due to limited data availability, it is not able to split up the output measures according to the different insurance lines which are provided by life insurance firms.

Revenue of life insurers is measured by the *sum of premium and investment income* (e.g. Cummins and Weiss, 2000 and Fenn et al., 2007). Premium income is measured by the sum of gross written premiums less ceded reinsurance premiums less the change in the provision for unearned premiums.

Insurers' inputs can be classified into three principal groups: labour, business services and materials, and capital. In most cases, physical measures for these inputs (e.g. the number of employees) are not available, but there is information about the costs an insurance firms incurs for the use of the inputs. They are already valuated by the corresponding input prices, thus, they represent the product of input quantities and prices.

Using the new cost/new profit efficiency approach as suggested by Tone (2002) and Cooper et al. (2006) (see section 3) allows us to directly take into account cost measures. This approach shows the major advantage that the derivation of input quantities and suitable input prices, which is rather difficult in case of insurance firms is not necessary.

Further it is important to note that most studies derive input quantities by dividing cost values by a uniform price/wage index over all firms. Compared to our approach, this approach leads to the same CE values (see Färe and Grosskopf, 1994). Technically, input prices are set to one by convention (see section 3 for methodological details), as has also been done by Paradi (2006), Edvardsen et al (2006), and Mountain (1999), among others.

[16] We tested for the influence of the output measure bonuses and rebates by leaving this measure out and re-estimating cost and profit efficiency levels. Our results proved to be robust and hardly differed between both models.

To measure insurers' costs, we choose acquisition and administration expenses which sum up to operating expenses to proxy the insurers' inputs for labour and business services (following e.g. Cummins and Zi, 1998 and Berger et al, 1997). Thereby, both administration and acquisition expenses contain the insurers' expenses for labour and business services. This fact again shows the advantage of our approach, as it would not be possible to derive separated input quantities for labour and business services.

The consideration of financial capital is also important in case of insurance firms.[17] The use of financial equity capital is common, whereas financial debt is used less often in insurance studies.[18] The use of equity capital as an input arises from the fact that insurance is viewed as risky debt (e.g. Cummins and Danzon, 1997). According to this approach, insurance premiums are discounted in the market to account for the insurer's default risk. Better capitalized insurers should thus be able to realize higher prices for their products compared to less capitalized insurers, other things equal. The reason is that a higher amount of capital increases the probability that unexpectedly high losses will be paid (Cummins and Weiss, 2000).

In this study, financial equity capital is considered by considering the *statutory policyholders surplus,* following the majority of the studies. It could be argued that this variable does not represent the insurer's costs for equity capital, but rather should be valuated by the price the insurance firm pays for equity capital. To measure the cost of equity capital, it would therefore be preferable to have information about the market value expected return on equity (Cummins and Weiss, 2000). However, in the German market, only approx. 20 percent of the German stock insurance firms are listed on the German Stock Exchange (Elgeti and Maurer, 2000): Besides, there is also a significant number of mutual and public-owned insurance firms in the German market. One approach for the approximation of equity costs is the use of average book values of return on equity (net income divided by policyholder surplus), but this approach shows two important drawbacks: First, it reduces the number of observation periods significantly, as the average book values of return on equity are obtained for three or five

---

[17] Some studies also include physical capital as an input measure (e.g. Meador et al., 1997). But in general, the amount of physical capital used by insurance firms is rather small. We checked for the influence of physical capital by including *capital expenses* into our analysis. The consideration of capital expenses has slightly any influence on our results. To avoid an increase in the number of variables used in our analysis, capital expenses were thus left out from the analysis.

[18] Financial debt is less often used, as insurer's reserves have both input and output characteristics. It is much more common to treat insurer's reserves (or the corresponding additions to reserves) as an output following the value-added approach, as has also been done in this study.

years prior to the year of analysis. Second, average return on equity can turn negative. A second approach which does not encounter the problem of negative return on equity, but provides only small variety in equity costs among insurers is the so-called three-tier approach to measuring the cost of capital based on tier ratings. Insurance firms are divided into three tiers according to their ratings, where the lowest capital costs are assigned to the insurance firms with the highest rating. Compared to the average return on book value approach, the three-tier approach did not materially change the results (Cummins et al., 1999). A third approach which is used to determine insurers' equity costs assumes identical capital costs over all firms by choosing the total return of a determined stock exchange for each year of the observation period (e.g. Cummins and Rubio-Misas, 2006). Due to limited data availability and the small influence of the different approaches on the efficiency results found in other studies, we follow the last approach and again, set prices to 1.

Summarizing, we measure insurers' output by the sum of incurred benefits net of reinsurance, additions to reserves, and bonuses and rebates. Costs are measured by the sum of acquisition and administration expenses, and equity capital. Revenues represent the sum of net premium income and investment income.

Table 1 presents summary statistics for the variables used in the analysis as described above for every year of the observation period.

[Table 1 about here]

The results show a large dispersion in all the variables between the smallest and largest firms in the sample, as well as between the three analysed groups of insurers.

Direct insurers show the smallest average values in terms of operating expenses, and outputs over the whole sample. In terms of equity capital, premiums, and investment income, independent agency insurers show slightly lower values for some years compared to direct insurers. But in general, independent agency insurers show higher cost, output and revenue levels. The largest group consists of the multi-channel insurers. In terms of the output measure, they showed on average a 3.48/ 2.58 times larger output compared to the direct insurers and independent agency insurers, resp. in 1997. Until 2005, the difference in output terms had slightly decreased. The differences between these groups are also present in terms of costs, and revenues.

6 Results

This section presents our results. We begin with the analysis of cost efficiency, profit efficiency and scale economies as well as the discussion of returns to scale for the whole industry. We then turn to the comparison of cost and profit efficiency levels for the different groups of insurers.

6.1 Average Efficiencies in the German Life Insurance Industry

As presented in section 3, scale efficiency results are derived from the cost efficiency estimations with CRS and VRS. Table 2 shows the average efficiency scores for cost efficiency under CRS (CE^{CRS}) and VRS (CE^{VRS}), as well as the scale efficiency scores, and the profit efficiency scores (PE^{VRS}). Mean values are presented by year for all insurers and by total output size quartiles. We first focus on the discussion of efficiency results for the entire sample before turning to the discussion of the results for the single size quartiles. Since efficiency scores were estimated separately for every year in the observation period, conclusions about the development of efficiency between groups during the observation period can be drawn. Due to the fact that firms exited and entered the market during the observation period, the annual subsamples do not include the same number of observations each year. Thus, the resulting firm specific efficiency scores for the single years cannot be compared to each other. However, this approach allows analyzing the development of the differences in cost and profit efficiency levels between the different groups over time.

[Table 2 about here]

The results show that CE^{CRS} ranges between 0.36 and 0.48 during the observation period. CE^{VRS} ranges between 0.52 and 0.61. PE^{VRS} ranges from 0.48 to 0.61.

Due to the discrepancy between CE^{CRS} and CE^{VRS} it is important to analyse scale efficiency to determine how firms can improve their efficiency by adjusting their size. Scale efficiency ranges between 0.71 and 0.80 on average, meaning that firms could improve their efficiency by 29 /20 percent, respectively, by moving to the optimal size.

Figure 4 shows that for German insurers scale efficiency increases with firm size: the figure presents a scatter plot of scale efficiency scores against the logarithm of total output which measures the size of the insurance firms for the year 2000.[19] Scale efficiency scores increase up to an output size of approx. 2.7 billion € where firms show a scale efficiency of 1, i.e.

[19] Due to space limitations, figure 4 only presents the scatter plot for 2000, but the results are consistent and stable over the whole observation period.

operate at optimal size. For firms being larger than 2.7 billion €, scale efficiency decreases again. We also analyzed the nature of returns to scale for every firm. The results show that all of the firms up to the size of 2.7 billion € show increasing returns to scale, while firms which are larger show decreasing returns to scale.

These results are confirmed for the whole observation period. Table 2 shows that increasing returns to scale apply to the majority of the German life insurance firms with only a few firms operating under CRS or DRS. Over the whole observation period, only approximately the largest 20 percent of the firms show DRS on average.[20] With regards to the underlying technology, the maintained hypothesis should be VRS.

An analysis of the average efficiency scores, and returns to scale determination for the single size quartiles underlines our aforementioned results. Quartile 1 contains the smallest firms, and quartile 4 the largest firms. The results clearly shows a positive relationship between CE and PE levels and size quartile, with larger firms being more cost and profit efficient. This relationship holds true for the whole observation period.

Scale efficiency also increases from quartile 1 to quartile 3, but decreases slightly in quartile 4 (with the only exception in 2001). The reason for this decline can be seen in the fact that the majority of the firms in quartile 4 exhibit decreasing returns to scale, i.e. have exceeded their optimal size. The results are also confirmed by the nature of returns to scale by quartiles: All firms in the two smallest quartiles 1 and 2 show increasing returns to scale. With the only exception of year 2004, the majority of firms in quartile 3 also represent increasing returns to scale. Constant or decreasing returns to scale can only be found in quartiles 3 and 4, whereby the majority of the firms showing decreasing returns to scale belong to quartile 4.

6.2 Cost and Profit Efficiency Levels by Distribution Systems

Tables 3 and 4 report our results of the groupwise comparison of average cost efficiency, scale efficiency, and profit efficiency scores for the three different groups of insurers which are analyzed. We tested the groups of direct and independent agency insurers, respectively, against the group of multi-channel insurers. The results of these comparisons allow us to compare the performance of the two single-distribution channel approaches with the multi-channel approach.

---

[20] These results are broadly consistent for cost and profit efficiency estimations. Firms reach their optimal size at a similar size in case of profit efficiency, and the number of firms operating under DRS slightly increases.

To compare the mean efficiency scores of different subgroups in the sample, we employ the nonparametric Mann-Whitney-U test. Traditional parametric statistics (e.g. t-tests) are not applicable for comparisons of mean efficiency scores (Brockett and Golany, 1994 and Siegel, 1997).[21]. We start with the comparison of direct and multi-channel insurers before turning to the independent agency insurers.

[Table 3 about here]

[Table 4 about here]

Surprisingly enough, direct insurers show lower CE^{CRS} levels compared to multi-channel insurers. The differences between both groups are significant until the year 2000. The reason for the large differences in CE^{CRS} can be attributed to scale advantages: Direct insurers show much lower scale efficiency levels, the differences being significant in most years. Further, our analysis shows that direct insurers show IRS over the whole observation period, thus all of them are operating under decreasing. average costs costs and none of them has reached its optimal size. The analysis of CE^{VRS} hence shows that the differences in cost efficiency between both groups disappear: at the end of the observation period, direct insurers even show slightly higher efficiency scores compared to multi-channel insurers. Differences in PE^{VRS} between both groups are rather small and insignificant with the only exception of the year 1998. As profit efficiency is only estimated under the assumption of VRS, it can be stated that the relation between both groups in terms of CE^{VRS} translates into profit efficiency. Thus, there do not seem to be any systematic differences in the revenue efficiency of both groups.

From our results, we conclude that H_1 has to be rejected: Direct insurers do not show the expected cost advantage compared to multi-channel insurers. This seems to be due to the low scale efficiency direct insurers show, and which does not permit them to realize their cost advantages. Though direct insurers are able to recoup some of their cost disadvantages over time, they have not reached a sufficient firm size on average which would permit them to realize their theoretical cost advantages compared to multi-channel insurers.

We explain the limited growth of direct insurers by two aspects: First, the nature of life insurance products is complex, and thus life insurance products are regarded as rather counselling-intensive products. As direct insurers do not provide their customers with the opportunity of personal advice, customers could rather rely on multi-channel insurers for the

---

[21] Nonparametric estimations, e.g. DEA, do not make any assumptions about functional form and distribution, the resulting efficiency scores do not meet the requirements made by these types of tests, primarily the assumption of standard normal distribution (e.g. Greene, 2003)

provision with life insurance products, and mainly make use of direct insurers for the purchase of rather standardised products. In case of life insurance products, term life insurance would represent such a rather standardized and less complex insurance product. Actually, our data set shows that the share of term life insurance policies in direct insurers' portfolios is larger on average compared to multi-channel insurers' portfolios. Further, a direct insurer has been the market leader for term life insurance products since 1994 (AMB Generali, 2006). Second, direct insurers' growth could also be limited by the fact that multi-channel insurers are increasingly adopting direct distribution as an additional distribution channel. Thus customers which are willing to use direct distribution channels do not necessarily need to switch to a direct insurer (Krah, 2006). This fact is underlined by the importance of reputation in insurance markets. Due to the fact that insurance products represent credence or trust goods, customers face high switching costs. Direct insurers are mainly young firms which were founded after the liberalisation of the market. In contrast to established multi-channel insurers, they have not been able to build up a long-term reputation. Thus, customers could prefer to use additional channels of an established multi-channel insurer instead of switching to a direct insurer (Ennew and Waite, 2007).

The comparison of multi-channel insurers and independent agency insurers shows that independent agency insurers show lower cost efficiency levels, both under the assumption of CRS and VRS. This could be expected according to theoretical considerations in section 2, as the distribution via independent agents incurs high costs. The differences between both groups are significant over the whole observation period, both under CRS and VRS. Concerning the scale efficiency scores, independent agency insurers also show lower scores compared to multi-channel insurers, but the differences are much smaller than in case of the direct insurers, and only significant for some years within the observation period.

With regards to profit efficiency, agent-based insurers are not able to recoup their disadvantage in terms of cost inefficiency. They show lower average profit efficiency scores over the whole observation period and from 2000 on, the differences are statistically significant. Thus, we have also to reject H_2: Compared to multi-channel insurers, independent agency insurers are not able to recoup their higher costs by corresponding higher revenues which would lead to similar profit efficiency levels between either groups or even higher profit efficiency levels of independent agency insurers.

However, our result does not imply that independent agency insurers would not be able to provide their customers with higher service quality. It only states that the specialized distribution system of independent agency insurers does not seem to be superior neither in terms of costs nor in terms of revenues to a distribution via multiple channels. The differences in profit efficiency between both groups have increased since the beginning of the observation period. This result could indicate that independent agency insurers have lost part of their customer base over the observation period. The reason could be the increasing importance of distribution by independent agents for multi-channel insurers, which has been shown in section 2. Thus, insurance customers which want to make use of the services of independent agents are no longer limited to the product range of insurance firms working exclusively with independent agents. They have increasingly the opportunity to purchase products of multi-channel insurers.

Summarizing, it can be stated that we must reject both hypotheses H_1 and H_2. Our results show that direct insurers able to realize their expected cost advantage versus multi-channel insurers. Also, independent agency insurers are unable to take an advantage of their hypothesized service superiority. Thus, the distribution of life insurance products via multiple channels seems to be superior to specialized single distribution channels, as none of the specialised insurers shows comparative performance advantage.

7 Conclusions

The aim of the present paper is twofold: First, it analyses the performance of single-channel distribution and multi-channel distribution firms in the German life insurance. It is thus able to explain the structure of the industries' distribution systems, where the distribution of life insurance products is dominated by multi-channel distribution firms, while specialized single-distribution insurers have only small market shares. Second, our paper gives insight into cost and profit efficiency levels of German life insurance firms during the period 1997-2005, and delivers information about scale economies in the German life insurance industry.

Applying an empirical framework developed by Berger et al. (1997) we estimate cost and profit efficiency for three groups of life insurance firms which differ in their distribution systems: multichannel insurers, direct insurers, and independent agent insurers for a sample of German life insurers. Testing a set of hypothesis, we find economic evidence for the coexistence of the different distribution systems which is the absence of comparative performance advantages of specialised insurers.

According to economic theory, direct insurers should show higher cost efficiency compared to multiple channel insurers due to their theoretical cost advantages (H_1). Independent agent insurers should be able to compensate their higher costs by higher revenues compared to multiple channel insurers (H_2). However, our results show that both hypotheses have to be rejected: specialized single channel insurers do not outperform multichannel insurers in terms of cost or profit efficiency and, thus, do not represent a superior distribution system. This result explains why their market share has remained small despite of the increasing importance of direct distribution and the increasing use of independent agent insurers in the German life insurance market.

Our results also explain the development in the distribution systems of the German life insurance industry after its liberalisation. As had been expected, the dominance of exclusive agents which prevailed in the German life insurance industry until its liberalisation in 1994 has been declining for the benefit of the distribution via direct distribution channels, on the one hand, and independent agents, on the other hands. However, it is not the specialized direct and independent agent insurers which have benefited from this development mainly, but the multi-channel insurers which have succeeded in incorporating additional channels into their distribution systems. Thus, one might conclude that the distribution via multiple channels is superior to specialized distribution systems in the life insurance industry.

Further, our work is able to give insight into cost, profit, and scale efficiency levels in the German life insurance industry. With regards to cost efficiency, we obtain mean values which range from 0.36 to 0.48 (CE^{CRS}) and 0.52 to 0.61 (CE^{VRS}), respectively. These scores are in line with the existing DEA efficiency studies on cost efficiency on life insurance markets in general and Germany in particular: For the period 2002 to 2005, Ubl and Dobiky (2007) report CE estimates under the assumption of CRS for the German life insurance market, ranging from 0.35 to 0.39, which is similar to our CE^{CRS} results.[22] The profit efficiency we estimated ranges from 0.48 to 0.61. To our knowledge, there is no study which has analysed DEA profit efficiency for the German life insurance industry so far. [23]

We further find that most German life insurance firms operate under increasing returns to scale. This holds true for the whole observation period. These results are in line with the previous studies on returns to scale in life insurance industries which find an inverse

[22] For comparable results for the US life insurance industry see Cummins and Zi (1998) and Cummins et al. (1999).

[23] Berger et al. (1999) use a Distribution Free Approach (DFA) to estimate efficiency for US life insurance firms for the period 1988-1992, and report rather low profit efficiency scores; the average profit efficiency score is only 0.26. Though, the results should not be compared, as DFA efficiency scores are usually lower compared to DEA results (Cummins/Zi 1998). Paradi (2006) uses a DEA approach and reports average PE^{VRS} of 0.567 for a sample of Canadian life and health insurance firms for the year 1998. Thus his results are very similar to ours.

relationship between size and the percentage of firms operating under increasing returns to schale and a direct relationship between size and the proportion of firms operating with decreasing returns to scale (Cummins/Weiss, 2000). Our findings support also results from two recent studies: Bikker and van Leuvensteijn (2005) find that Dutch life insurance industries, on average, enjoy scale economies. Fenn et al. (2007) conclude that European insurance firms of all types seem to be operating under decreasing costs, i.e. under increasing returns to scale. This holds especially true for life insurance firms.

To sum up, our work represents a twofold contribution to the existing literature. It contributes to the previous research on the coexistence of different distribution systems in insurance industry which had been limited to the comparison of exclusive agent versus independent agent insurers so far. Further, it gives insight into cost, profit and scale efficiency levels of the German life insurance industry during the post-liberalisation period 1997-2005.

Future research should address the question if our results are transferable to other markets which show different distribution systems structures, e.g. the UK were independent agent insurers have a much longer tradition in the distribution of life insurance products. Prospective studies might also include the analysis of of distribution systems in other insurance lines characterized by differing product characteristics, e.g. distribution systems in property-liability insurance, where products are rather standardized, but higher service intensity is needed in case of claim occurance.

References

AMB Generali (ed.) (2006), *CosmosDirekt: Umsatz und Ertrag in 2006 deutlich gesteigert,* Presseinformation, Saarbrücken.

Anderson, E., Ross, W.T., Weitz, B. (1998), Commitment and Its Consequences in the American Agency System of Selling Insurance, *Journal of Risk and Insurance*, **65**, 637-669.

Bundesanstalt für Finanzdienstleistungsaufsicht (Federal Financial Supervisory Authority) (ed.) (2006), *Annual Report 2005*, Bonn/ Frankfurt am Main.

Banker, R.D. (1984), Estimating the Most Productive Scale Size Using Data Envelopment Analysis, *European Journal of Operational Research*, **17**, 35-44.

Banker, R.D /Charnes, A./ Cooper, W. (1984), Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis, *Management Science*, **30**, 1078-1092.

Barrese, J./Nelson, J. M. (1992), Independent and Exclusive Agency Insurers: A Reexamination of the Cost Differential, *Journal of Risk and Insurance*, **49**, 375-397.

Barrese, J./Doerpinghaus, H. I./ Nelson, J. M. (1995), Do Independent Agent Insurers Provide Superior Service? The Insurance Marketing Puzzle, *Journal of Risk and Insurance,* **62**, 297-308.

Berger, A. N./Cummins, J. D./Weiss, M. A. (1997), The Coexistence of Multiple Distribution Systems for Financial Services: The Case of Property-Liability Insurance, *Journal of Business*, **70**, 515-546.

Berger, A. N./Cummins, J. D./Weiss, M. A./Zi, H. (2000), Conglomeration versus Strategic Focus: Evidence from the Insurance Industry, *Journal of Financial Intermediation*, **9**, 323-362.

Berger, A.N./Humphrey, D.B. (1992), Measurement and Efficiency Issues in Commercial Banking, in Griliches, Z. (ed.), *Output Measurement in the Services Sectors*, National Bureau of Economic Research, Studies in Income and Wealth, Vol. 56, Chicago: University of Chicago Press, 245-279.

Bikker, J.A./van Leuvensteijn, M. (2005), An exploration into competition and efficiency in the Dutch life insurance industry, *CPB Discussion Paper*, no. 48, September 2005, CPB Netherlands Bureau for Economic Policy Analysis.

Briec, W./Keerstens, K./Leleu, H./Vanden Eeckaut, P. (2000), Returns to Scale on Nonparametric Deterministic Technologies: Simplifying Goodness-of-Fit Methods Using Operations on Technologies, *Journal of Productivity Analysis*, **14**, 267-274.

Brockett, P.L./Golany, B. (1994), Using Rank Statistics for Determining Programmatic Efficiency Differences in Data Envelopment Analysis, *Management Science*, 42, 466-472.

Brockett, P. L./Cooper, W. W./Golden, L. L./Rousseau, J. J./Wang, Y., (2005), Financial Intermediary versus Production Efficiency of Marketing Distribution Systems and Organizational Structure of Insurance Companies, *Journal of Risk and Insurance*, **72**, 393-412.

Cattani, K.D./Gilland, W.D./Swaminathan, J.M. (2004), Coordinating Traditional and Internet Supply Chains, in Simchi-Levi, D./Whu, S.D./Shen, Z.M. (eds.), *Handbook of Quantitative Supply Chain Analysis: Modelling in the E-Business Era*, Boston et al.: Kluwer.

Charnes, A./Cooper, W.W./Rhodes, E. (1978), Measuring the efficiency of decision making units, *European Journal of Operational Research*, **2**, 429-444.

Coelho, F.J./Easingwood, C. (2004), Multiple Channels in Services: Pro, Cons and Issues, *The Service Industries Journal*, **24**, 1-29.

Coelli, T./Rao, D.S. P./O' Donnell, C. J./Battese, G. E. (2005), *An introduction to efficiency and productivity analysis*, 2nd edition , New York et al.: Springer.

Cooper, W.W./Seiford, L.M./Tone, K. (2006), *Introduction to Data Envelopment Analysis and Its Uses*, New York et al.: Springer.

Cummins, J.D. (1999), Efficiency in the U.S. Life Insurance Industry: Are Insurers Minimizing Costs and Maximizing Revenues?, in Cummins, J.D./ Santomero, A.M. (eds.), Changes in the Life Insurance Industry: Efficiency, Technology, and Risk Management, Boston et al.: Kluwer.

Cummins, J.D./Danzon, P.M. (1997), Price Shocks and Capital Flows in Liability Insurance, *Journal of Financial Intermediation*, **6**, 3-38.

Cummins, J. D./Rubio-Misas, M. (2001), Deregulation, Consolidation, and Efficiency: Evidence from the Spanish Insurance Industry, Journal of Money, Credit, and Banking, **38**, 323-355.

Cummins, J.D./Tennyson, S./Weiss, M.A: (1999), Consolidation and Efficiency in the U.S. Life Insurance Industry, *Journal of Banking and Finance*, **23**, 325-357.

Cummins, J. D./VanDerhei, J. (1979), A note on the relative efficiency of property-liability insurance distribution systems, *Bell Journal of Economics and Management Science*, **10**, 708-719.

Cummins, J. D./Weiss, M. A./Zi, H. (1999), Organizational Form and Efficiency: The Coexistence of Stock and Mutual in the Property-Liability Insurers, *Mamagement Science,* **45**, 1254-1269.

Cummins, J.D./Weiss, M.A. (2000), Analyzing Firm Performance in the Insurance Industry Using Frontier Efficiency and Productivity Methods, in Dionne, G. (ed.), *Handbook of Insurance*, Boston et al: Kluwer.

Cummins, J.D./Zi, H. (1998), Comparison of Frontier Efficiency Methods: An Application to the U.S. Life Insurance Industry, *Journal of Productivity Analysis*, **10**, 131-152.

Dahmen, P. (2004), *Multi-Channel Distribution Strategies in the Financial Services Industry*, Wiesbaden: Deutscher Universitäts-Verlag.

Debreu, G. (1951), The Coefficient of Resource Utilization, *Econometrica*, **19**, 273-92.

De Young, R./Hazan, I. (1998), The performance of de novo commercial banks: A profit efficiency approach, *Journal of Banking and Finance,* **22**, 565-587.

Dzienziol, J./Eberhardt, M./Renz, A./Schackmann, J. (2002), Multi-Channel Pricing for Financial Services, in Sprague, R.H. (ed.), Proceedings of the 35th Hawaii International Conference on System Sciences, Los Alamitos, Calif. et al.: IEEE Computer Society. Easingwood, C./Coelho, F. (2003), Single versus Multiple Channel Strategies: Typologies and Drivers, *The Service Industries Journal*, 23, 31-46.

Easingwood, C./Storey, C. (1996), The Value of Multi-Channel Distribution Systems in the Financial Services Sector, The Services Industries Journal, **16**, 223-241.

Eckardt, M. (2007), *Insurance Intermediation – An Economic Analysis of the Information Services Market*, Heidelberg: Physica.

Edvardsen, D.F./Forsund, F.R./Hansen, W./Kittelsen, S.A.C./Neurater, T. (2006), Productivity and Regulatory Reform of Norwegian Electricity Distribution Utilities, in Coelli, T./Lawrence, D. (eds.), *Performance Measurement and Regulation of Network Utilities*, Cheltenham: Edward Elgar, 97-131.

Elgeti, R./Maurer, R. (2000), Zur Quantifizierung der Risikoprämien deutscher Versicherungsaktien im Kontext eines Multifaktorenmodells, Zeitschrift für die gesamte Versicherungswissenschaft, **89**, 577-603.

Ennew, C.T./Waite, N. (2007), *Financial Servies Marketing*, Amsterdam et al.: Elsevier.

Färe, R./Grosskopf, S., Lovell, C.A.K. (1983), The Structure of Technical Efficiency, *Scandinavian Journal of Economics*, 85, 181-190.

Färe, R./Grosskopf, S. (1985), A nonparametric cost approach to scale efficiency, *The Scandinavian Journal of Economics*, **87**, 594-604.

Färe, R./Grosskopf, S./Lovell, C. A. K. (1994), *Production Frontiers*, Cambridge et al.: Cambridge University Press.

Farrell, M.J. (1957), The Measurement of Technical Efficiency, *Journal of the Royal Statistical Society*, Series A, General, 120, Part 3, 253-81.

Ferrier, G. D./ Lovell, C.A.K. (1990), Measuring Cost Efficiency in Banking – Econometric and Linear Programming Evidence, *Journal of Econometrics*, **46**, 229-245.

Fenn, P. Vencappa, D./ Diacon, S./ O'Brien, C./ Klumpes, P.(2007), Market Structure and the Efficiency of European Insurance Companies: A Stochastic Frontier Approach, *Journal of Banking and Finance*, forthcoming 2007.

Finsinger, J./Schmidt, F.A. (1993), Gebundener versus ungebundener Vertrieb, Schmalenbachs Zeitschrift für betriebswirtschaftliche Forschung, **45**, 216-226.

Gesamtverband der Deutschen Versicherungsindustrie (German Insurance Association) (ed.) (2006,) *Die Deutsche Lebensversicherung in Zahlen 2005*, Berlin.

Greene, W.H. (2203), *Econometric analysis*, 5th edition, Upper Sadle River, N.J. et al: Prentice-Hall.

Hancock, D. (1985), The Financial Firm: Production with Monetary and Nonmonetary Goods, *Journal of Political Economy*, 93, 859-880.

Hoppenstedt (ed.) (1999), *Versicherungsjahrbuch 1999*, Darmstadt et al.: Hoppenstedt.

Hoppenstedt (ed.) (2000), *Versicherungsjahrbuch 2000*, Darmstadt et al.: Hoppenstedt.

Hoppenstedt (ed.) (2001), *Versicherungsjahrbuch 2001*, Darmstadt et al.: Hoppenstedt.

Hoppenstedt (ed.) (2002), *Versicherungsjahrbuch 2002*, Darmstadt et al.: Hoppenstedt.

Hoppenstedt (ed.) (2003), *Versicherungsjahrbuch 2003*, Darmstadt et al.: Hoppenstedt.

Hoppenstedt (ed.) (2004), *Versicherungsjahrbuch 2004*, Darmstadt et al.: Hoppenstedt.

Hoppenstedt (ed.) (2005), *Versicherungsjahrbuch 2005*, Darmstadt et al.: Hoppenstedt.

Hoppenstedt (ed.) (2006), *Versicherungsjahrbuch 2006*, Darmstadt et al.: Hoppenstedt.

Hoppenstedt (ed.) (2007), *Versicherungsjahrbuch 2007*, Darmstadt et al.: Hoppenstedt.

Joskow, P. L. (1973), Cartels, competition and regulation in the property-liability insurance industry, *Bell Journal of Economics and Management Science*, **4**, 375-427.

Keerstens, K./ Vanden Eeckaut, P. (1999), Estimating returns to scale using non-parametric deterministic technologies: A new method based on goodness-of-fit, European Journal of Operational Research, **113**, 206-214.

Koopmans, T.C. (1951), Analysis of Production as an Efficient Combination of Activities, in Koopmans, T.C. (ed.), *Activity Analysis of Production and Allocation*, Cowles Commission for Research in Economics, Monograph No. 13, New York: Wiley, 33-97.

Klumpes, P. J.M. (2004), Performance Benchmarking in Financial Services: Evidence from the UK Life Insurance Industry, *Journal of Business*, **77**, 257-273.

Krah, E.-S. (2006), Die Allianz baut kräftig um, *Versicherungsmagazin*, **53**, 24-25.

Kumbakar, S.C./Lovell C.A.K. (2000), *Stochastic Frontier Analysis*, Cambridge: University Press.

Maurer, R./Somowa, B (2007), The German Insurance Industry: Market Overview and Trends, in Cummins, J.D./Venard, B. (Eds.), *Handbook of International Insurance*, New York et al.: Springer.

Mayers, D./Smith, C.Jr. (1981), Contractual Provisions, Organizational Structure, and Conflict Control in Insurance Markets, *Journal of Business*, **54**, 407-434.

Meador, J.W./Ryan, H.E.Jr./Schellhorn, C.D. (1997), Product Focus Versus Diversification: Estimates of X-Efficiency for the U.S. Life Insurance Industry, T*he Wharton Financial Institutions Working Paper Series* 97-16, The Wharton School: University of Philadelphia.

Mountain, C. (1999), Factor price misspecification in bank cost function estimation, *Journal of International Financial Markets, Institutions and Money*, **9**, 163-82.

Muth, M. (1993), The new world of financial services: facing up to the losses, *The McKinsey quaterly*, **2**, 73-92.

Neuberger, D. (2007) The Evolution of Direct Banking: Entry, Exit and Long-Run Equilibrium, in Cornwall, L.M. (ed.), *New Developments in Banking and Finance*, New York: Nova Science Publishers, 137-158.

O' Shaughnessy, J. (1988), *Competitive Marketing: A Strategic Approach*, Boston: Unwin Hyman.

Paradi, J. (2006), Profit Efficiency – Health Insurance, in Avkiran, N.K. (ed.), *Productivity Analysis in the Service Sector with Data Envelopment Analysis*, 3rd ed., Ipswich, Queensland : N.K. Avkiran.

Ray, S.C. (2004), *Data Envelopment Analysis – Theory and Techniques for Economics and Operational Research*, Cambridge: University Press.

Regan, L./Tennyson, S. (1996), Agent Discretion and the Choice of Insurance Marketing System, *Journal of Law and Economics*, **39**, 637-666.

Regan, L. (1997), Vertical Integration in the Property-Liability Insurance Industry: A Transaction Cost Approach, *Journal of Risk and Insurance*, **64**, 41-62.

Siegel, S. (1997), *Nichtparametrische statistische Methoden*, 4., unveränderte Auflage, Frankfurt a.M.: Verlag Dietmar Klotz.

SwissRe (Ed.) (2000), E-Business in der Versicherungswirtschaft: Zwang zur Anpassung – Chance zur Erneuerung?, *sigma*, 5/2000,1-34.

SwissRe (Ed.) (2006), World Insurance in 2005: moderate premium growth, attractive profitability – Statistical appendix, *sigma 5/2006*, update December 2006, 1-14.

Tillinghast Towers Perrin (Ed.) (2004), *Tillinghast Vertriebswege-Survey 2002/2003 – Executive Summary*, Köln.

Tillinghast Towers Perrin (Ed.) (2006), *Vertriebswege-Survey Deutschland 2006 – Executive Summary*, Köln.

Tone, K. (2002), A strange case of the cost and allocative efficiencies in DEA, *Journal of the Operational Research Society*, 53, 1225-1231.

Trigo Gamarra, L. (2007), Does the Product Quality Hypothesis Hold True? – Service Quality Differences between Independent and Exclusive Insurance Agents, *Thünen-Series of Applied Economic Theory*, no. 76, March 2007.

Tsay, A.A./ Agrawal, N. (2004), Modeling Conflict and Coordination in Multi-Channel Distribution Systems, in Simchi-Levi, D./Wu, D.S./ Shen, Z.-J. (eds.), Handbook of Quantitative Supply Chain Analysis, New York et al.: Springer.

Ubl, E./Dobiky, F. (2007), Ownership and Efficiency in the German Life Insurance Market: A DEA Bootstrap Approach, working paper.

Webb. K.L. (2002), Managing channels of distribution in the age of electronic commerce, *Industrial Marketing Management*, **31**, 95-102.

Wilson, P.W. (1993), Detecting outliers in deterministic nonparametric frontier models with multiple ouputs, *Journal of Business and Economic Statistics,* **11**, 319-23.

Yuengert, A. (1993), The Measurement of Efficiency in Life Insurance: Estimates of a Mixed Normal-Gamma Error Model, *Journal of Banking and Finance* **17**, 483-96.

Zhu, J. (2003), Quantitative Models For Performance Evaluation And Benchmarking, Boston et al.: Kluwer.

Zweifel, P., Ghermi, P. (1990), Exclusive vs. Independent Agencies: A Comparison of Performance, The Geneva Papers on Risk and Insurance Theory, **15**, 171-192.

Figure 1: Input-oriented technical efficiency under CRS and VRS, one input-one output case

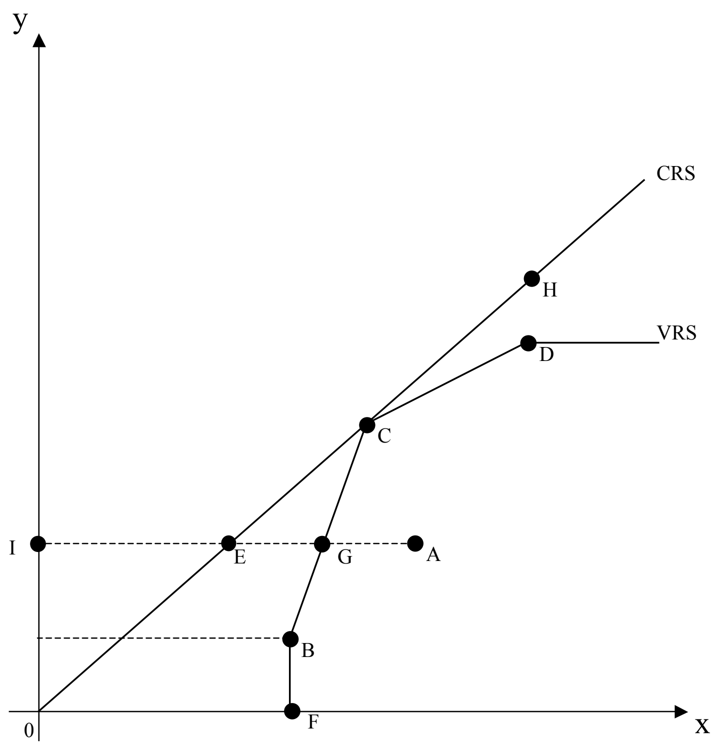

Figure 2: Cost efficiency measurement in the two input-one output case under CRS

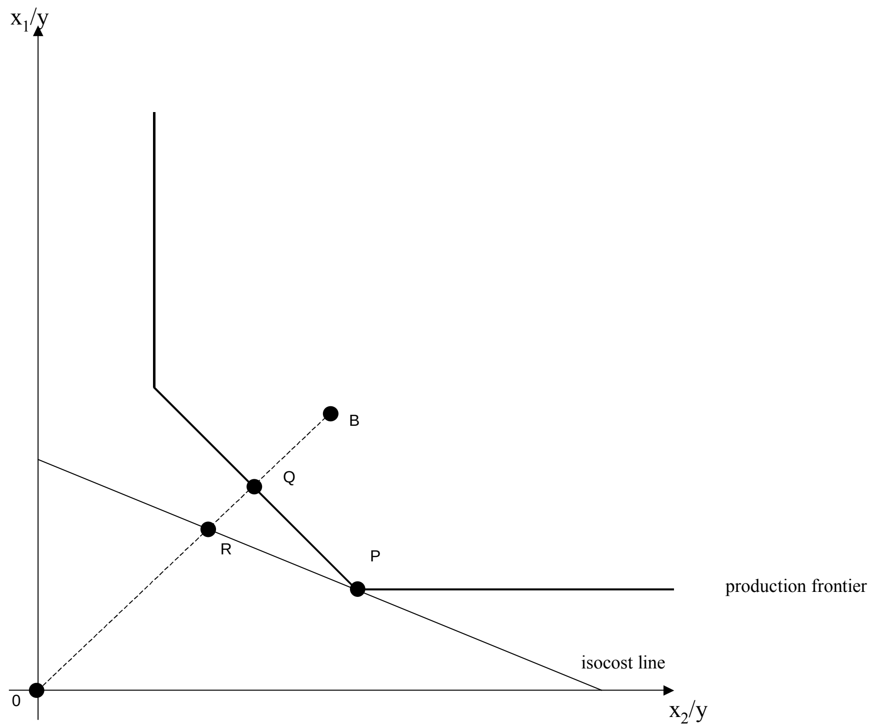

Figure 3: Profit efficiency measurement in the one input-one output case under VRS

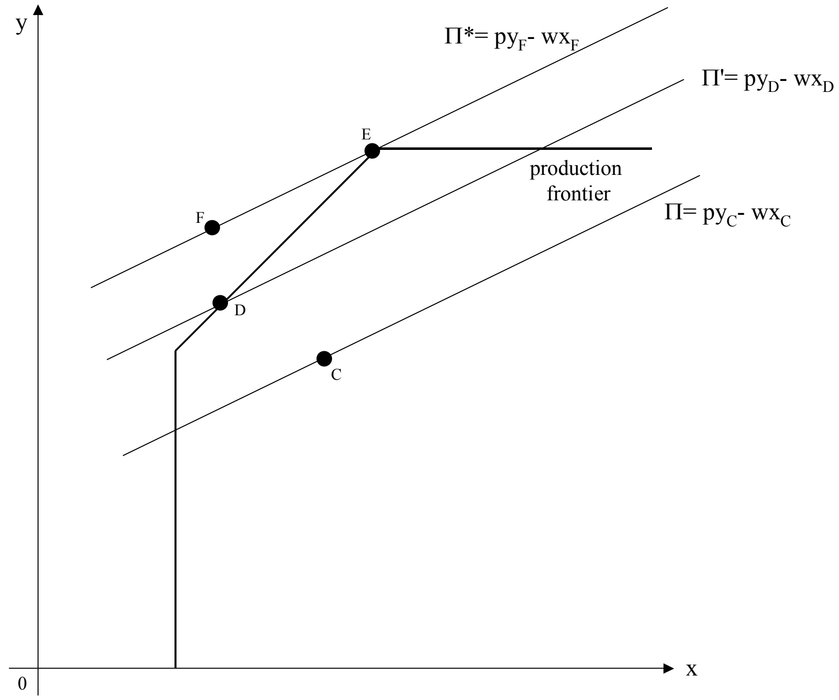

Table 1: Outputs, Costs, and Revenues for German Life Insurance Firms, 1997-2005

1997												
	Multi-channel insurer			Direct insurers			Independent agent insurers			Total		
	Mean (Std. Dev.)	Min	Max	Mean (Std. Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.
Operating expenses	71490.10 (91610.28)	1479.96	480515.99	15781.50 (18565.84)	761.57	49941.34	38551.41 (40695.31)	224.40	104870.17	61480.89 (83873.58)	224.40	480515.99
Equity capital	45531.04 (59737.20)	1638.33	286459.97	17197.88 (22286.88)	1268.47	71987.34	14561.20 (10813.86)	2495.72	35745.44	38727.46 (54416.86)	1268.47	286459.97
Output	665393.96 (841210.13)	16929.43	3605517.22	191125.66 (340009.05)	375.32	1034803.52	257480.60 (366517.78)	985.49	1110370.48	564821.09 (777453.70)	375.32	3605517.22
Premiums (net of reinsurance)	421225.06 (514967.12)	11904.23	2203442.63	155341.95 (250342.17)	2283.24	750610.51	189567.29 (239347.20)	1041.58	729265.52	364483.79 (476645.65)	1041.58	2203442.63
Investment income	302979.71 (390573.78)	3468.31	1810744.74	73291.94 (152810.95)	258.16	471480.34	115221.79 (156653.97)	357.95	485890.23	255452.37 (360522.05)	258.16	1810744.74
n	64			9			10			83		

1998												
	Multi-channel insurer			Direct insurers			Independent agent insurers			Total		
	Mean (Std. Dev.)	Min	Max	Mean (Std.Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.
Operating expenses	75244.55 (7541.33)	1486.66	475679.53	14706.06 (19535.24)	732.05	54076.06	38204.53 (42493.02)	106.72	118148.87	63174.95 (88580.20)	106.72	475679.53
Equity capital	50666.22 (6017.86)	1653.51	337217.44	17885.23 (24790.38)	2112.50	82675.90	17376.76 (12009.19)	4838.29	41588.49	42404.65 (59571.72)	1653.51	337217.44
Output	717843.49 (902658.89)	12600.30	3891376.61	174614.37 (341555.60)	348.24	1124836.65	235807.11 (372175.59)	1295.26	1225368.03	590017.87 (829585.85)	348.24	3891376.61
Premiums (net of reinsurance)	458380.36 (563632.78)	10229.26	2289492.51	141669.82 (252033.80)	408.87	814164.17	172832.33 (239860.69)	986.10	802353.05	383267.40 (518166.66)	408.87	2289492.51
Investment income	344094.29 (445027.14)	4991.12	2155050.48	78837.00 (185464.25)	22.55	625372.01	106221.53 (161486.61)	425.91	526065.23	281351.86 (408548.47)	22.55	2155050.48
n		69			11			12			92	

1999												
	Multi-channel insurer			Direct insurers			Independent agent insurers			Total		
	Mean (Std. Dev.)	Min	Max	Mean (Std.Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.
Operating expenses	109955.98 (143402.42)	1796.73	724927.76	18404.26 (23938.36)	636.22	68182.58	58768.52 (69916.92)	166.37	200539.89	93506.88 (131402.27)	166.37	386166.49
Equity capital	56672.63 (73302.08)	1663.64	386166.49	21092.45 (27837.42)	2806.51	90744.08	18624.13 (14142.13)	4868.42	43355.50	47937.32 (66613.19)	1663.64	4120042.51
Output	865196.56 (1050325.28)	5468.28	4120042.51	216338.23 (389890.89)	3124.61	1232148.87	263611.73 (394942.11)	1698.93	1327350.51	717803.00 (971548.19)	1698.93	2472583.68
Premiums (net of reinsurance)	542502.22 (652739.43)	2232.81	2472583.68	174494.42 (283113.38)	4426.79	877200.36	192535.63 (264296.77)	1408.55	901463.82	457774.51 (603170.63)	1408.55	2339792.33
Investment income	405192.68 (505059.75)	5868.62	2339792.33	90908.48 (186718.10)	634.71	601581.35	119145.18 (177897.74)	490.02	578935.16	334489.32 (466515.65)	490.02	724927.76
n	71			10			12			93		

2000												
	Multi-channel insurer			Direct insurers			Independent agent insurers			Total		
	Mean (Std. Dev.)	Min	Max	Mean (Std.Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.
Operating expenses	97909.80 (147833.59)	1122.00	843474.00	17233.60 (21685.05)	420.00	56427.00	71564.33 (82972.30)	123.00	285024.00	85002.82 (133712.12)	123.00	843474.00
Equity capital	73461.38 (133513.97)	1687.00	943094.00	23066.50 (30138.21)	2726.00	98000.00	20240.75 (16596.61)	4939.00	53248.00	60328.09 (117949.89)	1687.00	943094.00
Output	1083910.69 (1918057.36)	13801.00	13501076.00	232036.70 (385557.94)	4350.00	1184012.00	276499.42 (404306.53)	2154.00	1328884.00	874627.07 (1704500.53)	2154.00	13501076.00
Premiums (net of reinsurance)	681127.94 (1088798.48)	9460.00	7359222.00	199397.20 (307958.98)	5514.00	936858.00	211211.67 (260212.73)	1703.00	883050.00	560940.55 (971590.69)	1703.00	7359222.00
Investment income	552107.00 (1045628.17)	5166.00	7433390.00	98003.50 (190399.67)	1214.00	610123.00	128162.92 (194041.58)	600.00	632337.00	441436.15 (926780.84)	600.00	7433390.00
n	65			10			12			87		

2001												
	Multi-channel insurer			Direct insurers			Independent agent insurers			Total		
	Mean (Std. Dev.)	Min	Max	Mean (Std.Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.
Operating expenses	134494.35 (210914.95)	1161.18	1229533.54	17959.66 (21996.13)	1119.82	56808.99	58549.42 (58433.97)	5514.32	162215.99	111891.08 (189694.46)	1119.82	1229533.54
Equity capital	97070.61 (157819.71)	3929.20	1101824.20	17922.78 (15892.72)	4315.92	45777.25	31040.89 (29629.25)	7235.93	87107.26	79912.77 (141455.93)	3929.20	1101824.20
Output	1031580.51 (1813338.5)8	2878.66	12786620.81	140414.10 (174130.17)	5948.60	464502.79	225907.80 (395082.56)	9714.43	1248947.92	830615.20 (1627870.04)	2878.66	12786620.81
Premiums (net of reinsurance)	807078.90 (1302804.42)	9691.68	8732933.42	152310.38 (195261.07)	11763.82	517204.73	226614.44 (300396.92)	12532.08	975058.90	660859.39 (1171781.05)	9691.68	8732933.42
Investment income	626032.50 (1283923.43)	6174.01	9366708.21	74897.45 (104634.20)	1426.92	295932.87	114769.76 (182526.56)	598.69	566171.87	500121.97 (1143912.67)	598.69	9366708.21
n	62			8			11			81		

2002												
	Multi-channel insurer			Direct insurers			Independent agent insurers			Total		
	Mean (Std. Dev.)	Min	Max	Mean (Std.Dev.)	Min.	Max.	Mean (std. Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.
Operating expenses	134494.35 (210914.95)	1161.18	1229533.54	17959.66 (21996.13)	1119.82	56808.99	58549.42 (58433.97)	5514.32	162215.99	111891.08 (189694.46)	1119.82	1229533.54
Equity capital	97070.61 (157819.71)	3929.20	1101824.20	17922.78 (15892.72)	4315.92	45777.25	31040.89 (29629.25)	7235.93	87107.26	79912.77 (141455.93)	3929.20	1101824.20
Output	1031580.51 (1813338.58)	2878.66	12786620.81	140414.10 (15892.72)	5948.60	464502.79	225907.80 (395082.56)	9714.43	1248947.92	830615.20 (1627870.04)	2878.66	12786620.81
Premiums (net of reinsurance)	807078.90 (1302804.42)	9691.68	8732933.42	152310.38 (195261.07)	11763.82	517204.73	226614.44 (300396.92)	12532.08	975058.90	660859.39 (1171781.05)	9691.68	8732933.42
Investment income	626032.50 (1283923.43)	6174.01	9366708.21	74897.45 (104634.20)	1426.92	295932.87	114769.76 (182526.56)	598.69	566171.87	500121.97 (1143912.67)	598.69	9366708.21
n		61			9			10			80	

2003												
	Multi-channel insurer			Direct insurers			Independent agent insurers			Total		
	Mean (Std. Dev.)	Min	Max	Mean (Std.Dev.)	Min.	Max.	Mean (std. Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.
Operating expenses	118310.35 (146598.77)	1454.64	617001.44	23133.63 (23829.30)	715.83	60847.22	68178.84 (66376.34)	7442.49	178662.61	100709.89 (133168.39)	715.83	617001.44
Equity capital	89703.78 (97926.79)	4232.25	420935.41	51766.63 (95346.70)	4361.83	301482.50	35139.84 (29714.73)	7835.41	88309.82	77933.30 (92911.17)	4232.25	420935.41
Output	920842.12 (1107858.94)	12590.16	4171369.35	306220.88 (377201.16)	6647.25	1045807.79	315279.73 (413517.92)	16791.06	1364558.91	768432.40 (1011561.34)	6647.25	4171369.35
Premiums (net of reinsurance)	705769.52 (837311.44)	7789.43	3032742.57	276004.12 (315865.44)	14032.26	840557.25	263052.91 (318241.48)	10340.28	1068751.81	596547.38 (763396.68)	7789.43	3032742.57
Investment income	494271.71 (639754.22)	6867.74	2828119.03	138571.64 (187104.01)	2321.99	574130.32	140468.14 (210406.63)	1153.68	689348.88	405607.46 (581980.00)	1153.68	2828119.03
n	60			9			11			80		

2004												
	Multi-channel insurers			Direct insurers			Independent agent insurers			Total		
	Mean (Std. Dev.)	Min	Max	Mean (Std.Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.
Operating expenses	163287.66 (209300.00)	1478.30	881012.90	27681.62 (27691.16)	754.02	71825.18	83804.65 (89733.44)	5563.82	225699.43	138407.60 (191354.88)	754.02	881012.90
Equity capital	106901.18 (135125.06)	3330.43	784437.80	55629.33 (97915.98)	5181.50	311697.00	33367.93 (29821.04)	7962.88	105941.93	92126.13 (125426.16)	3330.43	784437.80
Output	937895.23 (1093076.12)	12391.42	4159399.46	322551.47 (400133.70)	2435.17	1165112.77	279674.51 (293195.84)	20901.22	746233.42	788261.88 (1005391.99)	2435.17	4159399.46
Premiums (net of reinsurance)	753928.74 (901867.34)	7252.40	3256099.43	287619.69 (323591.59)	3758.42	878850.67	306752.33 (360091.56)	22520.77	1164044.39	646909.66 (826505.42)	3758.42	3256099.43
Investment income	342746.95 (412606.40)	5374.78	1595722.97	134033.84 (180541.48)	45.67	548980.72	132630.74 (207238.64)	1104.48	658715.06	293616.33 (381939.11)	45.67	1595722.97
n		62			9			10			81	

	2005											
	Multi-channel insurer			Direct insurers			Independent agent insurers			Total		
	Mean (Std. dev.)	Min	Max	Mean (Std.dev.)	Min.	Max.	Mean (Std. dev.)	Min.	Max.	Mean (Std. Dev.)	Min.	Max.
Operating expenses	114033.04 (142508.12)	1675.40	610685.29	23938.09 (27745.76)	1123.07	75868.48	65213.82 (70903.01)	2123.76	187892.92	96668.77 (129812.99)	1123.07	610685.29
Equity capital	117240.31 (143284.21)	5360.85	800598.00	53478.54 (97087.69)	5283.96	322734.00	37154.91 (37197.48)	8120.33	127747.43	99259.41 (132526.85)	5283.96	800598.00
Output	1060494.36 (1239131.02)	21321.02	4962515.02	358402.28 (459015.78)	6820.73	1270142.40	414714.71 (502232.49)	19988.93	1580092.67	892010.39 (1133976.93)	6820.73	4962515.02
Premiums (net of reinsurance)	792810.37 (902858.21)	13590.57	3450666.51	300326.19 (354097.08)	10140.13	871895.14	344564.25 (408646.25)	21054.60	1284288.55	675219.08 (827179.50)	10140.13	3450666.51
Investment income	437933.50 (537406.05)	11149.49	2289547.56	129540.45 (181030.02)	620.56	565360.66	142171.26 (203215.37)	1367.83	612107.27	362414.09 (491390.27)	620.56	2289547.56
n	60			10			10			80		

Note: All monetary variables are expressed in 2000 Thousend Euro units by deflating with the German Consumer Price Index

Table 2: Average efficiency results for German life insurance firms, 1997-2005

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Quartile 1									
CE^{CRS}	0.192	0.190	0.217	0.194	0.215	0.182	0.218	0.247	0.198
CE^{VRS}	0.530	0.520	0.517	0.552	0.536	0.513	0.547	0.512	0.566
SE	0.410	0.405	0.459	0.381	0.388	0.359	0.426	0.518	0.367
PE^{VRS}	0.472	0.340	0.376	0.416	0.418	0.307	0.484	0.435	0.476
% IRS/% CRS/% DRS	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0
Quartile 2									
CE^{CRS}	0.449	0.447	0.418	0.419	0.358	0.420	0.363	0.442	0.394
CE^{VRS}	0.523	0.524	0.473	0.473	0.449	0.540	0.457	0.485	0.514
SE	0.856	0.848	0.884	0.877	0.792	0.782	0.802	0.918	0.772
PE^{VRS}	0.503	0.476	0.453	0.446	0.384	0.463	0.509	0.488	0.505
% IRS/% CRS/% DRS	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0
Quartile 3									
CE^{CRS}	0.532	0.603	0.551	0.582	0.477	0.462	0.442	0.500	0.407
CE^{VRS}	0.546	0.619	0.563	0.595	0.505	0.491	0.458	0.518	0.421
SE	0.971	0.973	0.977	0.977	0.944	0.941	0.962	0.966	0.962
PE^{VRS}	0.541	0.624	0.636	0.611	0.596	0.591	0.668	0.593	0.575
% IRS/% CRS/% DRS	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	100/ 0/ 0	75.0 /5.0/ 20.0	0.35/ 5.0/ 60.0	90.0/ 5.0/ 5.0
Quartile 4									
CE^{CRS}	0.674	0.694	0.610	0.699	0.548	0.532	0.486	0.495	0.439
CE^{VRS}	0.760	0.789	0.753	0.731	0.612	0.561	0.597	0.605	0.617
SE	0.907	0.890	0.823	0.959	0.920	0.963	0.841	0.828	0.727
PE^{VRS}	0.818	0.833	0.827	0.830	0.821	0.543	0.773	0.762	0.735
% IRS/% CRS/% DRS	14.3/ 4.8/ 81.0	21.7/4.3/73.9	8.7/4.3/87.0	61.9/4.8/33.3	65.0/5.0/30.0	100/ 0/ 0	0 /0 /100	0/ 0/ 100	0/ 0/ 100
Total sample									
CE^{CRS}	0.461	0.484	0.450	0.471	0.397	0.399	0.377	0.419	0.360
CE^{VRS}	0.590	0.613	0.576	0.586	0.526	0.526	0.515	0.530	0.530
SE	0.784	0.779	0.788	0.797	0.756	0.761	0.758	0.804	0.707
PE^{VRS}	0.584	0.568	0.574	0.573	0.553	0.476	0.608	0.568	0.573
% IRS /% CRS/% DRS	78.3/ 1.2/ 20.5	80.4/ 1.1/ 18.5	77.4/ 1.1/ 21.5	90.8 /1.1/ 8.0	91.4/ 1.2/ 7.4	95.0/ 1.3/ 3.8	68.8/ 1.3/ 30.0	59.3/ 1.2/ 39.5	72.5/1.3/ 26.3

Figure 4: Scale efficiency vs. size for German life insurance firms in 2000

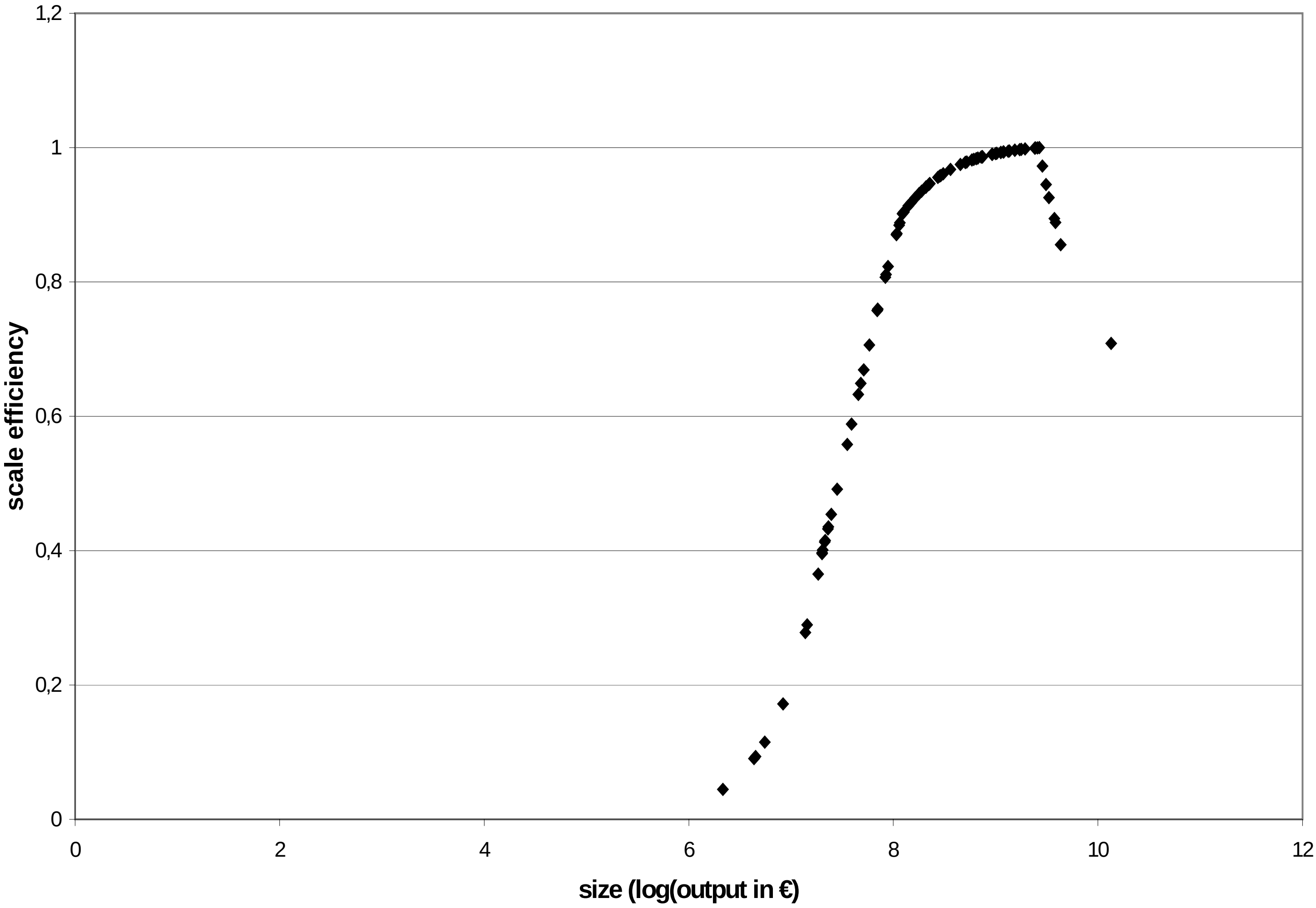

Table 4: Comparison of average cost and scale efficiency by groups, 1997-2005

	Multi-Channel Insurers			Direct insurers			Independent agent insurers		
	CE^{RS}	CE^{VRS}	SE	CE^{CRS}	CE^{VRS}	SE	CE^{CRS}	CE^{VRS}	SE
1997	0,508	0,604	0,843	0,282*	0,622	0,482*	0,322*	0,473*	0,677
1998	0,552	0,646	0,849	0,25*	0,607	0,444*	0,230*	0,430*	0,682*
1999	0,499	0,605	0,836	0,230*	0,577	0,525*	0,282*	0,406*	0,722
2000	0,538	0,620	0,862	0,307*	0,607	0,516*	0,246*	0,384*	0,678*
2001	0,435	0,551	0,803	0,320	0,584	0,540*	0,239*	0,341*	0,651*
2002	0,439	0,547	0,821	0,325	0,601	0,546*	0,223*	0,335*	0,591*
2003	0,401	0,527	0,786	0,370	0,618	0,636	0,256*	0,359*	0,701
2004	0,447	0,550	0,833	0,380	0,576	0,638	0,279*	0,363*	0,773
2005	0,384	0,544	0,737	0,308	0,560	0,563	0,263*	0,410*	0,667

*: Differences between efficiency scores are statistically significant between groups according to the Mann-Whitney-U-test.
Multichannel insurers were tested against direct and independent agent insurers, resp. Detailed test results are available from the author on request.

Table 5: Comparison of average profit efficiency scores by groups, 1997-2005

	Multichannel insurers	Direct insurers	Independent agent insurers
	PE^{VRS}	PE^{VRS}	PE^{VRS}
1997	0.597	0.575	0.507
1998	0.624	0.357*	0.440
1999	0.615	0.437	0.446
2000	0.624	0.486	0.367*
2001	0.588	0.616	0.309*
2002	0.501	0.513	0.290*
2003	0.637	0.767	0.321*
2004	0.588	0.628	0.387*
2005	0.606	0.582	0.362*

***:** Differences between efficiency scores are statistically significant between groups according to the Mann-Whitney-U-test.
Multichannel insurers were tested against direct and independent agent insurers, resp. Detailed test results are available from the author on request.