# Dynamic Simulation for Strategic Insurance Management

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*In this paper, a dynamic model-based management consultancy project carried out for a major insurance company in Turkey is presented. The objective of the project was to address certain strategic managerial problems of the company by using systemic dynamic simulation. The main strategic problem of concern was the fact that the company exhibited a fast growth between 1988 and 1993, followed by a persistent stagnation and even a slight decline. This article describes the main structures of the model, presents the validity tests and lists the major results of the study. The model is developed and validated using real data of seven years, between 1989 and 1996. Dynamic behavior of the model for all the major variables exhibits close resemblance to the real time histories. The main profit of the model is that it generates a systemic and dynamic understanding of company's internal and external interactions so as to enable creative solutions for the existing and potential problems. One of the recommendations of the project has been actually initiated as a pilot project. A new interactive gaming version of the model is in the final stages of the completion. The model and the game version can be used as a "learning laboratory" in the company, which would be a first step toward "organizational learning".*

## 1. Introduction

This paper summarizes a model-based management consultancy project carried out for Halk Sigorta, one of the leading firms in the Turkish insurance sector. Managing directors of Halk Sigorta felt that the company had some potential problems and requested that an external team (Bogaziçi University socio-economic system dynamics research group – SESDYN) analyze these problems scientifically. The project was carried out in 1996-1997. The main objective of the project was to address certain managerial/organizational problems of the company by using dynamic simulation analysis. The dynamics behind the organizational problems of the company were analyzed by building a management simulation model of the company. While the project focused mainly on the "strategic", long-term management problems, some "tactical" short-term problems in the "claims" and "accident" departments were modeled as well. In this paper, we focus only on the strategic, long-term problems, present the strategic simulation model and summarize the results obtained at the end of the project. (See Barlas et al. 1997, for summary descriptions of the "claims" and "accident" models).

## 2. The company and strategic problems

Halk Sigorta functions countrywide in five regional divisions and has over 500 agencies. The company is the sixth biggest insurance firm in Turkey in terms of total premium revenues. The central division which is located in İstanbul, generates about 45 per cent of total policies. Ninety per cent of the policy underwriting are performed by agencies, whereas the remaining ten per cent are done directly by the sales personnel of the company. The company specializes in "elementary" insurance branches (branches other than life and health insurances). Like most elementary insurance companies, most of its revenues (about 80 per cent) are obtained from “accident” and “fire” policies.

Top management of Halk Sigorta was concerned about two potential problems. The first one had to do with the fact that the company exhibited a fast growth between 1988 and 1993, followed by a persistent stagnation and even a slight decline. In 1996, after three years of stagnation, management had enough reason to believe that the problem may not be of temporary, short-term nature. The second question raised by top management was the continuous demand by various departments for additional employees, in spite of stagnation/decline in policy sales. In order to analyze these two problems and build a simulation model to tackle them, the research team conducted numerous interviews with managers and employees and carried out extensive data analysis (both company data and market/competitor data). It was possible to obtain reliable data only after 1988, ie. for 96 months. Results of these interviews and data analyses are summarized below:

a- The basic dynamics of most variables confirm top management’s problem description: a rapid growth between 1988 and 1992-93, followed by a stagnation, even a slight decline in some branches and regions. Total number of policies underwritten per year, plotted in Figure 1, shows this behavior. The same dynamics is observed in Figure 2, for policies underwritten in the two major departments: accident and fire. (In the fire department, the situation is worse, declining after 1993). In Figures 1 and 3, premiums earned (in 1989 constant $ values) are plotted. We see that the total premiums (Figure 1) and accident premiums (Figure 3) exhibit the basic boom-then-stagnation behavior. (Fire premiums are fluctuating, which shows that the fire price per policy must have varied substantially in order to account for the discrepancy between the dynamics of policies and premiums). Finally, in-force (active) policies naturally exhibit a dynamics similar to policies underwritten per year: growth-then-stagnation. (Figure 4).

b- Market share of the company (measured in terms of premium revenues) also displays a growth-then decline dynamics. The overall market share peaks at 9.5% in 1991 and gradually drops to 6.5% in 1995. (Figure 5). One difference between the market share behavior and the dynamics of premium revenues is that the premium revenues grow until 1993 (Figure 1). This discrepancy indicates that some competitors began to perform relatively better as early as in 1991. The fundamental dynamics of the market share in the two major branches, accident and fire, are also the basic growth-then decline. (Figure 5).

c- On the “expenditures” side, one would normally expect a similar growth-then-decline behavior from the “claims” files and claims payments. But Figures 6, 7 and 8 tell a somewhat different story: The number of claims files exhibit a mild growth, even after 1993, both in total claims (Figure 6) and in accident claims (Figure 7). This points to a potential problem –in terms of “quality” of policies- for the company. As for the claims payments seen in Figures 6 and 8, they boom till 1992 an then display a mild growth (in accident and in grand total). Again, it indicates a potential problem in terms of profitability after 1992. (Fire payments are on the other hand very unstable, due to high variability in fire losses).

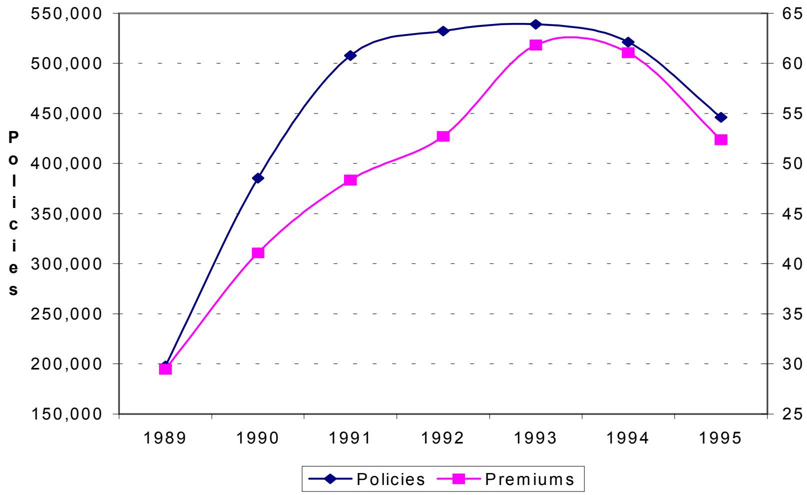


Figure 1 - Total Policies Underwritten & Premiums
[US$ mio, in 1989 constant prices]

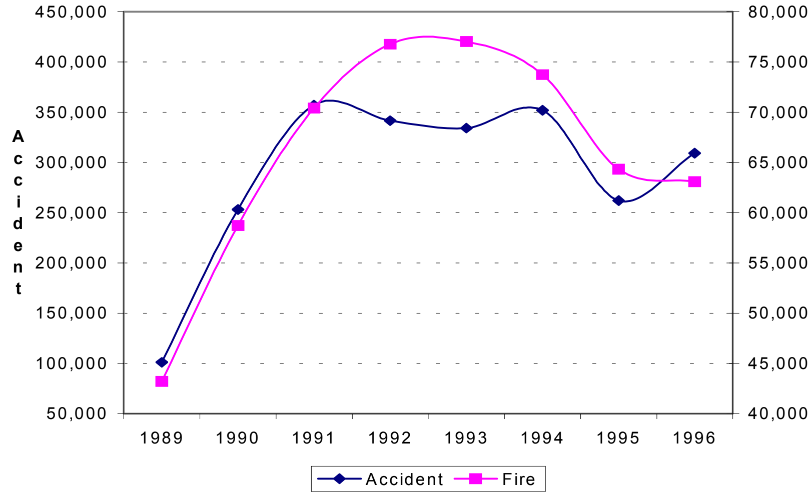


Figure 2 - Accident & Fire Policies Underwritten

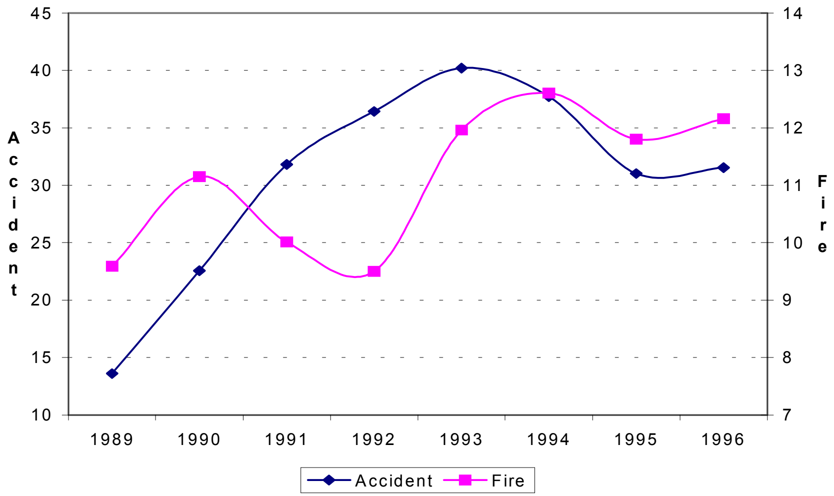


Figure 3 - Accident & Fire Premiums [US$ mio, in 1989 constant prices]

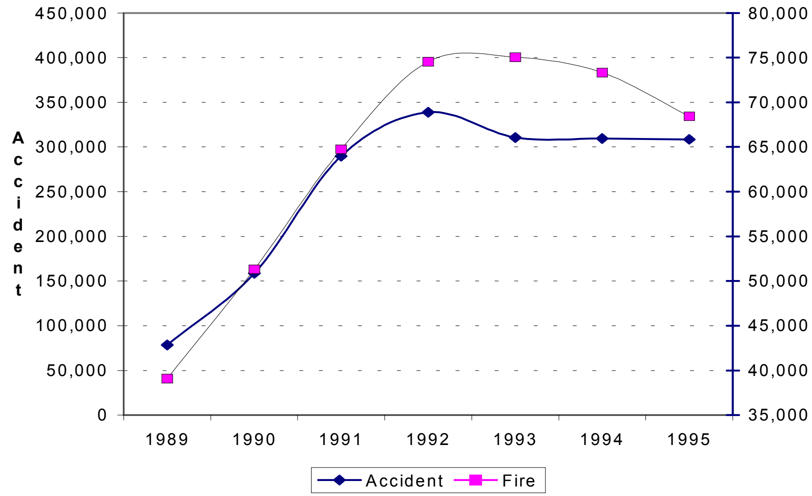


Figure 4 - Active Policies (Accident & Fire)

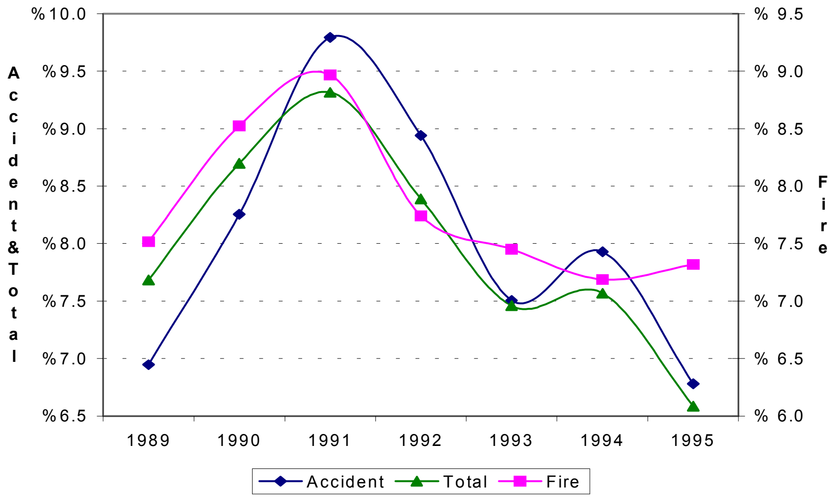


Figure 5 - Market Shares

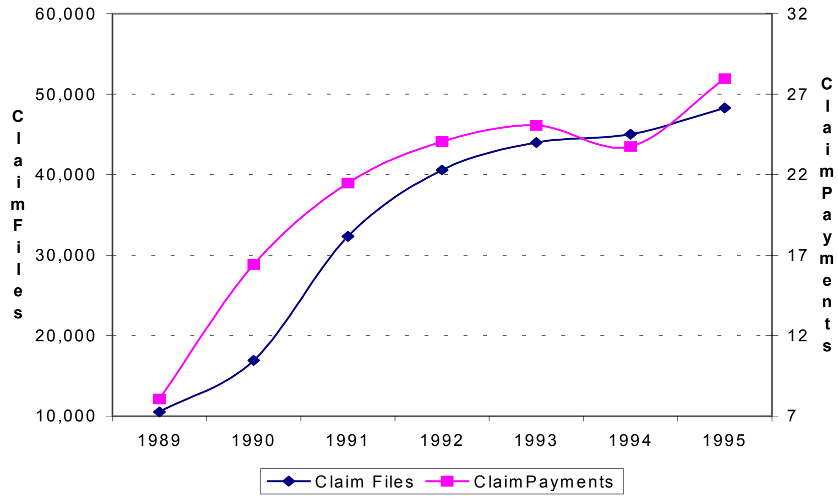


Figure 6 - Total Claim Files & Claim Payments [US$ mio, in 1989 constant prices]

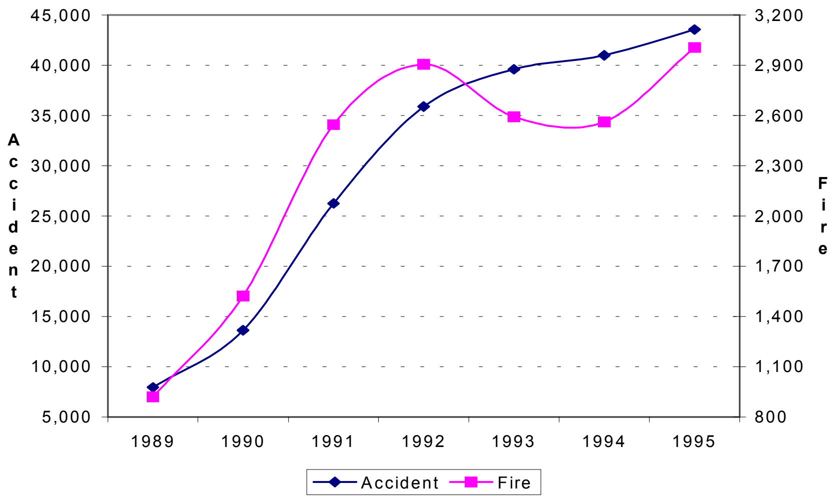


Figure 7 - Accident & Fire Claims

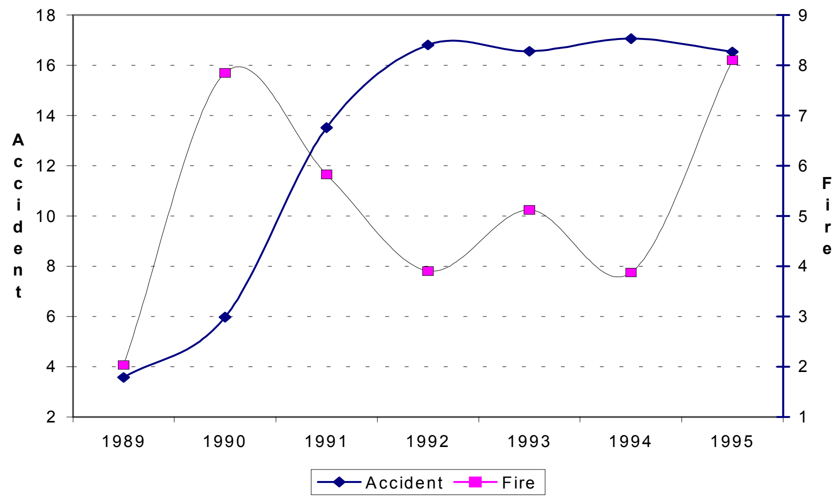


Figure 8 - Accident & Fire Claim Payments [US$ mio, in 1989 constant prices]

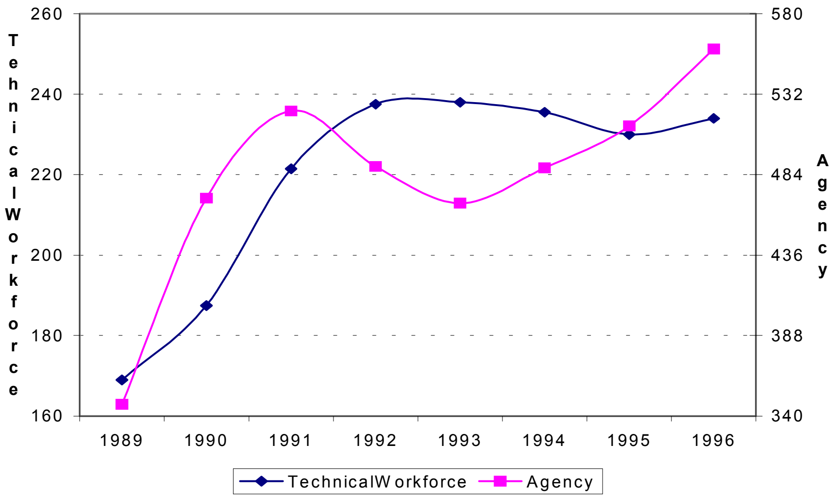


Figure 9 - Technical Workforce & Agencies

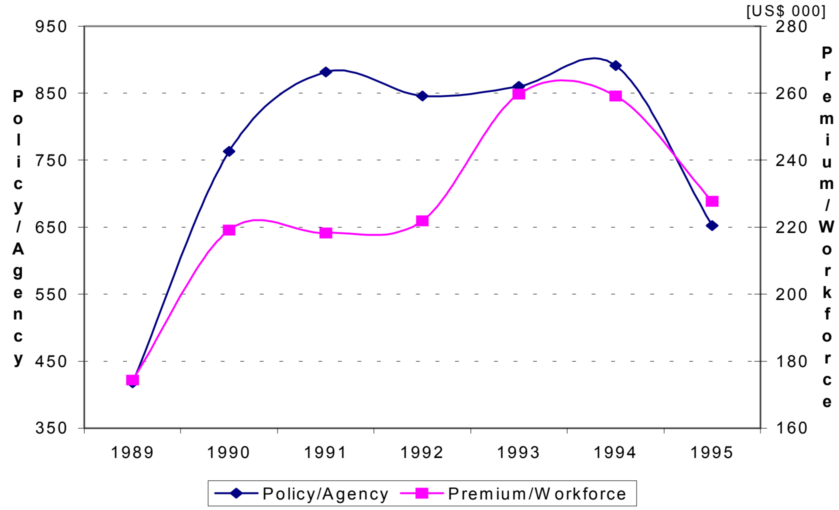


Figure 10 - Productivity Ratios

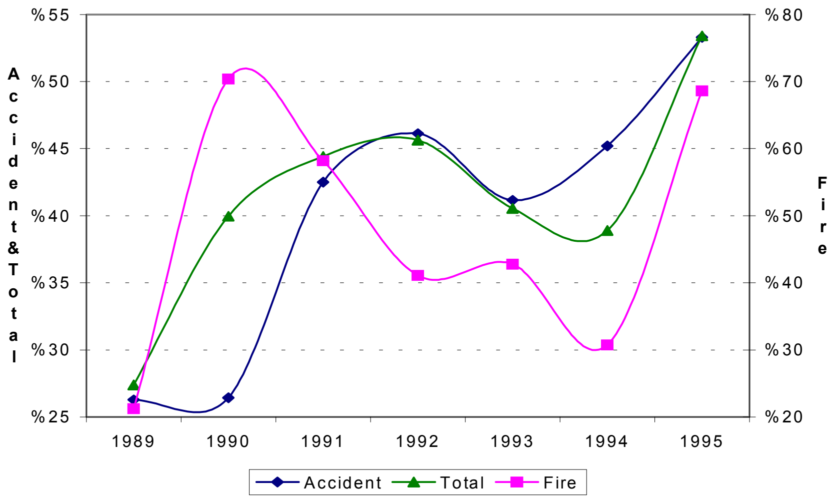


Figure 11 - Loss Ratio

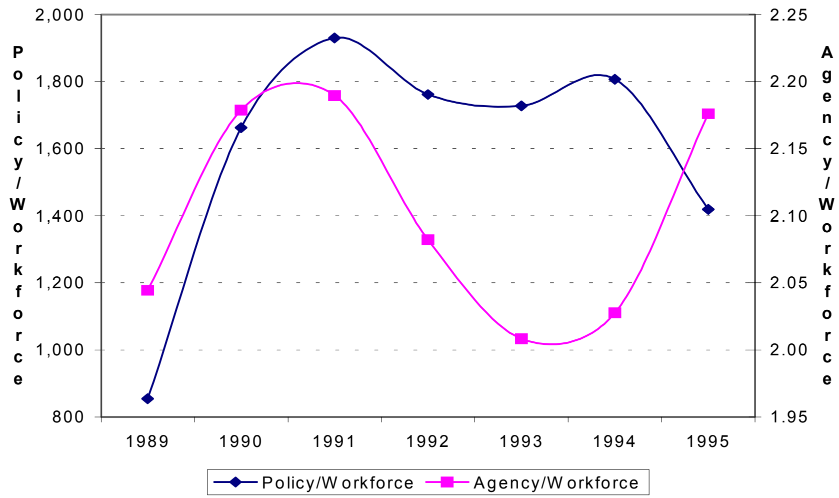


Figure 12 - Work Intensity Ratios

d- The basic “growth-then-stagnation” dynamics of the company is also observed in the “workforce” and “agency” numbers. (“Technical” workforce refers to the workforce in each branch department such as accident, fire, etc., in the claims department, in marketing and direct sales, in finance, in automation and in regional branches). Figure 9 shows that workforce and agency numbers both display a fastgrowth followed by a rather flat dynamics.

e- Certain measures of “productivity” are examined in Figure 10. The productivity of agencies (policy/agency) exhibits a sharp increase between 1989 and 1991, then stabilizes at around 850 and finally drops down to 650 in 1995. A global performance measure for workforce could be “premiums/workforce” seen in Figure 10. Its behavior is similar to that of agency productivity, except that premiums/workforce exhibits a two-phase growth: one in ‘89-90 and one in ‘92-’93. Finally, a typical strategic performance measure used by insurance companies is the “loss ratio”, defined as “claim payments/premiums earned”. Naturally, a company would like to keep it as low as possible and certainly not above 1. Overall loss ratio and accident loss ratio plotted in Figure 11 are at satisfactory levels (around 50%), although they have both been increasing over the years. Fire loss ratio is rather unstable, due to high variability in both policy prices and claim payments, as seen before.

f- Top management’s question: “why do various departments keep demanding for additional employees, in spite of stagnation/decline in policy sales?” has several potential answers: In the claims department, the need for additional workforce can be explained by an increase in the claim files as already seen in Figures 6 and 7. But in the technical branch departments (such as accident and fire), the policy sales (ie. the workload) has been declining. The workforce need must then be explained by some other “hidden” workload. One such implicit workload discovered in this study is the “Agency/Workforce” ratio. A major daily routine performed by the technical workforce is to answer the questions asked by agencies - by telephone or in actual visits. The employees that we interviewed stated that they spent a significant amount of time “serving” the agencies. Thus, in addition to the policy volume, the agencies in themselves constitute a workload. In Figure 12, observe that the “Agency/Workforce” ratio has increased in the past 3 years. (Finally, another related fact not shown in graphs is that although the total technical workforce remained almost constant in the past 5 years, the low-level workforce has decreased from about 150 to 125, while the middle-management numbers have increased. It could be that there are “too many chiefs, not enough indians” in the company).

Most of the above observations/problems are supported by data and some are confirmed by interviews with employees and managers. These problems are of dynamic feedback nature (primarily characterized by a boom-then-stagnation or decline) and system dynamics methodology is thus appropriate. (System dynamics methodology has already been applied to insurance management: Senge (1987) reports using system dynamics in the analysis of “claims” management problems and Doman et al (1995) presents an application of the method to strategic life insurance management).

## 3. Structure of the Model

A key decision made in the early phases of the project was to model the company in two parts: İstanbul (central region) and Regions (all other regional divisions). İstanbul and all other regions perform almost equally in terms of total number of policies and premiums. Another decision was to take the simulation time unit as one month. The model was built as a discrete one, so that the simulation step DT was also fixed at one month.

The company is modeled into 10 major segments some of which are similar structurally: *İstanbul Accident, İstanbul Fire, İstanbul Claims, İstanbul Agencies, Regions Accident, Regions Fire, Regions Claims, Regions Agencies, Marketing* and *Finance*. *Accident, Fire, Claims* and *Agencies* segments for İstanbul and Regions are very similar in structure with differing parameters. Furthermore, *Accident* and *Fire* segments are also quite similar, with some minor structural and parameter differences; we may call these "policy" segments. In summary, the broad generic structure of the model can be discussed under five headings: *Policies (Accident or Fire), Claims, Agencies, Marketing and Finances.* Such a generic structural summary of the model (several times simpler than the actual one) is given in Figure 13.

*Policies (Accident and Fire)* segments are the parts of the model where policies are underwritten and maintained. The upper left portion of Figure 13 summarizes this process: Policies are underwritten, they maturate through three stages and finally renewed or cancelled. (The reason for having different stages is that policies must pay a down payment in their 1$^{st}$ month and then pay the rest of the premium in 5 installations in the next 5 months). Finally, "Policy Workforce" at the very bottom in Figure 13 is also part of the *Policies* segment.

Since 90 per cent of underwriting are performed by the *agencies*, they play a very important role in the system. The number of agencies as well as their productivity, together determine the business volume of the company. Agency productivity depends on "Commission Rate", "Claims Payment Delay", marketing done by the company and finally the "Market Saturation Effect" (the closer the market to full saturation the harder to sell new policies). These influences are shown on the left portion of Figure 13. In figure 1, the broad causal loop diagram of these structures is shown. The influences determining the dynamics of the number of agencies are also represented in the same segment. The agency opening and closing decisions are made dependent on sales volume or profitability of the company and the ratio of agencies/employee. This means that, for new agencies to open, the company must not only be profitable enough, but it must also have enough employees to provide a minimum service needed by the new agencies. Otherwise new agencies constitute an undesired workload for the company employees and both parties become dissatisfied. (As discussed above, in the "problems" section).

In the *Claims* segment, the structure of claims files generation as a function of the total active policies and the processing rates of these claims and payments are handled. The relationship between the "Claim Workforce" and "Claim Files" is important in this process, as they determine the speed and quality of "claim settlements". This segment is summarized on the right of Figure 13.

The structures and parameters of the market such as market expansion rate (due to new cars sold and houses constructed), market shares, market saturation level, price and marketing expenditures are handled in the *Marketing sector*. (Summarized in the middle of Figure 13).

Finally, the monetary aspects of polices and claims are the handled in the *Finance* segment. The premium revenues and claim payments, as well as financial costs and revenues are calculated in this sector. (Also, premiums and claim payments of the other insurance branches such as *transportation, agriculture* and *engineering* are treated here as simple percentages of *accident* and *fire* policies). *Finances* segment is summarized in the lower right hand of Figure 13.

## 4. Validation, Experimentation and Results

Validation of system dynamics models has two major aspects: *structure* validation and *behavior* validation. (Barlas 1996). Structure validation means to demonstrate that the model's internal structure (set of relationships) is a good enough description of the real system, with respect to the problems of interest. *Behavior* validity means that the output behavior of the model is close enough to the real dynamic behavior. The structural validation of the insurance model was carried out by numerous logic, extreme-condition, sensitivity, and boundary tests. (Barlas 1996). The qualitative and long nature of these tests makes it impossible to show the results in the context of such an article. We simply state that the model was found to be structurally reliable and show some results that demonstrate its behavior validity.

The model parameters and input functions were estimated and behavior validation was carried out using numerous the real data of seven years from 1989 to 1995 (in some cases '96). In Figure 14, the accident and fire policies underwritten by the company and the ones generated by the model are plotted. Note that in both branches, the fundamental behavior (boom-then-stagnation) of policy sales are fairly well captured by the model. There is also a reasonable numeric fit between the real and model-generated behaviors, although there are of course significant discrepancies on a point-by-point basis. (System dynamics type of –ex ante- simulation models are not expected to produce point-by-point forecasts. See Barlas 1996). In Figure 15, total premiums earned by Halk Sigorta and the ones generated by the model are plotted. There is again a fairly good match between the two behaviors. The premiums earned by branches are plotted in Figure 16. The premiums generated by the model, plotted on the same graph displays very good resemblance to the real data, both in fire and in accident branches. The total market shares of the company is given in Figure 17. Although the model slightly overestimates the real market share in the early years and it slightly underestimates it in later years, the fundamental dynamics is well captured. On the expenditures side, the total claim payments are plotted in Figure 18, where we once again observe a good fit. Finally, the technical workforce and agency numbers are plotted in Figure 19. Although there are some significant differences on a point-by-point basis, we can again state that the fundamental dynamics match reasonably well. The model exhibits more or less the same level of acceptable behavior validity with respect to some other variables; we omit them in this article to avoid repetition. Overall, the model demonstrates a good level of both structural and behavior validity.

Numerous simulation experiments were carried out on the model in order to find some answers to the problems listed above in Section 2. Simulation results showed what factors have caused stagnation / decline and how to avoid a similar decline in the future. It was concluded that achieving another growth phase and sustaining it was extremely difficult, hence not necessarily desirable. Main results can be summarized as follows:

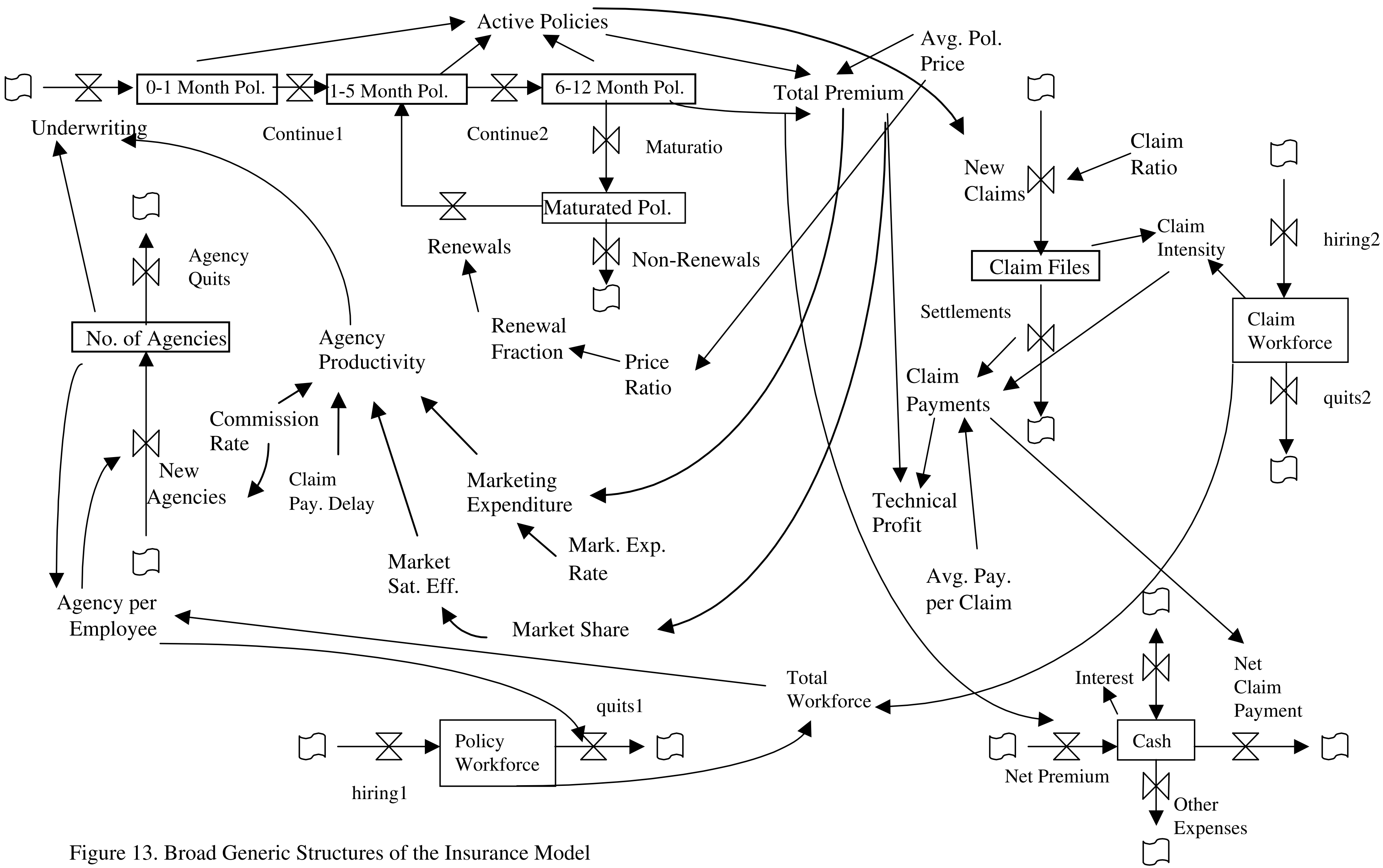

Figure 13. Broad Generic Structures of the Insurance Model

a) In the current structure, the production depends heavily on the agencies. Therefore for an increase in policy sales/market share, either the number of agencies or the productivity per agency should be increased. Increasing the number of agencies is not an easy solution. There exists a threshold "agency/employee" ratio in the sector which changes between 1-2. This ratio means that each agency not only sells policies, but she also takes away from company's own resources by asking frequent questions, visiting company employees etc. If this threshold is exceeded, the agencies become no more profitable for the company and they basically create unnecessary workload for the company employees. Therefore, an agency-dependent growth becomes quickly unprofitable, since it requires excessive employee hiring as well
b) Increasing the productivity per agency is not easy either. The productivity of an agency depends on many factors such as policy price, advertisement and market saturation effect, in addition to his own quality. In order to overcome the market saturation effect, advertising and price reduction strategies should be implemented simultaneously, which may not be profitable. A better strategy for the long-term is to start a high-quality agency fleet training program. This would not only increase the agency productivity, but also push the critical "agency/employee" threshold upward, since higher-quality agency would need less help from the company workforce .
c) Another suggested strategy is to make the company's policy production less dependent on agencies and more on company's own employees. Such a shift to "direct sales" can be achieved by means of telephone, ATM, Interactive TV and Internet. The process must start with training of a pilot salesteam within the company.

d) The renewal percentage of the existing policies are not high (≈60%-70%). Studies should be done to increase the renewal percentage. This is one area where the policy volume can be increased by company's own workforce, which is relatively less dependent on agencies.
e) The demand for additional employees by various departments was discovered to be partly because of the steady increase in the number of people in the managerial positions, which meant a relative reduction in the number of employees that to do the daily routine work. It seems that some managerial positions have been created just to promote people. To reverse this trend, hierarchical layers must be reduced and some artificial managerial positions must be gradually eliminated. Other promotion and incentive mechanisms must be established.

## 5. Conclusion

This simulation-based systemic management consultancy project proved to be useful both for the client and for the analyst-team. The main profit of the model is that it generates a systemic and dynamic understanding of company's internal and external interactions so as to enable creative solutions for the existing and potential problems. It must be emphasized that the learning that has occurred during the modeling process itself was extremely valuable. Some of the findings were obtained as a result of simulation experiments and analysis, but other results were already obtained in the earlier phases of model building. The model, together with all the findings were submitted to the company. One of the recommendations –shifting to “direct sales” by company workforce- has been initiated as a pilot project in the company.

A new *interactive gaming* version of the model is in the final stages of the completion. The model and the game version can be used as a “learning laboratory” in the company, which would be a first step toward “organizational learning”.

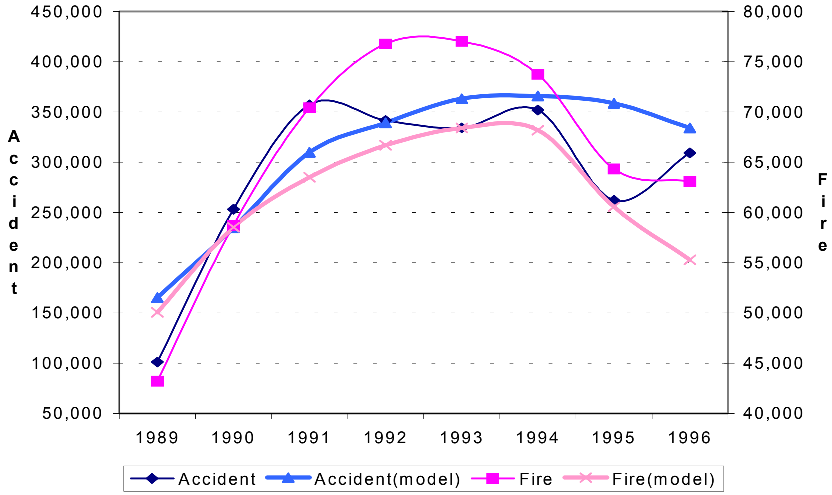


Figure 14 - Accident & Fire Policies Underwritten

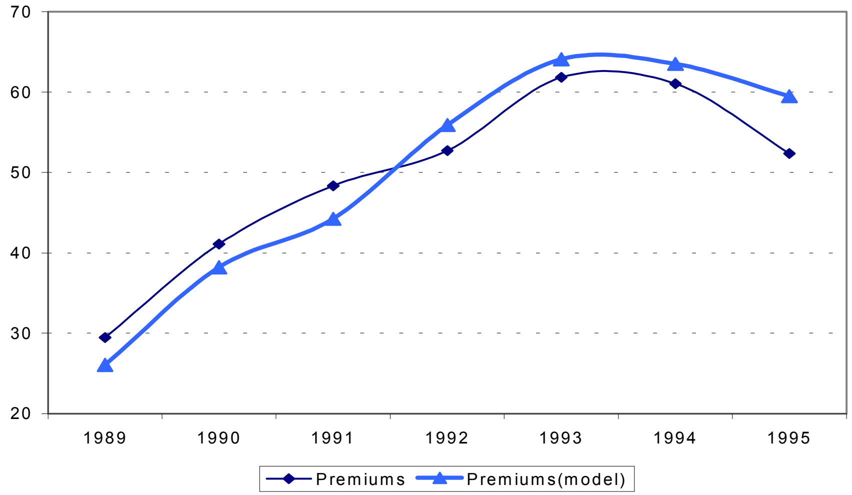


Figure 15 - Total Premiums [US$ mio, in 1989 constant prices]

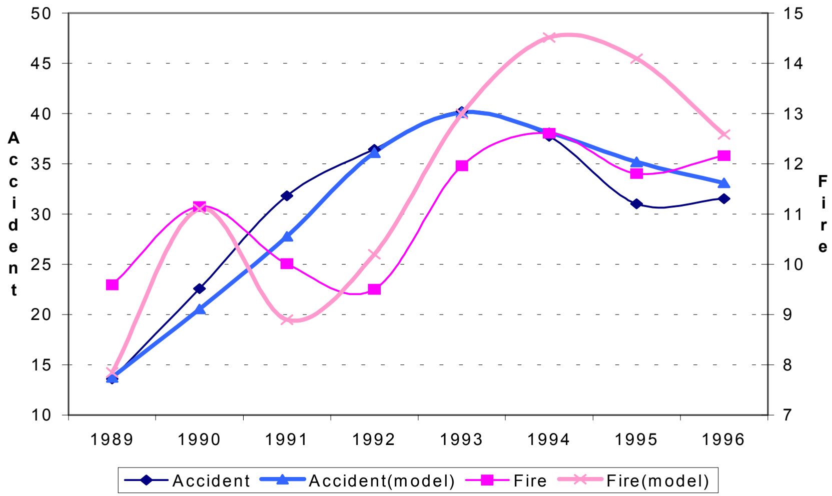


Figure 16 - Accident & Fire Premiums [US$ mio, in 1989 constant prices]

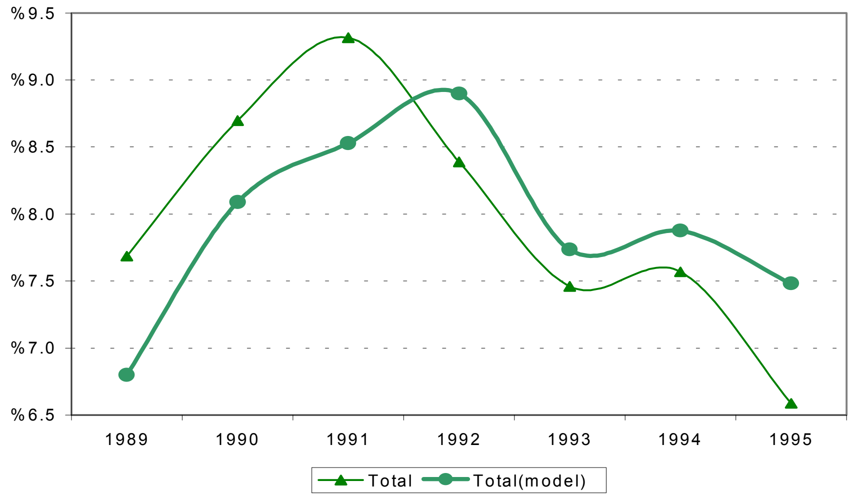


Figure 17 - Market Share

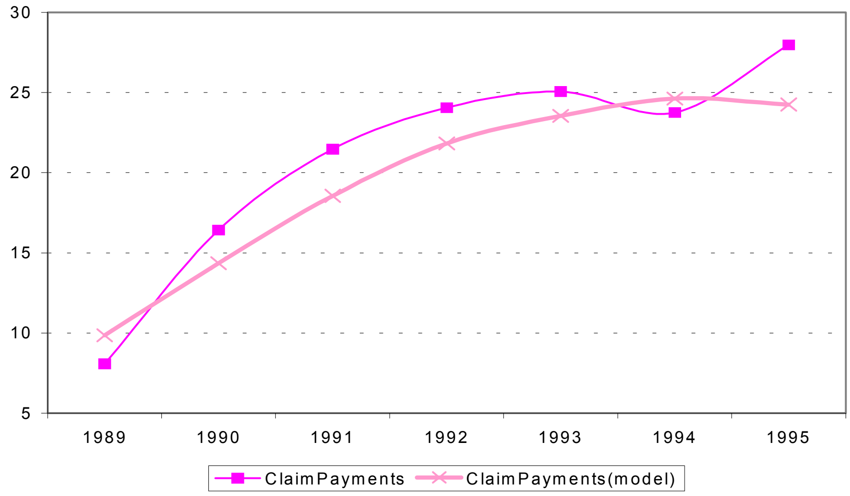

Figure 18 - Total Claim Payments [US$ mio, in 1989 constant prices]

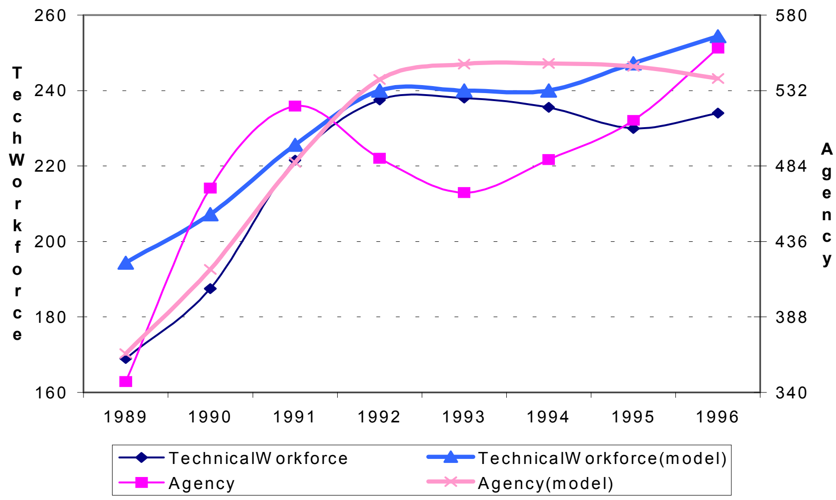

Figure 19 - Technical Workforce & Agencies

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