“A Dynamic Financial Analysis of the Effect of Growth on Property-Liability Insurers”

Stephen P. D'Arcy, Richard W. Gorvett
USA

Summary

Dynamic Financial Analysis (DFA) represents a new area of study for insurance researchers, an area requiring new tools and new expertise. The need for DFA developed as the financial world became a more risky place, a trend that started in the 1970s when foreign exchange rates and interest rates became more volatile. DFA is a powerful business planning tool that will allow researchers to assess the financial risk of individual insurers and of different business strategies. It can be used to highlight the financial or operating conditions that might generate unfavorable outcomes, allowing company managers to deal with these potential conditions appropriately. DFA can provide a calibrated tool to replace rough intuition for measuring the effects of operational decisions.

The actuarial consulting firm Miller, Herbers, Lehmann & Associates has developed a public-access DFA model that is available, via the internet, at no charge. The general approach used in this model, the key risks of U. S. property-liability insurers subject to modeling, the parameters incorporated in the financial aspects of the model, and examples of the output from the model are described in D'Arcy, Gorvett, et al. (1997 and 1998). One of the objectives of this model is to serve as a learning tool for researchers interested in obtaining hands-on experience with DFA. To further this objective, we propose to utilize the public access DFA model to analyze the effect of growth on property-liability insurers. One benefit of this project will be to illustrate the data requirements of the model, the parameter selection process, the system and time requirements for running the model, the output from the model, and how a researcher can utilize the model to understand the financial or operational positions of an insurer. Additionally, this project will provide an analysis, using the DFA model, of the impact of growth rates and persistency on insurance profitability.

For a property-liability insurer, the growth rate can have a number of important effects as companies that grow rapidly face several problems. First, as premiums increase, the premium-to-surplus levels rise, which increases leverage under solvency analysis. Additionally, the growth rate itself is one of the factors considered in insurance solvency analysis under the IRIS system. Finally, new business generally has both a higher loss ratio and a higher expense ratio than more seasoned business, which reduces profitability (D'Arcy and Doherty (1989 and 1990), Feldblum (1996)). The relationship between an insurer's growth rate and profitability is complex and requires consideration of the long-term impact, an analysis that can more effectively be accomplished through the use of a DFA model.

The public-access model has been developed and extensively tested. The authors have used this model on numerous occasions, both for research purposes and for applications to specific insurance companies. Prior applications have illustrated the importance of the growth rate as one of the key strategic operating decisions. Thus, this work will focus on that key variable.

"UN ANALISIS FINANCIERO DINAMICO DEL EFECTO DE LA EXPANSION EN LOS ASEGURADORES DE RESPONSABILIDADES DE PROPIEDAD"

Stephen P. D'Arcy, Richard W. Gorvett
USA

Resumen

El Analisis Dinámico Financiero (ADF; en inglés, Dynamic Financial Analysis o DFA) representa una nueva area de estudios para los peritos en el campo de seguros, una área que exige conocimientos y herramientas nuevos. El ADF se ha desarrollado junto con los crecientes riesgos asociados con el mundo financiero, empezando en la década de los 70 cuando se volvieron más volátiles los cambios de divisas y las tasas de intereses. El ADF es una herramienta de planificación empresarial que posibilita una valoración más precisa tanto de los riesgos a que se exponen los aseguradores individuales como de los riesgos asociados con las prácticas impresoriales. Se puede usar para destacar las condiciones financieras u operantes que puedan producir un resultado desfavorable, para que los gerentes de empresa puedan reaccionar debidamente a estas condiciones potenciales. El ADF provee una herramienta calibrada para medir los efectos de las decisiones operacionales, que sustituye el empleo de la mera intuición.

La empresa de consultas actualiares Miller Herbers, Lehmann, y Socios ha desarrollado un modelo del ADF disponible al público gratis por internet. En D’Arcy, Gorvett, et al (1997 y 1998), se describe al acercamiento general que se emplea en este modelo, además de los más importantes riesgos de los aseguradores de seguros de responsabilidades (*liability*), según los límites del modelo; los parámetros incorporados en los aspectos financieros del modelo; y ejemplos de los productos obtenidos del modelo. Uno de los objetivos de este modelo es que sea de utilidad didáctica para aquellos investigadores que quieran adquirir experiencia directa con el ADF. Para alcanzar esta meta, pretendemos utiizar el modelo del ADF disponsible al público para analizar el efecto de la expansión en los aseguradores de responsabilidades. Un beneficio de este proyecto será la ilustración de los siguientes aspectos: las exigencias de

datos del modelo, los requisitos de tiempo y de sistema para poner en marcha el modelo, y las maneras en que un investigador podría utilizar el modelo para mejor entender las posiciones financieras u operacionales de un asegurador. También, este proyecto suplirá un análisis, usando el ADF, de los efectos de la la tasa de expansión y persistencia en la rentabilidad de seguros.

Para los aseguradores de responsabilidades de propiedad, la tasa de expansión puede tener varios efectos a medida que las compañias que crecen rápidamente se enfrentan con varios problemas. Primero, al subir las primas, los niveles de la relación prima a superávit suben también, lo cual aumenta el apalancamiento según el análisis de solvencia. Además, la misma tasa de crecimiento es uno de los factores que se consideran en el análisis de solvencia de seguros bajo el sistema IRIS. Por último, tanto la razón de pérdidas como la razón de gastos suele ser más alta en un negocio nuevo que en uno establecido, lo que reduce la rentabilidad (D'Arcy y Doherty 1989 y 1990; Feldblum 1996). Es compleja la relación entre la tasa de expansión de un asegurador y su rentabilidad, y hay que considerarla en cuanto a sus efectos a largo plazo. Un análisis de estos factores se puede llevar a cabo más eficazmente mediante el empleo de un modelo del ADF.

Se ha desarrollado y se ha probado extensivamente el modelo de acceso público.

Los autores han usado este modelo en diversas ocasiones , tanto para propósitos de investigación como para sus aplicaciones para determinadas empresas de seguros. Las aplicaciones anteriores han ilustrado la importancia de la tasa de crecimiento en su capacidad como una de las más importantes decisiones operativas estratégicas. Por eso, este trabajo se enfocará en ese variable tan clave.

"A Dynamic Financial Analysis of the Effect of Growth on Property-Liability Insurers"

Stephen P. D'Arcy, Richard W. Gorvett
USA

Dynamic Financial Analysis (DFA) is a new approach to modeling insurance companies that developed in the 1990s as a result of the convergence of several trends. One trend was the increase in financial risk that had begun in the 1970s as first inflation and then interest rates became increasingly volatile. Another trend was the increased access to computers powerful enough to accommodate the sophisticated mathematical techniques involved in DFA. A third trend was the adoption of similar types of analyses in banks and other financial institutions.

The general approach of DFA was applied first by insurers in Europe, then in Canada and the United States. The first applications were to life insurers, under a process termed Dynamic Solvency Testing or Dynamic Financial Condition Analysis. The primary impetus for the initial applications of these techniques was the interest rate volatility of the late 1970s and early 1980s that led to the financial distress of some life insurers. The focus of these applications was to improve solvency monitoring and reduce the likelihood of insurers becoming insolvent. DFA was envisioned as a powerful new regulatory tool. Although DFA is used by some regulators, the complexity of the modeling process and number of adjustments that need to be made to apply DFA to a specific company has limited the regulatory applications. Instead, DFA has developed into a versatile strategic planning tool (CAS, 1995 and 1996, Correnti, Sonlin and Issac, 1998, Hodes, Feldblum et al, 1996).

The term *Dynamic Financial Analysis* explains the approach very accurately. *Dynamic* indicates that this approach reflects the uncertainty involved in modeling an insurance company. Stochastic variables are used to represent factors that will affect the company's operations. This approach leads to a range of possible outcomes, along with their associated probabilities, rather than simply a single best estimate of the outcome. Factors that will affect the operations or balance sheet of a company are allowed to vary, rather than being estimated as a single deterministic value. Interest rates, for example, are represented by sophisticated mathematical models rather than a single estimate of the future rate. DFA is *dynamic* in that it reflects the range of possible outcomes rather than just one or a few estimates.

Historically, insurance companies focused on the underwriting side of their operations, and neglected or ignored the investment side. The top managers of insurance companies typically had strong backgrounds in underwriting, sales, claims, or actuarial work, and rarely rose from the investment area. Most management attention was paid to underwriting issues, and investments, although expected to produce a steady return, were not given much attention. This changed in many companies in the 1980s as investment income began to dwarf underwriting returns and as investment returns became more volatile. Now insurers tend to coordinate their underwriting and investment operations and pay close attention to both assets and liabilities. The term *financial* reflects the integration of underwriting and investment, with variables such as interest rates impacting both investment values and underwriting returns.

The final term of DFA, *analysis*, is a most appropriate choice of language for this process. *Analysis* is defined in Webster's Seventh New Collegiate Dictionary (1965) as, "An examination of a *complex*, its elements and their relations." *Complex* is in turn defined as "A whole made up of complicated or interrelated parts." An insurance company is truly a complicated structure with many interrelations, and DFA provides a valuable method for studying these factors and their relationships.

By now, all major actuarial consulting firms have developed their own DFA models that can be applied to clients' operations. However, the proprietary nature of the models and the need for the consulting firms to keep key aspects of their models confidential (to protect their value) lead to somewhat of a "black box" structure. Clients see the input values and the output values, and are given a general explanation of how the model operates, but the exact inner workings of the model are not seen. To get around this limitation, many large insurers have developed their own DFA models. Again, for proprietary reasons, these models are not available for other firms or individuals to use. The development of a realistic DFA model takes several years and a significant commitment of actuarial, programming and other staff time. After such an extensive investment, it is reasonable for consultants or companies to want to keep their models confidential.

Researchers wanting to utilize DFA to analyze insurance operations have faced the daunting task of having to invest extensive time and effort to, in essence, duplicate the DFA models currently in use. This hurdle has dissuaded most researchers from applying DFA. Given the importance of DFA modeling and the valuable contributions that it provides in the analysis of insurance operations, this deterrent has had a negative effect on actuarial research. However, the consulting firm of Miller, Herbers, Lehmann, & Associates, Inc. (MHL), has made its DFA model publicly available for use by companies, regulators, students, researchers and even other consulting firms. This model, the latest version of which is termed *DynaMo3*, is available at no charge at www.mhlconsult.com. By providing open access to this model, this firm has changed the nature of DFA for users, from being a mysterious black box to being a transparent model. This opportunity should advance the use of DFA as a widely used tool for the insurance industry.

Although the initial intent of DFA was to serve as a tool for regulators to monitor solvency, the current models can be far more useful for strategic planning. Properly used, DFA models can allow managers to try out various strategies, and then adopt the ones that are expected to be the most successful. Managers can observe the effect of adding a new line of business or writing in a new territory. The impact of raising or lowering prices, adopting new underwriting rules, changing the reinsurance treaty, adopting a new claim processing strategy, shifting the investment portfolio or the mix of business, can all be tested before being adopted. DFA can truly have a revolutionary impact on the insurance industry, once the models are sufficiently refined and widely accepted. However, we have a long way to go before the models reach that level. By facilitating research on DFA, MHL has helped hasten the accomplishment of this goal.

DynaMo3

The dual objectives considered by the team that developed this model were to create a model that was realistic enough to be useful, but at the same time simple enough to be understood. Thus, when choices had to be made about how complex a particular relationship needed to be, the general guidelines were to balance being realistic and simple. Enhancements that added only a little to the accuracy of the model, but much to the complexity, were not included. However, when a relationship had to be complex to be at all useful, the complex relationship was included.

Several papers have been published describing the details of this model (D'Arcy, Gorvett, et al, 1997a, 1997b, 1998; Walling, Hettinger, et al, 1999). In essence, Dynamo3 simulates the results of a property-liability insurance company over the next five years for multiple stochastically generated runs. The balance sheet, the operating statement and the Insurance Regulatory Information System (IRIS) test results are calculated for each run. The sheer volume of information that is available requires careful selection of the items to view, since it is easy to get lost in the details. Commonly, users will select such items as the surplus (statutory and GAAP), loss ratio, combined ratio, net investment income, net written premiums and gross or net income to analyze. For each selected item, the expected value and the distribution of results over all of the simulations can be viewed. An example of an output graph from the DFA model is shown as Exhibit 3. In this situation, the user is evaluating the effect of changing the reinsurance arrangements of the company. The unshaded curve represents the base conditions and the filled in curve represents the revised strategy. In this situation, the revisions appear to be preferable, since the likelihood of adverse outcomes is reduced and the distribution is shifted to the left, indicating greater surplus values.

DynaMo3 consists of six separate but interrelated modules. The modules are for investments, underwriting, the interest rate generator, catastrophes, taxation and loss reserve development. The basic model contains two lines of business, although additional lines can be added. Each line of business is divided into three age categories: new business, first renewals and second and subsequent renewals. The loss frequency, severity and premium levels can vary by age category of the business.

The key variables in Dynamo3 are listed on Exhibit 1. The primary variable is the short term interest rate, which affects the investment income, the market value of bonds and other investments, the inflation rate, loss severity, premium levels and loss reserve development. Interest rates are modeled based on the Cox-Ingersoll-Ross (CIR) one factor model (Cox, Ingersoll and Ross, 1985). This selection represents the tradeoff between realism and simplicity. Although this interest rate model, with a combination of a deterministic mean reversion term and a stochastic term that is a function of the square root of the current interest rate, all based on continuous time, is relatively complex, it is not nearly as complex as more advanced interest rate models that have been proposed. However, a simpler model would not be realistic enough to be useable, and the more sophisticated models do not add enough to be worth the extra effort involved in understanding, and parameterizing, these models.[1]

DynaMo 3 consists of 24 different Excel worksheets, which are listed in Exhibit 2. The General Input page allows the user to indicate the first year to be simulated, the parameters of the CIR interest rate model and the pre-payment rates for mortgage backed securities. The Investment Input worksheet provides for a detailed listing, along the lines of Schedule D required by regulators in the United States, of all the investments of the insurer. The Reinsurance Input worksheet provides detailed information on the company's reinsurance program. The next two worksheets, XYZ Company - HMP - I and XYZ Company - WC - I, describe the current book of business of the insurer for each line of coverage, in this case Homeowners and Workers' Compensation, including information on premiums, losses, exposures, expenses, frequency and severity, market condition, growth targets and renewal rates. The next three worksheets, XYZ Company - HMP - O and XYZ Company - WC - O and LINE SUMMARY, provide detailed information about the output of the simulation for each of the next five years. The next worksheet, Cat Generator, is the catastrophe module. This worksheet includes the parameters for simulating the number of catastrophes (based on a Poisson distribution) the size of each catastrophe (based on a lognormal distribution), a geographic locator and a contagion matrix based on a distribution of historical relationships.

The next six worksheets provide information that is used to calculate the values of bond investments. The five individual bond worksheets (Bond 1 - 5) each provide for a different set of bonds, allowing the risk premium and effective tax rate to vary. The Bond Summary worksheet summarizes the book and market values of all bond investments. The Stocks worksheet is used to value the equity investments of the insurer, both common and preferred, and affiliated and unaffiliated. The Tax Calculator determines the tax liability of the insurer, after calculating the taxes under both the regular tax rate and the alternative minimum tax calculation. The Investment Determination worksheet provides information on the insurer's cash flows and how they are allocated to different types of investments. The Output worksheet shows the company's balance sheet for the five year projection period and the IRIS ratios. The Statutory Summary worksheet shows the financial statement and income statement for each of the projection years on a statutory basis. The GAAP Summary shows the same information on a Generally Accepted Accounting Principles basis. The Simulation Data worksheet is the sheet on which the user indicates the number of runs to be simulated and which variables are to be analyzed. The final worksheet, Rnd Numbers, lists the random numbers used in the simulation to aid in checking the model.

DynaMo3 is set up with the data of a hypothetical insurer, XYZ Company, although users can replace the example values with those that represent whatever insurer they wish to analyze. XYZ Company is a small insurer that wrote approximately $59 million of premium in the most recent year, equally split between Homeowners and Workers' Compensation. The company writes in two states, Florida and Illinois. The company has $102.5 million in assets ($93 million in bonds) and a statutory surplus of just under $50 million. Of the 58,000 Homeowners exposures, 38,000 have been with the insurer through two or more renewal cycles. Of the 21,800 Workers' Compensation exposures, 16,650 have been with the company through two or more renewal cycles. This is the company that will be used in the analysis of the impact of growth.

Aging Phenomenon

A well known, but not extensively reported, trait of property-liability insurance is that new business has a very high loss ratio, often in excess of the initial premium. The loss ratio declines with each renewal cycle. After a book of business has been in force for several years, the loss ratio has generally declined to the point that the book of business is profitable. Longer-term business has an even lower loss ratio, making it very profitable for most insurers. In theory, the profits on this long-term business offset the losses incurred on the book in the early years, so that, over the life of the book of business, the insurer earns a reasonable profit.

The aging phenomenon appears to occur for every property-liability line of business for every insurer that has examined this trend. Since long-term business is extremely profitable for an insurer, it is understandable that most insurers do not want to share the results of their internal studies on this experience with competitors. One reason proposed for this phenomenon is that errors occur in the initial underwriting reviews or initial policyholder classification that under price new policies, and these errors are gradually remedied during subsequent renewals. Another reason proposed is that underwriters gradually weed out the undesirable policyholders as additional information is revealed. This reason would suggest that the more aggressive insurers are with regard to renewal underwriting, the faster the improvement in loss ratio. However, the aging phenomenon also occurs in states that do not allow nonrenewal of policyholders except for nonpayment of premium. Thus, the aging phenomenon is not solely the result of renewal underwriting. Another possible explanation is the tendency of high risk (but otherwise unidentifiable) policyholders to be dissuaded from renewing their policies after experiencing problems during claim settlements. These policyholders therefore go to other insurers, causing their new business loss ratios to be high.

Only a few studies on the aging phenomenon have been published. D'Arcy and Doherty (1989) demonstrate how the aging phenomenon affects pricing strategies as interest rates change. D'Arcy and Doherty (1990) document the automobile experience of seven unidentified insurers, and explain how asymmetric information between insurers and policyholders leads insurers to "lowball" their initial price to gain access to the private information that will be revealed during the contract term. Feldblum (1996) proposes that insurers analyze profitability on a cohort basis over the life of a book of business, rather than aggregating all business together.

Since the original research on the aging phenomenon has been published, a new service has developed in the property-liability insurance area to help provide companies with more information on applicants for auto insurance. The service, termed the Comprehensive Loss Underwriting Exchange (CLUE), allows participating insurers (approximately 95 percent of industry) to access the claim histories of any new applicant that has previously been insured by another participating insurer. By sharing claim histories, insurers reduce the informational asymmetry on new business. Anecdotal evidence suggests that CLUE has reduced the loss ratio for new business. However, the aging phenomenon is still clearly evident in company experience. For example, many new applicants have no insured claim history because they were either uninsured, insured under a parent's or someone else's policy, in the military, individuals who had licenses but never drove or purchased insurance, or people who lived internationally. In such situations, there may be no relevant information available from CLUE.

As a result of the aging phenomenon, the growth rate has a significant effect on an insurer's profitability. A rapidly growing company is likely to have a much higher loss ratio than a more slowly growing insurer simply due to the greater proportion of new business being written. Thus, the growth rate is a key strategic variable for an insurer. In addition, the persistency rate, the proportion of policies a company renews each cycle, also affects profitability. The more long-term business an insurer is able to retain, the more profitable this business will be.

Optimal Growth Rate

The objective of this study is to determine the optimal growth rate for XYZ Company through the use of the DFA model. The first step in this process is to determine the appropriate metric to optimize. The DFA model provides a wealth of values to consider in this process. One important parameter is the policyholders surplus, either statutory or GAAP, at the end of the five year projection period. The larger the surplus, the more profitable the company has been over the intervening years and the more the company is worth. Another value that could be used is the net income, both underwriting and investment income, over the projection period. This value reports the short-term profitability of the insurer. Another value to consider is the net income over the projection period plus the terminal value of the company at the end of the five-year period.

The basic approach for this analysis is to assume several different growth rates within the range of reasonable values. In this case, the growth rates ranged from 0 to 10 percent, in increments of 2.5 percentage points. For each growth rate selected, 500 simulations were run. Both the mean values for each growth rate and the distribution of results were analyzed. The mean values of statutory and GAAP surplus in the year 2006 and the gross income for the five-year projection period 2002-2006 are shown on Exhibit 4. The distribution of the results for the statutory surplus in 2006 are displayed in Exhibit 5. Based on any of these parameter values, the optimal growth rate is 0 percent. Thus, the company should not attempt to grow in order to maximize any of these values. The primary reason for this result is that if the company is not attempting to grow, its book of business gradually ages (has been with the company through more renewal cycles) and the loss ratio declines.

In order to understand if this strategy is indeed optimal, the relationships inherent in the DFA model need to be fully understood. One important factor to consider is the implied rate change variable. This value, which goes into the rate level calculation, is a function of the desired growth rate, the strategic variable, and market conditions. One prominent feature of the property-liability insurance market is the underwriting cycle. Market conditions shift over time between soft markets, in which strong competition limits the ability of insurers to raise prices, and hard markets, in which insurance coverage is difficult to obtain and insurers are more free to raise prices without losing market share. The program DynaMo3 provides for four distinct market conditions: mature hard, immature soft, mature soft, and immature hard. The market cycles through these different conditions based on a stochastic function that reflects differing probabilities of movement from one condition to another. Depending on the specific market condition and the targeted growth rate, an implied rate change value is determined. The higher the targeted growth rate, the lower the implied rate change, since it is more difficult to attract new business if rates are increasing. Implied rate changes are higher in hard markets and lower in soft markets. Based on the 500 simulated runs, the implied rate change for the 0 percent growth rate averaged 1.3% compared to an average implied rate change of -1.2 percent for a 10 percent growth rate. Essentially, if the insurer is not trying to grow, then it can raise rates, on average over the 500 simulations, 1.3 percent per year over the loss cost inflation rate to achieve this target. In order to grow by 10 percent per year, the insurer would have to restrain rate levels 1.2 percent per year below the loss cost inflation. The higher rates would lead to greater profitability and the lower rates reduced profitability. This effect compounds the impact of the aging phenomenon, lowering the loss ratios on longer-term business.

Another consideration of rate changes is the potential impact on persistency. DynaMo3 separates business into three age categories: one for new business, one for first renewal business, and one for second and subsequent renewals. A separate persistency rate can be applied to each category. For homeowners, the base case renewal rates are 75 percent for new business (75 percent of new business renews each year), 90 percent for first renewals and 95 percent for second and subsequent renewals. For workers compensation the values are 80 percent, 90 percent and 90 percent.[2] Rate changes are likely to affect the renewal rates, with higher rate changes reducing the renewal rates. Lower renewal rates reduce the profitability of long term business, because fewer policies would remain with the insurer. In the current version of DynaMo3, the renewal rates are not directly affected by the level of rate changes.

Value of the Firm

Based on the criteria of statutory or GAAP policyholders surplus at the end of the projection period, or gross income during the five-year projection period, the optimal growth strategy is no growth. However, as shown on Exhibit 6, the net written premium at the end of the projection period is quite sensitive to the growth rate. Although the surplus is higher with lower growth rates, the premiums increase with the growth rate. These premiums represent future prospective earnings, so the larger the premiums, the greater the possible future earnings. Thus, the terminal value of an insurer is likely to be a function of both the surplus, either statutory or GAAP, and the premium level. Therefore, the correct optimization would be based on the income during the projection period plus the terminal value of the company.

In order to determine the relationship between the terminal value of the firm and the premium level, the difference between the market capitalization and shareholder equity was compared with the most recent year's earned premium for the property-liability insurers reported in Value Line. This comparison was done, by insurer, on an aggregate basis and in a regression. Although the results for individual companies range widely, the median, mode and average of these values are all approximately 0.6. A regression was run for the following relationship:

$$MV\text{-}PHS = a * NWP + ,$$

where MV = Market value of the firm

PHS = GAAP policyholders surplus

NWP = Net written premium for the latest year

The coefficients of the regression are 1.06 for the entire sample, and .56 for the companies that are predominately property-liability insurers. These values were used to estimate the terminal value of the firm under varying growth rates. As shown on Exhibit 6, the optimal growth rate is very sensitive to the coefficient of the net written premium. When the premium level is omitted, the optimal growth rate, for the range considered, is zero. If 60 percent of the Net Written Premium for the final year of the projection period is added to the GAAP Policyholders Surplus and the Gross Income during the projection period, the optimal growth rate would be 5 percent per year. If 100 percent of the Net Written Premium is included, the optimal growth rate is 10 percent, or higher.

This approach illustrates how DFA can be used in strategic planning. This application requires careful choice of the appropriate parameter to optimize, and accurate valuation of the relevant variables.

Several additional factors should also be considered. In this study, the gross income value was included in the maximization formula on the assumption that taxation would affect the results of the different growth rates similarly. The effect of taxation on the property-liability insurance industry is significant, especially since the Tax Reform Act of 1986. Although the tax positions of insurers differ widely, both relative to other insurers and over time, the impact of taxes needs to be considered. DynaMo3 includes a tax module that can be applied, or altered to meet the specific circumstances. Including the tax effect could alter the optimal growth strategy.

Another factor to consider is the premium-to-surplus ratios that occur as a result of the different growth rates. Higher growth rates lead to both higher levels of written premium and lower levels of surplus. Thus, the net written premium to statutory surplus ratio, which averages 1.2 over the 500 simulations for 0 percent growth, is on average 2.7 for the 10 percent growth rate. Although this level is generally acceptable to regulators, values in excess of 3.0 frequently raise concern. The proportion of outcomes that lead to unacceptable premium-to-surplus levels could be added as a constraint in the maximization process. Similarly, Dynamo3 provides the results of eight of the eleven of the Insurance Regulatory Information System (IRIS) tests.[3] Another constraint could be to put a limit on the number of failed tests allowed – for example, specifying that no more than three of these tests can have failing values in more than 1.0 percent of the runs.

One limitation of DynaMo3 is that whatever growth rate is targeted is applied in every type of market condition. Since it is more difficult to grow at a particular rate in a soft market than in a hard market, a company has to temper its rate levels more in a soft market to achieve the targeted growth. An alternative strategy for managing growth would be to vary the growth rate target based on the market conditions, growing more slowly in soft markets and more rapidly in hard markets. Examining the effect of this type of strategy would require making modifications to the DFA program. Since Dynamo3 is a public access model, based on Excel with clear documentation, making such a revision is relatively straightforward. This program was written with the recognition that individual insurers or researchers would want to modify the basic program to meet their varying needs. Thus, the program can be readily customized to meet particular goals.

Caveats and Conclusion

Any application of a financial model should include the warning that all models are simplified versions of reality, and cannot be relied upon to mimic reality in all circumstances. In order to be useful, a model includes a number of simplifying assumptions about the real world to focus attention on particular relationships. No model can include all possible relationships or anticipate all feasible developments. Each model has both parameter and process risk. Parameter risk deals with the use of the correct value for a variable. Process risk refers to the relationships being correctly reflected. This particular DFA model deals with quantifiable risk only. In addition, insurers face other significant risks that cannot be accurately quantified in advance, but, if they occurred would have a major impact on the industry. One example of an excluded risk is the chance of a line of business being socialized, with the government taking over the coverage. Automobile insurance in British Columbia is an example of this occurrence. Management fraud is another risk that is excluded from this DFA model. Although fraud plays a large role in insurer insolvencies, all insurers are not equally exposed to this problem. Quantifying the actual risk of its management perpetrating a fraud against the company is beyond the scope of actuarial analysis, and is therefore not included in the model. This means, though, that the actual risk of financial difficulty for an insurer is higher than the model would indicate, because there is some, albeit unknown level of, risk of fraudulent behavior by management. Other catastrophic risks are also left out of this model. A devastating meteor strike, a new global weather pattern that leads to unprecedented windstorms and flooding, a novel legal determination making employers liable for currently uncompensated employee losses, all would impact the insurance industry adversely. None of these are reflected in the model because the likelihood of their occurrence and the severity of their impact cannot be readily quantified. Leaving them out of the model doesn't mean that they cannot happen, or that the modelers don't think they could occur, it only means that these risks are too difficult to incorporate in this model.

In conclusion, DFA can be a very useful tool for both solvency testing and strategic planning. DFA should not be considered the ultimate solution to all the problems of operating, or regulating, an insurance company. Following the strategies that appear best based on DFA models will help an insurer, but not guarantee long-term success. DFA allows insurers to position themselves to better take advantage of opportunities and avoid potential problems that can be accurately projected by the use of mathematical modeling. However, additional risks and developments beyond the ability of the model to quantify should be expected to occur. DFA can be a significant help in managing an insurance company, but it will not provide managers with answers to all the problems that face the insurance industry. Insurance is too complex to be modeled completely.

References

Ahlgrim, K. C., D'Arcy, S. P. and Gorvett, R. W. "Parameterizing Interest Rate Models." *CAS Dynamic Financial Analysis Call Paper Program*, 1999, pp. 1-50.

Casualty Actuarial Society Valuation and Financial Analysis Committee, Subcommittee on Dynamic Financial Models (1995) "Dynamic Financial Models of Property-Casualty Insurers" *Casualty Actuarial Society Forum*, Fall

Casualty Actuarial Society Valuation and Financial Analysis Committee, Subcommittee on the DFA Handbook (1996) "CAS Dynamic Financial Analysis Handbook." *Casualty Actuarial Society Forum*, Winter

Correnti, S., Sonlin, S. M. and Issac, D. B. "Applying A DFA Model to Improve Strategic Business Decisions." *CAS Dynamic Financial Analysis Call Paper Program*, 1998, pp. 15-51.

Cox, J. C., Ingersoll, J. E. and Ross, S. A. "A Theory of the Term Structure of Interest Rates." *Econometrica*, Vol. 53, 1985, pp. 385-407.

D'Arcy, S. P. and Doherty, N. A. "The Aging Phenomenon and Insurance Prices". *Proceedings of the Casualty Actuarial Society*, Vol. 76, 1989, pp. 24-44.

D'Arcy, S. P. and Doherty, N. A. "Adverse Selection, Private Information and Lowballing in Insurance Markets." *Journal of Business*, Vol. 63, No. 2, April 1990, pp. 145-164.

D'Arcy, S. P., Gorvett, R. W., Herbers, J. A. and Hettinger, T. E. "Building a Dynamic Financial Analysis Model that Flies." *Contingencies*, Vol. 9, No. 6, November-December, 1997a, pp. 40-45.

D'Arcy, S. P., Gorvett, R. W., Herbers, J. A., Hettinger, T. E., Lehmann, S.G. and Miller, M. J. "Building a Public Access PC-Based DFA Model." *CAS Dynamic Financial Analysis Call Paper Program*, 1997b, pp. 1-40.

D'Arcy, S. P., Gorvett, R. W., Hettinger, T. E. and Walling, R. J. "Using the Public Access Dynamic Financial Analysis Model: A Case Study." *CAS Dynamic Financial Analysis Call Paper Program*, 1998, pp. 53-118.

Feldblum, S. "Personal Automobile Premiums: An Asset Share Pricing Approach for Property/Casualty Insurance." *Proceedings of the Casualty Actuarial Society*, Vol. 83, 1996, pp. 190-296.

Hodes, T., Cummins, J. D., Phillips, R. and Feldblum, S. "The Financial Modeling of Property/Casualty Insurance Companies." *CAS Dynamic Financial Analysis Call Paper Program*, 1996, pp. 3-88.

Walling, R. J., Hettinger, T. E., Emma, C. C. and Ackerman, S., "Customizing the Public Access Model Using Publicly Available Data." *CAS Dynamic Financial Analysis Call Paper Program*, 1999, pp. 239-266.

Webster's Seventh New Collegiate Dictionary (G. & C. Merriam Company, Springfield, MA) 1965

Exhibit 1
Key Variables in DynaMo3

Financial	Underwriting
Short-term interest rate	Loss frequency and severity
Term structure of interest rates	Rates and exposures
Default potential of investments	Expenses
Equity performance	Underwriting cycle
Inflation	Loss reserve development
Mortgage pre-payment patterns	Jurisdictional risk
	Aging phenomenon
	Payment patterns
	Catastrophes
	Reinsurance
	Taxes

Exhibit 2
DynaMo3 Worksheets

Disclaimer
General Input
Investment Input
Reinsurance Input
XYZ Company - HMP - I
XYZ Company - WC - I
XYZ Company - HMP - O
XYZ Company - WC - O
LINE - SUMMARY
Cat Generator
Bond Summary
Bond 1
Bond 2
Bond 3
Bond 4
Bond 5
Stocks
Tax Calculator
Investment Distribution
Output
Statutory Summary
GAAP Summary
Simulation Data
Rnd Numbers

Exhibit 3
Year 2006 Surplus Distribution
Different Reinsurance Assumptions
Lowered Stop Loss Attachment Point

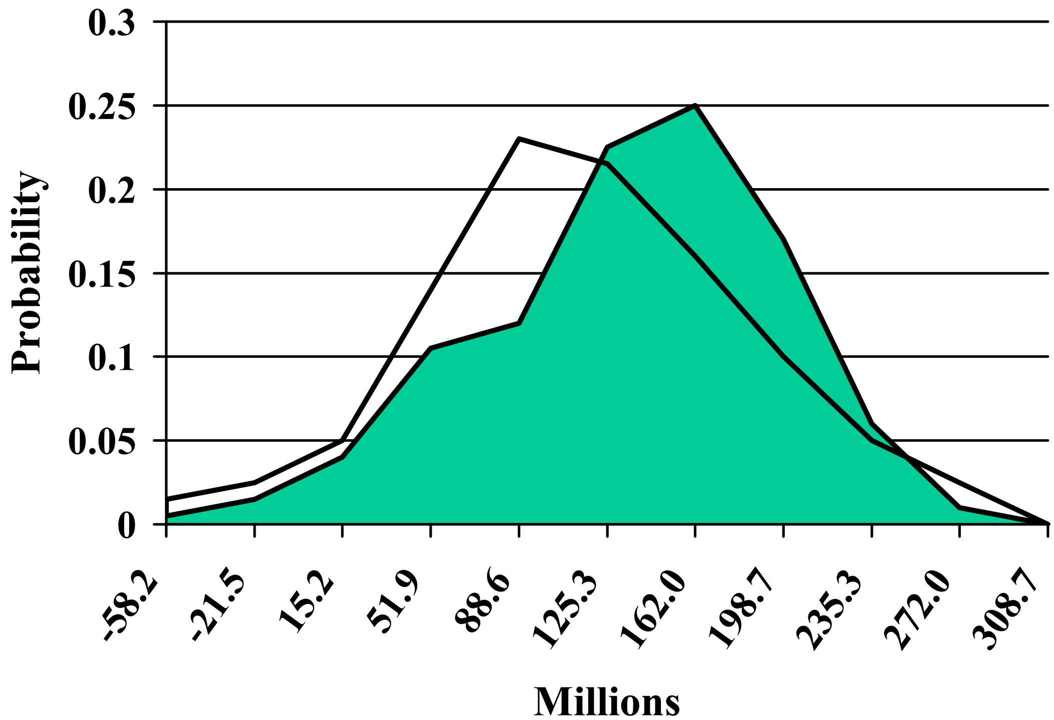

Exhibit 4
Statutory and GAAP Surplus and Gross Income
for Different Growth Rates
Mean Values of 500 Simulations

Growth Rate	Statutory Policyholders Surplus in 2006 (000 omitted)	GAAP Policyholders Surplus in 2006 (000 omitted)	Gross Income 2002-2006 (000 omitted)
0%	56, 419	68,810	18,645
2.5%	53,585	67,113	15,572
5.0%	50,164	64,958	12,151
7.5%	45,854	62,007	7,783
10.0%	40,371	58,186	2,306

Exhibit 5
Statutory PHS 2006
Under Different Growth Rates

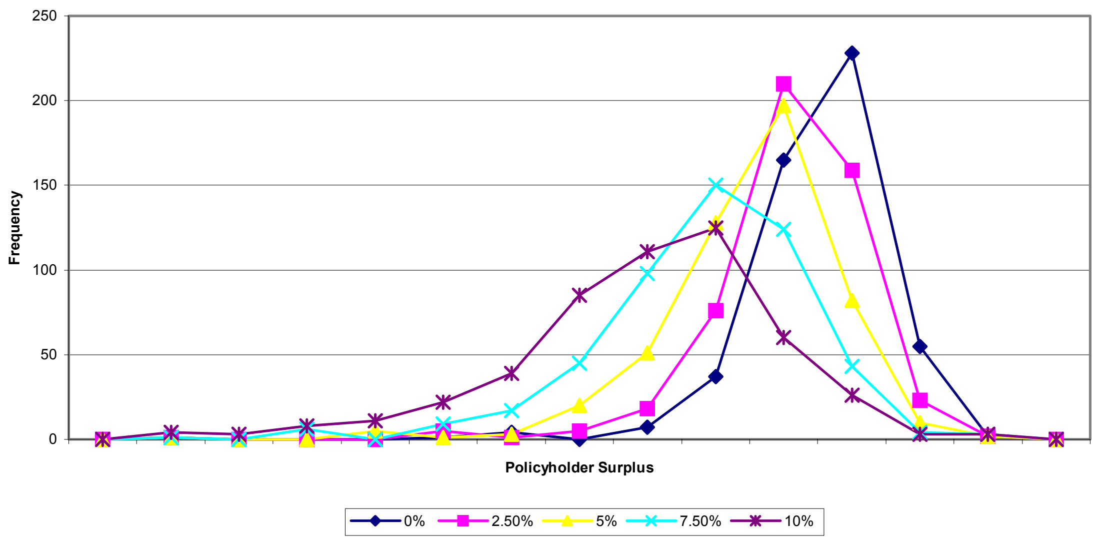

Exhibit 6
Gross Income plus Terminal Value of the Firm
for Different Growth Rates
Mean Values of 500 Simulations

Growth Rate	GAAP Policyholders Surplus in 2006 (000 omitted)	Gross Income 2002-2006 (000 omitted)	Net Written Premium in 2006 (000 omitted)	Gross Income + GAAP PHS	Gross Income + GAAP PHS + .6 x NWP	Gross Income + GAAP PHS + 1.0 x NWP
0%	68,810	18,645	65,776	87,455	126,921	153,231
2.5%	67,113	15,572	75,003	82,685	127,687	157,688
5.0%	64,958	12,151	85,190	77,109	128,223	162,299
7.5%	62,007	7,783	96,374	69,790	127,614	166,164
10.0%	58,186	2,306	108,602	60,492	125,653	169,094

[1] For a more complete explanation of interest rate models and selecting appropriate parameters, see Ahlgrim, D'Arcy and Gorvett, 1999.
[2] These values can be changed by the user.
[3] The three tests involving loss reserve adequacy are not determined. The reserve levels in Dynamo3 are set at the indicated values with no margin for inadequacy or redundancy.