Assurances et gestion des risques
Insurance and Risk Management

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Volume 77, numéro 3-4, 2009–2010

URI : https://id.erudit.org/iderudit/1091945ar
DOI : https://doi.org/10.7202/1091945ar

Aller au sommaire du numéro

Éditeur(s)

Faculté des sciences de l'administration, Université Laval

ISSN

1705-7299 (imprimé)
2371-4913 (numérique)

Découvrir la revue

Citer cet article

Zhang, L. & Nielson, N. (2009). The Pricing of Multiple Line P&C Insurance Based on the Full Information Underwriting Beta. *Assurances et gestion des risques / Insurance and Risk Management*, *77*(3-4), 237–264. https://doi.org/10.7202/1091945ar

Résumé de l'article

Cet article propose un modèle financier de tarification en assurance qui permet de tarifer les classes multi-riques d'assurance de dommages des compagnies dite « Property & Casualty » fondé sur une méthodologie dite « Full Information Underwriting Beta ». Il complète la littérature existante sur la tarification d'assurance sur la conformité du modèle sur les classes multi-risques et reflète le risque systématique des différentes classes d'assurance commerciale. Fondées sur les données de l'industrie canadienne des assurances de dommages (« Property & Casualty »), les conclusions empiriques primaires de cet article récusent fortement l'argumentation d'études antérieures à l'effet que les types de souscription bêta dans chaque classe distincte sont variables. Ces études font valoir que variation est proportionnelle à la durée de la période si la prime de la classe correspondante peut servir d'investissement. Nos résultats montrent aussi que la marge bénéficiaire de souscription en assurance de responsabilité est la plus basse par rapport aux trois classes d'assurance commerciale suivantes : assurance automobile, assurance des biens et assurance de responsabilité.

Assurances et gestion des risques, vol. 77(3-4), octobre 2009-janvier 2010, 237-264
Insurance and Risk Management, vol. 77(3-4), October 2009-January 2010, 237-264

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by Li Zhang and Norma Nielson

ABSTRACT

This paper develops a financial model of insurance pricing that is able to price insurance by line in a multi-line property & casualty insurance company based on the Full Information Underwriting Beta Methodology. It extends the existing literature in insurance pricing in that the model is suitable for multi-line pricing and reflects the systematic risk of different business lines. Based on Canadian Property & Casualty insurance industry data, the primary empirical findings in this paper strongly reject the argument in prior studies that underwriting betas of distinct lines vary in proportion to the length of the period that the premium of the corresponding line can be kept for investment. The results also show that the expected underwriting profit margin of liability insurance is the lowest among three distinct business lines: auto insurance, property insurance, and liability insurance.

Keywords: Multi-line insurance pricing, fair underwriting profit margin, insurance capital asset pricing model, full information underwriting beta methodology.

RESUMÉ

Cet article propose un modèle financier de tarification en assurance qui permet de tarifer les classes multi-riques d'assurance de dommages des compagnies dite « Property & Casualty » fondé sur une méthodologie dite « Full Information Underwriting Beta ». Il complète la littérature existante sur la tarification d'assurance sur la conformité du modèle sur les classes multi-risques et reflète le risque

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systématique des différentes classes d'assurance commerciale. Fondées sur les données de l'industrie canadienne des assurances de dommages (« Property & Casualty »), les conclusions empiriques primaires de cet article récusent fortement l'argumentation d'études antérieures à l'effet que les types de souscription bêta dans chaque classe distincte sont variables. Ces études font valoir que variation est proportionnelle à la durée de la période si la prime de la classe correspondante peut servir d'investissement. Nos résultats montrent aussi que la marge bénéficiaire de souscription en assurance de responsabilité est la plus basse par rapport aux trois classes d'assurance commerciale suivantes : assurance automobile, assurance des biens et assurance de responsabilité.

Mots clés : Tarification des classes d'assurance multi-risques, juste marge bénéficiaire de souscription, modèle de tarification, méthodologie beta.

1. INTRODUCTION

The Capital Asset Pricing Model (CAPM) developed in the mid-1960s by Sharpe (1964), Lintner (1965) and Mossin (1966) and tested for the Canadian market by Morin (1980), Abeysekera (1987), and Smith (1993) has been widely applied in insurance to estimate both the fair total rate of return and the fair underwriting profit margin[1] (e.g., Cooper, 1974; QuirinWater, 1975; Biger & Kahane, 1978; Fairley, 1979; Hill, 1979; Hill & Modigliani, 1987; Urrutia, 1986, D'Arcy &Garven, 1990; Derrig, 1994; D'Arcy & Gorvett, 1998; Cummins & Phillips, 2005). In the early applications of CAPM to estimate fair underwriting profit margin, Cooper (1974) and Biger & Kahane (1978) assumed no taxes, and that each dollar of premium can be invested for a whole year before it was paid out as claim or expense; systematic risk was measured by the underwriting beta that reflects the correlation between an insurer's underwriting portfolio and the market portfolio. The model by Quirin and Waters (1975), ignoring taxes, implied that the underwriting profit margin should be equal to the negative of the risk-free rate of interest. Their empirical results, utilizing a sample of 25 Canadian insurers for the period of 1961-1971, however, indicated that, on average, the underwriting return is positive. Quirin and Waters sumarized the possible reasons for the deviation as: 1) the taxes and the risk of insolvency were not included in their model; and 2) the deviation may be because of the particular sample period, the particular market (in this case Canadian), and peculiarities of the accounting data.

Later studies extended the initial model in three ways. First, the assumption that the premium received could be invested for the whole year was relaxed in most of the later studies to allow premiums to be retained for a fraction of a year, k (e.g., Fairley, 1979; Kahane, 1979; Urrutia, 1986; Hill & Modigliani, 1987). Second, taxes were included in later refinements of the models with Fairley (1979), Hill 1979, Urrutia (1986), Hill & Modagliani (1987), and Derrig (1994) using different tax rates for underwriting income and investment income to reflect the special tax treatment on investment income.

Third, the mono-line models began to be applied to multi-line companies. Biger & Kahane (1978) described an indirect method to derive the distinct line underwriting beta from the betas of individual assets and the beta of the company's stock. This method involved extensive data collection for investment assets and "it is quite possible that noise in the data will cause the results to be obscure" (pp. 129). Fairley (1979) argued that the underwriting beta of a distinct line was the product of the leverage factor, k, of the distinct line and the liability beta that was assumed constant over all business lines where the liability beta was defined as the covariance of the return on liabilities and market return divided by the variance of the market return. The implicit assumption was that the underwriting betas of distinct lines vary in proportion to the length of the period that the premium of the corresponding line can be kept for investment. "In the insurance industry, where 'risk' is generally conceived in terms of total variability, the lines with the longer cash flows are viewed as the 'riskiest'" (Fairley 1979, pp. 200).

However, the length of the period over which claims are paid is only one risk factor present. Other characteristics of business lines, such as the interdependence of the accident events, and the sizes and frequencies of the claims, are all important risk factors that should be considered. Fairley (1979) recognized explicitly that his assumption of loss beta being "constant by line is important and strong, and future work should be directed at relaxing it." Urrutia (1987) estimated distinct line underwriting betas by performing factor analysis on the combined ratios; however, the rationale for using factor analysis and the details of the methodology were not fully discussed in his paper.

The ability to accurately measure the underwriting profit margin is very important in both profit/premium-rate regulation and pricing in P&C insurance industry and in maintaining firms' healthy financial status. Using a single combined underwriting profit margin for all business lines may cause positive or negative abnormal profits depending on the business-participation weight of each distinct business line. The aggregate results may be misleading, especially if there exists a systematic distortion caused by the combination of the distinct lines of business, Cummins & Harrington (1985) argued that betas differed across insurers and that this variation may be attributable to the inter-insurer differences in product-line mix. D'Arcy & Garven (1990) pointed out that future research on various pricing models for distinct lines of business could provide more accurate results and avoid the aforementioned problem.

The purpose of this paper is to contribute to the existing literature on fair underwriting profit margin by developing an Insurance Capital Asset Pricing Model (ICAPM) that reflects the risk characteristics of different business lines. The current model extends prior ICAPM models in these steps: first, the mono-line model is extended into a multi-line insurance pricing model. Specifically, Full Information Beta methodology (Cummins & Phillips, 2005) is applied to estimate the underwriting betas of property insurance, auto insurance, and liability insurance; then the full information underwriting beta of each distinct business line is applied to estimate the fair underwriting profit margin and fair premium of each business line. Finally, in addition to the corporate income tax rate, other taxes are incorporated into the model to allow further study of the impacts of taxes on the fair insurance pricing. Our paper also provides comparative statics analysis with respect to the important parameters in the Insurance Capital Asset Pricing Model with the quantitative results of their impacts on insurance pricing presented.

This paper is organized as follows. The theoretical model and the comparative statics analysis are presented in section 2. Data and variables are discussed in section 3. This is followed by the empirical results and discussion in section 4. Conclusions appear in section 5.

2. THEORETICAL MODEL AND COMPARATIVE STATICS ANALYSIS

An insurer's total return is comprised by the return from its investment activity and the return from its underwriting section, \ which interact with each other. The derivation of the fair underwriting profit margin (FUPM) follows the traditional ICAPM (e.g., Fairley, 1979; Hill & Modigliani, 1987). An insurer's after-tax actual return can be expressed as the sum of the returns from its underwriting operation and its investment activities. For simplicity, the insurer is assumed to have initial equity investment, V_e, and to have written insurance for an expected premium income, $\bar{P}$ (the net premium earned). The actual return to shareholders, r_e, equals the after-tax profits from investment and underwriting activity divided by the insurer's initial equity. The relationship can be expressed as:

$$r_e = \frac{r_a \cdot V_a + r_u \cdot P) \cdot (1 - t_{CI})}{V_e} \tag{2.1}$$

where: $V_a = V_l + V_e$ (2.2)

$V_l = k \cdot P$ (2.3)

where:

r_e: is the return on insurer's equity;

r_a: is the return on insurer's investment portfolio;

r_u: is the insurer's underwriting profit margin, expressed as a percentage of net premium earned;

t_{CI}: is the effective corporate income tax rate;

V_a: is the value of insurer's assets;

V_e: is the value of insurer's equity;

V_l: is the value of claims reserve;

P: is the annual net premium earned (net of reinsurance);

k: is a leverage factor reflecting the average holding period of a dollar of premium[2] (Fairley (1979), pp.198).

Using standard methods, an insurer's actual return shown in equation (2.1) can be expressed as:

$$r_e = (r_a \cdot (1{+}k \cdot b){+}r_u \cdot b) \cdot (1{-}t_{CI}) \tag{2.4}$$

and the expected value of the insurer's actual return as:

$$E\,[r_e] = \{r_f + \beta_a \cdot (E\,[r_m] - r_f)) \cdot (1{+}k \cdot b) + \mathrm{E}\,[r_u] \cdot b\} \cdot (1{-}t_{CI}) \tag{2.5}$$

where:

r_f: is the risk-free rate;

β_a: is the beta of insurer's investment portfolio;

r_m: is the return on market portfolio;

b: is the ratio of the net premium earned to the insurer's equity.

$E[*]$: is the expectation operator.

An insurer's required return on equity by the capital market can also be derived from the CAPM:

$$E[r_e] = r_f + \beta_e \cdot (E[r_m] - r_f) \tag{2.6}$$

where, $\beta_e = (\beta_a \cdot (1+k \cdot b) + \beta_u \cdot b \cdot (1-t_{CI})$ (2.7)

where:

β_u; is the underwriting beta.

Hence, the expected required return on equity can be shown as follows:

$$E[r_e] = r_f + \{(\beta_a \cdot (1+k \cdot b) + \beta_u \cdot b) \cdot (1-t_{CI})\} \cdot (E[r_m] - r_f) \tag{2.8}$$

The fair underwriting profit margin is derived based on the non-arbitrage condition that, in equilibrium, the expected actual return should equal the expected required return by the capital market, i.e., equation (2.5) should be equal to equation (2.8). That is:

$$\{(r_f + \beta_a \cdot (E[r_m] - r_f)) \cdot (1+k \cdot b) + E[r_u] \cdot b\} \cdot (1-t_{CI})$$

$$= r_f + \{(\beta_a \cdot (1+k \cdot b) + \beta_u \cdot b) \cdot (1-t_{CI}) \cdot (E[r_m] - r_f) \tag{2.10}$$

From equation (2.10), it is observed that the fair underwriting profit margin (FUPM) depends on the risk-free rate, cash flows (i.e., leverage factor k), effective corporate income tax rate, premium-to-equity ratio, the systematic underwriting risk (i.e., the underwriting beta), and the equity risk premium. We further observe that the FUPM does not depend on the insurer's actual investment performance. The first term of equation (2.10) shows the risk-free investment return generated from policyholder's fund; the second term adjusts for corporate income tax. The third term indicates the risk premium for the insurer's underwriting activities. Although variables for expense rate and other-taxes rate (except corporate income tax) do not appear in the fair underwriting profit margin formula, the leverage factor k, which does appear, is directly influnced by the expense rate and other-taxes rate.

The underwriting profit margin is defined as one minus the sum of the expense ratio (including all taxes except corporate income tax) and loss ratio.

$$E(r_u) = \frac{E[P] \cdot (1 - t_{prem} - e) - E(L)}{E[P]}.$$

The above equation can be rearranged to produce the following expression for expected premium:

$$E[P] = \frac{E(L)}{1 - t_{prem} - e - E(r_u)} \tag{2.11}$$

where:

e: is the expense rate, measured as a percentage of premium;

t_{prem}: is the other-taxes rate, i.e., the total taxes paid except corporate income tax as a percentage of premium (e.g., premium tax, fire tax, property tax, payroll tax, etc.);

L: is the net loss incurred including claim adjustment expenses.

Consistent with prior research (e.g., Hill, 1979; Cummins & Harrington, 1985), the underwriting beta is estimated based on the market model. The underwriting profit margin is regressed against the current market return. Without auto-correlation, underwriting profit margin at time t can be expressed as:

$$r_{uit} = \alpha_i + \beta_{ui} \cdot r_{mt} + e_{it} \tag{2.12}$$

where:

α_i: is the constant in the regression model;

r_{uit}: is the i^{th} insurer's underwriting profit margin in period t;

r_{mt}: is the return on market portfolio in period t;

β_{ui}: is the i^{th} insurers' underwriting beta;

e_{it}: is the random error term in period t for the i^{th} insurer.

However, because the information content of underwriting profit margin reported in financial statements may have been reflected in the market performance before this information is reported, auto-correlation may exist. One way to mitigate this potential bias is to include lagged market returns in the regression model. Equation (2.12) can be adjusted by regressing the underwriting profit margin on both the current year and previous year's market returns, i.e.,

$$r_{uit} = \alpha_i + \beta 1_{ui} \cdot r_{mt} + \beta 2_{ui} \cdot r_{m(t-1)} + e_{it} \tag{2.13}$$

and

$$\beta_{ui} = \beta 1_{ui} + \beta 2_{ui} \tag{2.14}$$

The β_{ui} in equation (2.14) is called the sumbeta hereafter.

Once the underwriting beta/sumbeta, β_{ui} for each firm is estimated, the underwriting beta for each business line can be derived using the full information beta approach. Under this approach the underwriting beta of an insurer is the weighted average of the betas of its distinct business lines, i.e.,

$$\beta_{ui} = \sum_{j=1}^{J} \beta_{fuj} \cdot \omega_{ij} + \nu_{ui} \tag{2.15}$$

where the subscript i denotes the i^{th} firm; and the subscript j denotes the j^{th} business line:

β_{fuj}: is the full information underwriting beta for the j^{th} business line;

ω_{ij}: is firm i's business-participation weight for the j^{th} business line, using the premium written as the weight;

υ_{ui}: the random error term for firm i.

As a final aid to understanding the implications of the models developed, a comparative statics analysis is conducted with respect to: effective corporate income tax rate, expense-and-other-taxes rate[3], premium-to-equity ratio, and leverage. For the fair underwriting profit margin (FUPM), results of the comparative statics analysis are as follows:

$$\frac{\partial E\left[r_u\right]}{\partial t_{CI}} = \frac{r_f}{b \cdot (1 - t_{CI})^2} > 0 \tag{2.16}$$

$$\frac{\partial E\left[r_u\right]}{\partial (t_{prem} + e)} = 0 \tag{2.17}$$

$$\frac{\partial E\left[r_u\right]}{\partial b} = \frac{-r_f}{b^2 \cdot (1 - t_{CI})} < 0 \tag{2.18}$$

$$\frac{\partial E\left[r_u\right]}{\partial k} = -r_f < 0 \tag{2.19}$$

Equations (2.16) through (2.19), show that in a normal situation (i.e., where the risk-free rate and net claims incurred are greater than zero; and the effective corporate income tax rate is less than one), a higher effective corporate income tax rate leads to a higher FUPM; the expense-and-other-taxes rate is not directly related to FUPM; and both a higher premium-to-equity ratio (b) and a higher leverage factor (k) produce a lower FUPM. Because corporate income tax imposed upon insurers reduces their post-tax profitability, in order to provide competitive return to equityholders, insurers must raise their target underwriting profit. At any given level of total profit and the same volume of underwriting business, firms with high b and k achieve higher *rate of return on equity* than those with low b and k. Therefore, to obtain the same *rate of return on equity*, the target underwriting profits for firms with high b and k need not be as high as those for firms with low b and k. Also, ceteris paribus, high b and k indicate a higher default risk which, in turn, may mean insurers are not able to charge as high an underwriting profit margin (e.g., Phillips *et al.*,1998). Furthermore, a high leverage factor, *k,* indicates that policyholder funds are retained for a longer period of time, thus contributing more to investment activity and reducing the expected required profit from underwriting.

For the fair net premium (FNP), results of the comparative statics analysis are as follows:

$$\frac{\partial E[P]}{\partial t_{CI}} = \frac{\partial E[P]}{\partial E[r_u]} \cdot \frac{\partial E[r_u]}{\partial t_{CI}} = \frac{E(L)}{1 - t_{prem} - e - E(r_u))^2} \cdot \frac{r_f}{b \cdot (1 - t_{CI})^2} > 0 \quad (2.20)$$

$$\frac{\partial E[P]}{\partial (t_{prem} + e)} = \frac{E(L)}{1 - t_{prem} - e - E(r_u))^2} > 0 \quad (2.21)$$

$$\frac{\partial E[P]}{\partial b} = \frac{\partial E[P]}{\partial E[r_u]} \cdot \frac{\partial E[r_u]}{\partial b} = \frac{E(L)}{1 - t_{prem} - e - E(r_u))^2} \cdot \frac{-r_f}{b^2 \cdot (1 - t_{CI})} < 0 \quad (2.22)$$

$$\frac{\partial E[P]}{\partial k} = \frac{\partial E[P]}{\partial E[r_u]} \cdot \frac{\partial E[r_u]}{\partial k} = \frac{E(L)}{1 - t_{prem} - e - E(r_u))^2} \cdot -r_f < 0 \quad (2.23)$$

Equations (2.20) through (2.23), show that, in a normal situation, both a higher effective corporate income tax rate and a higher expense-and-other-taxes rate result in a higher fair net premium. Similarly both a higher premium-to-equity ratio and a higher leverage factor lead to a lower fair net premium.

3. VARIABLE DEFINITION AND SAMPLE SELECTION

3.1 Variable Definition

The variables needed to empirically estimate the FUPMs for the property-casualty insurance industry use both market data and operating data. The market data needed include the risk-free rate and the equity market return, which can be used to compute the equity risk premium. In this paper, the risk-free rate is measured by the yield on the 91-day Government of Canada T-bill. The equity market return is derived from the S&P/TSX composite total return index and calculated as the ratio of the difference between the year-end index and the year-beginning index to the year-beginning index.

Operating data are collected for each insurer and involve both the aggregate data for the overall business and data for the following distinct insurance business lines: auto insurance, property insurance, liability insurance, and all others. All the operating variables are either obtained or derived from *MSA Researcher P&C 2006* database published by MSA Research Inc. of Toronto. Specific variables are defined as follows:

– Underwriting profit margin: 1 minus the combined ratio, expressed as a percentage of net premium earned. Combined ratio, as reported by MSA, is the ratio of total underwriting expenses to net premiums earned.

– Premium-to-equity ratio: ratio of the net premium earned to the total of GAAP capital (at the beginning of the year).

– Leverage factor (k): the ratio of the net unpaid claims as a proportion of net premium earned.

– Net premium earned: direct premium earned plus any reinsurance premium received minus reinsurance premium ceded.

– Net loss incurred: net claims and adjustment expenses incurred, including any unpaid claims and corresponding expenses.

– Effective corporate income tax rate: the difference between the net income before tax and the net income after tax divided by the net income before tax.

– Expense-and-other-taxes rate: expenses as a proportion of net premium earned. Because taxes other than corporate income tax are aggregated with other expense items in the annual financial reports, for analytical purposes expenses must be combined with other taxes.

Net premium earned, net claims incurred, and k for each distinct line are derived from annual report data. In the estimation of the fair underwriting profit margins and fair net premiums for distinct business lines, it is assumed that the effective corporate income tax rate, expense-and-other-taxes rate, and premium-to-equity ratio are the same across insurance business lines as the aggregate rates for each insurer. While still somewhat restrictive, the assumptions are still relaxed considerably from what has appeared in earlier work. The firm's business-participation weight for business line j is measured as the proportion of the j_{th} line's net premium written divided by the insurer's aggregate net premium written.

3.2 Sample Selection

This subsection describes the data sources, sample selection procedures, and data screens employed to construct the samples. The sample adopted in the estimation of CAPM underwriting betas includes all active Canadian P&C insurers in the *MSA Research P&C 2006* database that satisfy the following criteria: 1) have at least 8 years of reported underwriting profit margin; 2) have an absolute underwriting profit margin less than or equal to 200; 3) have net premium earned greater than CAN$10,000. In total, 132 insurers satisfy the aforementioned criteria and are included in the CAPM underwriting beta estimation sample. The underwriting profit margins and market returns during the period from 1991 through 2005 are collected with the first sample – CAPM underwriting beta estimation sample – and produce 1724 company-year observations. Market data are collected from the Toronto Stock Exchange (TSX) Database. Summary statistics for the CAPM underwriting beta estimation sample are the annual rates and are presented in table 3.1.

TABLE 3.1
DESCRIPTIVE STATISTICS OF VARIABLES IN THE CAPM UNDERWRITING BETA ESTIMATION SAMPLE

Variable	Obs	Mean	Std Dev.	Min	Max
rm	15	11.91	15.10	-12.57	32.55
rf	15	4.61	1.83	2.22	8.73
riskprem	15	7.30	15.33	-16.36	27.70
upm	1724	-3.84	30.91	-180.80	188.80

Where:	
rm	Market return, in %, derived from the S&P/TSX composite total return index and calculated as the ratio of the difference between the year-end index and the year-beginning index to the year-beginning index.
rf	Risk-free rate, in %, measured by the yield on 91-day T-bill.
riskprem	Risk premium, in %, measured by the differnence between market return and the risk-free rate.
upm	Underwriting profit margin, in %, defined as 1 minus the ocombined ratio, which is the ratio of the total underwriting expenses as a percentage of net premiums earned.

After the CAPM underwriting betas are estimated for each insurer, the model requires every insurer's business-participation weight for each business line in order to estimate the Full Information Underwriting Beta (FIUB) of each distinct line. That information is, thereafter, used to estimate the fair underwriting profit margin (FUPM) and fair net premium (FNP) using equations (2.10) and (2.11). Because the MSA database contains data for distinct lines starting only from 1999 (with some by-line data not available, incomplete or inaccurate), the sample size used to estimate the FIUBs is smaller than what was available for the CAPM underwriting beta estimation. The FIUB estimation sample includes 804 company-year observations.

Estimation of the fair underwriting profit margin (FUPM) and fair net premium (FNP) using equations (2.10) and (2.11), in addition to the by-line participation weights, requires further information. Limitations on the availability of these additional variables further shrinks the sample size for the FUPM and FNP estimation sample. The sample used in the estimation of the FUPM and FNP are the insurers that 1) are in the FIUB estimation sample; 2) have complete and accurate by-line data for equations (2.10) and (2.11); 3) have positive leverage factors to reflect the average holding period of a dollar of premium before loss payment. The resulting sample contains 393 company-year observations. Summary statistics of the FUPM and FNP estimation sample are shown in table 3.2. The net premium earned and the net claims incurred, as presented in table 3.2, are the sum across all the insurers in the FUPM and FNP estimation sample; other parameters listed are the average across all the insurers in the FUPM and FNP estimation sample.

From table 3.2, it can be seen that, except in years 2000 and 2003, the number of insurers that reported complete and accurate distinct business lines was increasing. On average, over the period from 1999 to 2005 the sample comprised about 70% the total Canadian P&C insurance market and should be representative of the Canadian insurance market[5]. As expected, the leverage factor is highest for liability insurance, followed by auto insurance (including auto liability insurance), and then property insurance. This means that liability insurance has longest claim tail, followed by auto insurance and then property insurance. This ordering remains the same whether measured by the annual means or by the grand means. The results related to "other" business lines are not discussed in any detail here, because the combination of lines within this group make generalization impossible.

TABLE 3.2
DESCRIPTIVE STATISTICS OF INSURERS' OPERATING VARIABLES IN THE FUPM & FNP ESTIMATION SAMPLE

	1999		2000		2001		2002		2003		2004		2005		total		
Variable	**Obs**	**Mean**	**Obs**	**Mean**	**Obs**	**Mean**	**Obs**	**Mean**	**Obs**	**Mean**	**Obs**	**Mean**	**Obs**	**Mean**	**Obs**	**Mean**	**Std. Dev.**
upm	41	1.06	28	-6.35	61	-9.47	60	-2.07	31	0.01	90	11.90	82	9.80	393	2.64	19.13
incometax	41	0,25	28	0.33	61	0.47	60	0.29	31	0.30	90	0.42	82	0.26	393	0.34	0.78
expe_tax	41	0,33	28	0.33	61	0.33	60	0.30	31	0.29	90	0.34	82	0.34	393	0.33	0.13
b	37	1.37	28	1.54	61	1.40	60	1.53	31	1.85	90	1.52	82	1.40	393	1.49	0.82
k	39	0,93	28	0.97	61	1.06	60	0.98	31	0.95	90	0.86	82	1.00	393	0.96	0.56
auto_k	33	1.16	25	1.13	51	1.21	51	1.23	28	1.10	65	1.33	61	1.60	318	1.29	0.95
prop_k	27	0,36	26	0.41	57	0.45	57	0.39	28	0.40	78	0.39	70	0.42	355	0.40	0.31
liab_k	41	2.42	21	2.61	51	2.70	50	2.51	26	2.26	65	2.14	59	2.33	305	2.40	1.90
other_k	41	0.77	17	0.83	44	0.89	45	0.74	22	0.47	63	0.72	57	0.72	275	0.74	0.82
npe	41	165572	28	179441	61	205192	60	250661	31	260585	90	248276	82	280881	393	236194	319914
auto_npe	41	93351	28	105372	61	112673	60	132972	31	149670	90	122542	82	141828	393	124498	213585
prop_npe	41	53644	28	51244	61	61257	60	77213	31	71845	90	74953	82	83768	393	70854	101524
liab_npe	41	13169	28	16481	61	18964	60	26511	31	29279	90	31752	82	35206	393	26466	45918
other_npe	41	5492	28	6275	61	12250	60	13972	31	16825	90	19063	82	20095	393	14940	38681
nci	41	120264	28	140908	61	164646	60	194395	31	193085	90	152840	82	175408	393	164651	229097
auto_nci	41	72722	28	88642	61	97743	60	116385	31	125343	90	81297	82	90864	393	94306	165154
prop_nci	41	35216	28	36677	61	44046	60	48779	31	43390	90	40372	82	54566	393	44624	65853
liab_nci	41	9995	28	11906	61	14517	60	20102	31	21286	90	23338	82	22858	393	19006	34447
other_nci	41	2330	28	3577	61	8298	60	9128	31	9979	90	7784	82	7120	393	7235	23653

TABLE 3.2
SUITE

Where:	
upm	Underwriting profit margin, in %, defined as 1 minus the combined ratiothe ratio of the total underwriting expenses as a percentage of net premiums earned
incometax	Effective corporate income tax, calculated as the ratio of the difference between the net income before tax and the net income after tax to the net income before tax
expe_tax	Effective expenseandothertaxes rate (EOT), measured by the ratio of aggregate expenses and other taxes to the net premium earned
b	
k	Ratio of the net premium earned to the value of insurer's equity
auto_k	Leverage factor, reflecting the average holding period of a dollar of premium before it is used to pay expenses and losses. It is measured by the ratio of the net unpaid claims to the net premium earned.
prop_k	Leverage factor of auto insurance
liab_k	Leverage factor of property insurance
other_k	Leverage factor of liability insurance
npe	Leverage factor of all other insurance business lines
auto_npe	Total net premium earned, net of reinsurance, in $,000
prop_npe	Net premium earned of auto insurance, in $,000
liab_npe	Net premium earned of property insurance, in $,000
other_npe	Net premium earned of liability insurance, in $,000
nci	Net premium earned of all other insurance business lines, in $,000
auto_nci	Net claims and adjustment expenses incurred, including unpaid claims and corresponding expenses, in $,000
prop_nci	Net claims and adjustment expenses incurred of property insurance, in $,000
liab_nci	Net claims and adjustment expenses incurred of property insurance, in $,000
other_nci	Net claims and adjustment expenses incurred of liability insurance, in $,000
	Net claims and adjustment expenses incurred of all other insurance business lines, in $,000

4. EMPIRICAL RESULTS

This section presents the empirical results from time series regression (CAPM underwriting betas) and cross-section regression (Full Information Underwriting Beta of each distinct line), the empirical estimations of fair underwriting profit margins and fair net premium, and the comparative statics analysis results.

4.1 CAPM Underwriting Betas and Full Information Underwriting Betas

The CAPM underwriting beta and sumbeta estimates for Property & Casualty insurers are summarized in Table 4.1. The betas and sumbetas are estimated using equations (2.12) and (2.13) for each of the 132 insurers. The means, standard deviations, minimums and maximums of the beta and sumbeta estimates in the different size quantiles are provided with size measured by the average of an insurer's equity over the sample period. Consistent with the other studies the sumbeta is provided to reflect that the underwriting profit margin from the accounting reports may relate to market returns in the prior year. We conducted a Durbin-Watson test to examine the first-order auto-correlation of the residuals of the model based on equation (2.12). Almost half (57 out of 132) of the regressions indicate either the existence of first-order serial correlation or are inconclusive about the existence of first-order serial correlation. In order to examine the significance of this factor, the model was rerun including the lagged variable. Including the prior year's market return in the regression, the average R-square almost doubles. Thus, our paper reports both models.

From the results shown in Table 4.1, we find that small insurers on average have higher underwriting betas and exhibit larger standard deviations. Large insurers on average have lower underwriting betas and have smaller standard deviations. The means and standard deviations of medium-size insurers (the second and third quantile) fall in between. The findings are consistent with arguments in the prior research that beta is negatively related to size. However, that same relationship does not hold for sumbetas across firms of different sizes. Also, the difference observed between betas and sumbetas is larger for bigger firms. This observation indicates that, compared to smaller firms, larger firms exhibit a larger degree of early information release. The result could occur because larger firms are more heavily publicized; more financial information is released before the annual financial statements are officially reported. The results indicate that, after taking into account the early release of information, little difference in underwriting betas remains among firms of different sizes.

TABLE 4.1
CAPM UNDERWRITING BETAS FOR P&C INSURERS

The betas and sumbetas are estimated based on time series regressions using data from 1991 through 2005, and conducted for every firm based on the following equations.

$$r_{uit} = \alpha_i + \beta_{ui} \cdot r_{mt} + e_{it}$$

$$r_{uit} = \alpha_i + \beta 1_{ui} \cdot r_{mt} + \beta 2_{ui} \cdot r_{mt(t\text{-}1)} + e_{it}$$

$$sumbeta = \beta 1_u + \beta 2_u$$

Where,

r_{mt}	Market return, in %, derived from the S&P/TSX composite total return index and calculated as the ratio of the difference between the year-end index and the yearbeginning index to the yearbeginning index
r_{ut}	Underwriting profit margin, in %, defined as 1 minus the combined ratio, which is the ratio of the total underwriting expenses as a percentage of net premiums earned
size	The average of the GAAP capital and surplus over the sample period for each firm, in $,000

	Variable	Obs	Sample Mean	Sample Std. Dev.	Sample Min	Sample Max
total	beta	132	0.2405	0.5576	-1.1750	2.9020
	sumbeta	132	0.2911	0.8121	-1.9180	3.8370
	size	132	136396	193183	1187	1199408
small	beta	33	0.2883	0.8760	-1.1750	2.9020
	sumbeta	33	0.2657	1.1916	-1.9180	3.8370
	size	33	13075	6881	1187	25008
2	beta	33	0.2299	0.5028	0.6550	1.8870
	sumbeta	33	0.2629	0.6839	1.4150	2.4620
	size	33	40164	8499	25717	55893
3	beta	33	0.2449	0.4327	-0.4170	1.8450
	sumbeta	33	0.3325	0.7043	-0.9460	2.7320
	size	33	91418	28137	56220	151591
large	beta	33	0.1990	0.2478	-0.3110	0.8290
	sumbeta	33	0.3032	0.5590	-1.6330	2.1220
	size	33	400925	228877	163806	1199408

TABLE 4.2
REGRESSION RESULTS OF FULL INFORMATION UNDERWRITING BETA BY LINE

The table displays full information underwriting beta estimates for auto insurance, property insurance, liability insurance, and all other insurance business lines. The full information underwriting beta is estimated from the following crosssection regression.

$$\beta_{ui} = \sum_{j-1}^{J} \beta_{fuj} \cdot \omega_{ij} + \upsilon_{ui}$$

Where,

β_{ui}	Insurer i's underwriting beta
β_{fuj}	The full information underwriting beta for business line j
ω_{ij}	Firm i's businessparticipation weight for business line j, with the premium written as the weight
υ_{ui}	The random error term for firm i

The regression is estimated by OLS. The full information regression conducted separatedly for each calendar year and for the pooled 7year data set.

	1999	2000	2001	2002	2003	2004	2005	panel estimate
Panel A: The full information underwriting betas estimated from betas								
auto	0.38	0.32	0.37	0.29	0.35	0.14	0.20	0.29
	(3.46)**	(2.74)**	(3.59)**	(2.66)**	(3.11)**	(1.40)	(1.86)	(7.18)**
property	0.30	0.02	0.17	0.20	0.07	0.29	0.28	0.20
	(2.35)*	(0.13)	(1.45)	(1.62)	(0.48)	(2.55)*	(2.37)*	(4.26)**
liability	(0.26)	0.17	0.14	0.27	0.25	0.09	0.10	0.11
	(1.15)	(0.85)	(0.76)	(1.46)	(1.24)	(0.49)	(0.56)	(1.56)
other	0.16	0.12	0.13	0.08	0.26	0.40	0.21	0.19
	(1.20)	(0.78)	(1.00)	(0.68)	(1.73)	(3.15)**	(1.63)	(3.71)**
Observation	129.00	92.00	130.00	127.00	96.00	120.00	110.00	804.00
R-squared	0.19	0.12	0.18	0.16	0.20	0.21	0.18	0.16

F-test for panel estimates:	$\beta_{fu(auto)}/k_{auto} = \beta_{fu(prop)}/k_{prop}$	F(1,800)=5.00	Prob > F = 0.0256
	$\beta_{fu(auto)}/k_{auto} = \beta_{fu(liab)}/k_{liab}$	F(1,800)=12.64	Prob > F = 0.0004
	$\beta_{fu(prop)}/k_{prop} = \beta_{fu(liab)}/k_{liab}$	F(1,800)=12.25	Prob > F = 0.0005

	1999	2000	2001	2002	2003	2004	2005	panel estimate
Panel B: The full information underwriting betas estimated from sumbetas								
auto	0.59 (3.57)**	0.35 (2.19)*	0.53 (3.53)**	0.45 (2.94)**	0.48 (2.77)**	0.22 (1.50)	0.31 (2.12)*	0.42 (7.15)**
property	0.31 (1.63)	0.07 (0.34)	0.15 (0.89)	0.32 (1.89)	0.17 (0.83)	0.47 (2.85)**	0.52 (3.17)**	0.30 (4.45)**
liability	0.06 (0.19)	0.01 (0.03)	0.37 (1.34)	0.32 (1.21)	0.40 (1.32)	0.19 (0.72)	0.22 (0.92)	0.23 (2.19)*
other	0.07 0.34	(0.10) (0.45)	(0.11) (0.60)	(0.11) (0.66)	(0.08) (0.68)	0.17 (0.94)	(0.21) (1.16)	(0.08) (1.03)
Observation R-squared	129.00 0.17	92.00 0.12	130.0 0.16	127.00 0.17	96.00 0.16	120.00 0.17	110.00 0.23	804.00 0.15
F-test for panel estimates:	$\beta_{fu(auto)}/k_{auto} = \beta_{fu(prop)}/k_{prop}$ F(1,800)=5.00 Prob > F = 0.0256 $\beta_{fu(auto)}/k_{auto} = \beta_{fu(liab)}/k_{liab}$ F(1,800)=12.64 Prob > F = 0.0004 $\beta_{fu(prop)}/k_{prop} = \beta_{fu(liab)}/k_{liab}$ F(1,800)=12.25 Prob > F = 0.0005							
Absolute values of the tstatistics are shown in parentheses * significant at 5%; ** significant at 1%								

The Full Information Underwriting Betas for auto insurance, property insurance, liability insurance, and all other insurance lines are presented in Table 4.2. These results are based on a cross-section regression with the CAPM underwriting betas as the dependent variables and each firm's participation weights of business lines as the independent variables. In panel A, the dependent variables are the betas; and in panel B, the dependent variables are the sumbetas. The coefficients of the business participation weights are the estimates of the Full Information Underwriting Betas of the corresponding business lines. In the prior studies (e.g., Fairley, 1979; Michel & Norris, 1982; Hill & Modigliani, 1987), the underwriting betas were assumed and argued to be proportional to the leverage factors. Our empirical findings, based on the Canadian property & casualty insurance industry data, disprove this assumption. F-tests were conducted to test the null hypothesis that the by-line underwriting betas are proportional to the leverage factors, *k*, for the panel estimates. Our findings rejecting the null hypothesis are significant at the 95% confidence level. Therefore, our empirical results strongly supports the conclusion that underwriting betas are not proportional to leverage.

The positive underwriting betas of auto insurance, property insurance and liability insurance suggest that the underwriting profits of these insurance business lines are positively correlated with the financial market (i.e., generally follows the financial market). Although liability insurance presents the highest leverage factor of 2.4, its underwriting beta is the lowest, which indicate the lowest volatility in relation to the financial market.

4.2 The Results of Fair Underwriting Profit Margin and Fair Net Premium

In Table 4.3, the actual and the estimated fair underwriting profit margins and net premiums for distinct business lines are provided. The risk-free rate and the equity risk premium for systematic risk are listed in the first two rows of the table for the convenience of later discussion. The by-line FUPM and FNP estimates are calculated based on equations (2.10) and (2.11), and on the by-line Full Information Underwriting Betas as presented in Table 4.2. Panel A shows the actual and the estimated fair underwriting profit margins; panel B shows the actual and the estimated fair net premiums.

Comparing the results across different years, we find that FUPMs for all lines are closely related to the equity risk premium. When the equity risk premium is high, the FUPM is relatively high and tends to be positive; when the equity risk premium is low or negative, the FUPM is relatively low and may be negative. This phenomenon can be easily observed during the sample period because the risk-free rate and leverage factor k for all lines are relatively stable over the sample period with the betas and sumbetas for all lines positive. Comparing the results across different business lines within the same year, it is found that the FUPMs of liability insurance are always the lowest and are consistently considerably lower than the FUPM of the combined lines. This means that the effect of the high leverage factor, k, of liability insurance heavily influences its FUPM in a negative direction. For property and auto insurance, the effects of k interact with the effects caused by the underwriting beta and the equity risk premium. Sometimes the FUPMs of auto insurance are higher than those of property insurance, and sometimes lower[6]. Comparing the results based on betas and sumbetas, we find that during times when the equity risk premium is positive, most of the time the FUPM based on sumbetas are higher than those based on betas, since both betas and sumbetas are positive and most of the time sumbetas are higher than betas for both combined lines and for the distinct lines. When the equity risk premium is negative, the relationship is reversed. For FNP, since the amount of FNP depends on the amount of business that insurers assume, only the expected premium based on betas and on sumbetas in the same year can be compared. We find that when equity risk premium is positive, the FNPs based on sumbetas are higher than those based on betas.

TABLE 4.3
ESTIMATES OF FAIR UNDERWRITING PROFIT MARGIN AND FAIR NET PREMIUM

This table displays the estimates of the fair underwriting profit margin (FUPM) and fair net premium (FNP) for each year and for the aggregated 7year data set. The fair underwriting profit margin and fair net premiums were estimated based on the following formulas for combined lines and for each distinct line (i.e., auto insurance, property insurance, liability insurance, and other business lines). Both the estimates calculated based on betas and on sumbetas are provided.

$$E\left[r_u\right] = -r_f \cdot k + \frac{r_f \cdot t_{CI}}{b \cdot \left(1 - t_{CI}\right)} + \beta_u \cdot \left(E\left[r_m\right] - r_f\right) \qquad E\left[P\right] = \frac{E(L)}{1 - t_{prem} - e - E(r_u)}$$

Where,

$E[r_u]$	Fair underwriting profit margin, in %.
$E[r_m]$	Market return, in %, derived from the S&P/TSX composite total return index and calculated as the ratio of the difference between the year-end index and the year-beginning index to the year-beginning index.
r_f	Risk-free rate, in %, measured by the yield on 91-day T-bill.
k	The aggregate leverage factor, reflecting the average holding period of a dollar of premium before it is used to pay expenses and losses. It is measured by the ratio of the net unpaid claims to the net premium earned.
b	Ratio of the net premium earned to the value of insurer's equity
t_{CI}	Effective corporate income tax, calculated as the ratio of the difference between the net income before tax and the net income after tax to the net income before tax
β_u	Underwriting beta
$t_{prem} + e$	Effective expense-and-other-tax rate, measured by the ratio of aggregate expenses and other taxes to the net premium earned
E[P]	Fair net premium, in $,000
L	Net claims and adjustment expenses incurred, including unpaid claims and corresponding expenses.

Data year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**all years**
rf	4.72	5.49	3.79	2.58	2.87	2.22	2.73	3.48
rm-rf	26.87	2.02	-16.36	-15.02	23.85	12.26	21.40	7.86
Panel A: Actual and estimated fair underwriting profit margin (FUPM)								
1. Actual underwriting profit margin								
upm	1.06	-6.35	-9.47	-2.07	0.01	11.90	9.80	2.64
2. Estimated fair underwriting profit margin (FUPM) based on betas								
FUPM	2.96	-3.08	-5.39	-5.29	3.46	1.96	2.88	-0.33

auto FUPM	5.91	-3.80	-8.25	-6.80	5.97	-0.19	0.67	-0.99
prop FUPM	7.43	-0.47	-2.01	-3.23	1.08	3.68	5.60	1.36
liab FUPM	-17.18	-12.22	-10.15	-9.87	0.12	-2.60	-3.60	-6.28
other FUPM	1.93	-2.54	-3.08	-2.47	5.58	4.31	3.28	0.10
3. Estimated fair underwriting profit margin (FUPM) based on sumbetas								
FUPM	4.36	-2.98	-6.25	-6.07	4.71	2.60	4.00	0.08
auto FUPM	11.50	-3.74	-10.89	-9.20	8.93	0.75	3.05	0.01
prop FUPM	7.72	-0.36	-1.73	-5.12	3.58	5.88	10.57	2.16
liab FUPM	-8.55	-12.55	-13.87	-10.58	3.72	-1.35	-1.04	-5.36
other FUPM	-4.36	-2.97	0.85	0.50	-2.58	1.55	-5.73	-1.97
Panel B: Actual and estimated fair net premium (FNP)								
1. Actual net premium								
P	6,788,453	5,024,333	12,516,686	15,039,672	8,078,119	22,344,835	23,032,203	92,824,301
auto P	3,827,393	2,950,420	6,873,022	7,978,289	4,639,771	11,028,758	11,629,881	48,927,534
prop P	2,199,407	1,434,826	3,736,667	4,632,758	2,227,209	6,745,810	6,868,961	27,845,638
liab P	539,913	461,459	1,156,775	1,590,684	907,659	2,857,689	2,886,865	10,401,044
other P	225,192	175,702	747,247	838,344	521,584	1,715,663	1,647,756	5,871,488
2. Estimated fair net premium (FNP) based on betas								
FNP	7,741,271	5,660,361	13,848,043	15,458,228	8,888,535	21,342,220	22,887,123	95,625,693
auto FNP	4,908,767	3,524,443	7,909,046	9,073,173	5,993,527	10,985,533	11,452,489	54,243,382
prop FNP	2,437,904	1,530,839	3,885,856	3,987,570	1,929,205	5,792,223	7,441,381	26,581,140
liab FNP	488,832	422,838	1,145,849	1,507,025	933,576	3,043,453	2,703,338	10,146,257
other FNP	147,634	144,820	720,940	754,014	474,285	1,128,059	934,986	4,228,553
3. Estimated net premium based (FNP) on sumbetas								
FNP	7,975,575	5,668,933	13,686,717	15,299,156	9,056,140	21,556,442	23,301,688	96,209,631
auto FNP	5,406,293	3,527,676	7,641,995	8,798,514	6,280,064	11,143,474	11,886,503	55,047,731
prop FNP	2,450,134	1,533,237	3,901,551	3,887,361	2,001,093	6,002,198	8,111,139	26,904,919
liab FNP	544,905	421,092	1,093,305	1,493,852	983,709	3,099,615	2,807,320	10,274,624
other FNP	134,560	143,926	763,650	786,193	421,555	1,080,086	817,094	4,102,417

Overall, the empirical findings in Table 4.3 strongly support the statements that 1) using betas instead of sumbetas in insurance pricing may underestimate both the fair underwriting profit margin and the fair net premium when the market's equity risk premium is positive; 2) FUPMs are closely related to the equity risk premium, which varies across years; 3) FUPM varies across business line, with the lowest value observed for liability insurance. These findings imply that setting a single target underwriting profit margin for distinct business lines and across years is inappropriate and could be dangerous.

4.2.1 The Results of the Comparative Statics Analysis

This subsection examines the impacts of several parameters on insurance pricing, by changing the value of particular parameters respectively and holding the others constant at the same time. Through these sensitivity tests, the impact of each variable in insurance pricing can be discerned. This allows insurer management to put more effort into monitoring and improving the estimation accuracy of those parameters that are most important in insurance pricing. The results also allow insurer management and regulators to better evaluate the potential impact on premium rates that may be implied by alternative management decisions (e.g., new business plan or new financing that will influence the premium-to-equity ratio) or regulatory activities (e.g., changes in taxation policy).

Table 4.4 presents the results of the comparative statics analysis. The sensitivity results based on the beta estimates and the sumbeta estimates are consistent, even though the sumbetas are usually higher than betas. Also the results for the aggregated combined lines and for every distinct line are consistent. Panel A and panel B show the sensitivity of the fair underwriting profit margin and of the fair net premium respectively when the values of effective corporate income tax rate, effective expense-and-other-taxes rate, premium-to-equity ratio, and leverage factor change respectively.

These results show that a 1% increase in the effective corporate income tax (CIT) rate (i.e., CIT increases from 34% to 35%)[7] will lead to a 0.05% increase in fair underwriting profit margin (i.e., FUPM increases from -0.33% to -0.28%) and a 0.08% increase in fair net premium (i.e., 95,625,693,000*0.08% = $76,500,554 increase in the premium charged on the full market of the sample firms). This relationship implies that higher prices are needed to achieve the same level of post-tax profit as would have been required at the lower tax rate. Overall, however the results show that ICAPM is not highly sensitive to the change in CIT rate.

Change in the effective expense-and-other-taxes rate (EOT) does not influence the fair underwriting profit margin directly; however, it does directly influence the leverage factor, *k*. A higher EOT results in a lower *k*. As shown in Table 4.4, a lower *k* produces a higher FUPM; i.e., higher effective expense-and-other-taxes rate indirectly results in a higher fair underwriting profit margin. Our results also indicate that a 1% increase in EOT (i.e., EOT increases from 33% to 34%) produces an estimated 1.5% increase in fair net premium (i.e., 95,625,693,000*1.5% = $1,434,385,395 increase in the premium charged on the full market of the sample firms). Economically, an increase (or decrease) in premium of more than 1% is reasonable, since administrative issues ensure that it costs more than $1 to collect, report, and remit $1 of taxes to the government. Because the change in an economic parameter (e.g., tax rate) applies to all the insurers in the same market, insurers could pass all or at least part of these costs along to customers.

The fair underwriting profit margin and fair net premium are expected to decrease with an increase in default risk reflected in the premium-to-equity ratio. The results confirm this relationship and show that an increase of 0.1 in the premium-to-equity ratio (i.e., b increases from 1.49 to 1.59) causes the fair underwriting profit margin to decrease by 0.08% (i.e. FUPM falls from -0.33% to -0.41%) and the fair net premium to decrease by 0.11%.

Also expected, the results show that 0.1 increase in k (i.e., k increases from 0.96 to 1.06) leads to a 0.35% decrease in fair underwriting profit margin (i.e., FUPM decrease from -0.33% to -0.65%) and a 0.51% decrease in fair net premium.

The results of the comparative statics sensitivity analysis show that the effective expense-and-other-taxes rate has the greatest impact on insurance premium. The corporate income tax rate, premium-to-equity ratio and leverage factors also are important parameters influencing the insurance premium.

CONCLUSION

This paper presents new evidence on insurance pricing by line of Property & Casualty insurance. The analysis in the present paper differs from previous research in that it uses the full information beta methodology to estimate underwriting betas of distinct business lines, which are then applied to estimate the fair underwriting profit margin by line. Based on Canadian P&C insurance industry data, our empirical findings strongly support the argument that underwriting betas of distinct lines do not vary in proportion to the length of the time that the premium of the corresponding line is kept for investment. Another important finding is that larger firms appear to release more information earlier than do smaller firms, and that, after taking into account early information release, the difference in underwriting betas among firms with different sizes is not obvious. However, smaller insurance firms do exhibit a higher standard deviation in their underwriting beta. Additional empirical findings strongly support the

TABLE 4.4
RESULTS OF THE COMPARATIVE STATICS ANALYSIS

The table shows the results of the comparative statics analysis of fair underwriting profit margin (FUPM) and fair net premium (FNP) with respect to the parameters that reflect the insurers operation. The estimates of FUPM and FNP for combinedlines and each distinct line based on the average values of the parameters over the period from 1999 through 2005 are listed under the average estimates column. Keeping all other parameters unchanged, the values of corporate income tax (CIT), expenseandothertaxes rate (EOT), premiumtoequity ratio (b), and leverage factor (k) varies in turn; **the difference changes in FUPM** (the FUPM is expressed in%) are listed in panel A and the **percentage changes in FNP** are listed in panel B. For example, under "CIT+1%" column the results show the difference change in FUPM and percentage change in FNP for combinedline and each distinct line if the corparate income tax is increased by 1% point (i.e. CIT increases from 34% to 35%).

	average estimates	CIT-2%	CIT-1%	CIT-1%	CIT-2%	EOT-2%	EOT-1%	EOT-1%	EOT-2%	b-0.2	b-0.1	b+0.1	b+0.2	k-0.1	k+0.1
Panel A: sensitivity analysis of fair underwriting profit margin															
Estimates based on beta															
FUPM	-0.33	-0.10	-0.05	0.05	0.11	0.00	0.00	0.00	0.00	0.19	0.9	-0.08	-0.14	0.35	-0.35
auto FUPM	-0.99	-0.10	-0.05	0.05	0.11	0.00	0.00	0.00	0.00	0.19	0.9	-0.08	-0.14	0.35	-0.35
prop FUPM	1.36	-0.10	-0.05	0.05	0.11	0.00	0.00	0.00	0.00	0.19	0.9	-0.08	-0.14	0.35	-0.35
liab FUPM	-6.28	-0.10	-0.05	0.05	0.11	0.00	0.00	0.00	0.00	0.19	0.9	-0.08	-0.14	0.35	-0.35
other FUPM	0.10	-0.10	-0.05	0.05	0.11	0.00	0.00	0.00	0.00	0.19	0.9	-0.08	-0.14	0.35	-0.35
Estimates based on sumbeta															
FUPM	0.08	-0.10	-0.05	0.05	0.11	0.00	0.00	0.00	0.00	0.19	0.9	-0.08	-0.14	0.35	-0.35
auto FUPM	0.01	-0.10	-0.05	0.05	0.11	0.00	0.00	0.00	0.00	0.19	0.9	-0.08	-0.14	0.35	-0.35
prop FUPM	2.16	-0.10	-0.05	0.05	0.11	0.00	0.00	0.00	0.00	0.19	0.9	-0.08	-0.14	0.35	-0.35
liab FUPM	-5.36	-0.10	-0.05	0.05	0.11	0.00	0.00	0.00	0.00	0.19	0.9	-0.08	-0.14	0.35	-0.35
other FUPM	-1.97	-0.10	-0.05	0.05	0.11	0.00	0.00	0.00	0.00	0.19	0.9	-0.08	-0.14	0.35	-0.35
Panel B: sensitivity analysis of fair net premium															
Estimates based on beta															
FNP	95,625,693	-0.15%	-0.08%	0.08%	0.16%	-2.87%	-1.46%	1.50%	3.05%	0.28%	0.13%	-0.11%	-0.21%	0.52%	-0.51%
auto FNP	54,243,382	-0.15%	-0.08%	0.08%	0.16%	-2.84%	-1.44%	1.49%	3.02%	0.27%	0.13%	-0.11%	-0.21%	0.51%	-0.51%
prop FNP	26,581,140	-0.16%	-0.08%	0.08%	0.17%	-2.94%	-1.49%	1.54%	3.13%	0.28%	0.13%	-0.11%	-0.22%	0.53%	-0.53%
liab FNP	10,146,257	-0.14%	-0.07%	0.07%	0.15%	-2.64%	-1.34%	1.38%	3.79%	0.25%	0.12%	-0.10%	-0.19%	0.48%	-0.47%
other FNP	4,228,553	-0.15%	-0.08%	0.08%	0.17%	-2.89%	-1.47%	1.51%	3.07%	0.28%	0.13%	-0.11%	-0.21%	0.52%	-0.52%
Estimates based on sumbeta															
FNP	96,209,631	-0.15%	-0.08%	0.08%	0.17%	-2.89%	-1.47%	1.51%	3.06%	0.28%	0.13%	-0.11%	-0.21%	0.52%	-0.52%
auto FNP	55,047,731	-0.15%	-0.08%	0.08%	0.16%	-2.88%	-1.46%	1.51%	3.06%	0.28%	0.13%	-0.11%	-0.21%	0.52%	-0.51%
prop FNP	26,904,919	-0.16%	-0.08%	0.08%	0.17%	-2.98%	-1.51%	1.56%	3.17%	0.29%	0.13%	-0.11%	-0.22%	0.54%	-0.53%
liab FNP	10,274,624	-0.14%	-0.07%	0.08%	0.15%	-2.68%	-1.36%	1.39%	2.83%	0.26%	0.12%	-0.10%	-0.20%	0.48%	-0.48%
other FNP	4,102,417	-0.15%	-0.08%	0.08%	0.16%	-2.80%	-1.42%	1.46%	2.97%	0.27%	0.13%	-0.11%	-0.21%	0.51%	-0.50%

statements that 1) using betas instead of sumbetas in insurance pricing may underestimate the fair underwriting profit margin and fair net premium when the equity risk premium is positive; 2) FUPMs vary across business lines with liability insurance having the lowest FUPM; and 3) FUPMs are closely related to market equity risk premium, which varies over time.

Another contribution of this paper is the inclusion of corporate income tax and other taxes in the model that allows an examination of the impacts of taxes on insurance pricing. The fair underwriting profit margin is found to depend on the effective corporate income tax rate as well as the risk-free rate, leverage factor, premium-to-equity ratio, underwriting beta, and market equity risk premium. The fair net premium is found to be, in addition to the aforementioned parameters, also related to the expense-and-other-taxes rate.

Finally, the paper's comparative statics analysis shows that fair underwriting profit margin and fair net premium are positively related to effective corporate income tax rate, and are negatively related to the premium-to-equity ratio and to the leverage factor. Also, the fair net premium is positively related to effective expense-and-other-taxes rate. Empirical analysis confirms the results predicted by the comparative statics analysis and shows that effective expense-and-other-taxes rate has the largest impact on insurance premium and that effective corporate income tax rate, premium-to-equity ratio, and leverage factor are all important parameters influencing the insurance premium.

The underwriting beta derived based on the Capital Asset Pricing Model measures the systematic risk of insurance underwriting activity related to the financial market. Thus, the model presented in this paper is a suitable candidate for setting target underwriting profit margin by regulators since they would not normally set different rates for individual companies based on the firm-specific risks. Our findings further imply that setting a single target underwriting profit margin rate for distinct business lines and over time is inappropriate and could be dangerous.

As in all other studies, there are some limitations inherent in this approach. First, the model presented may not provide individual insurers with enough information to do accurate pricing because it considers only the systematic risk of the company. Other types of risk, e.g., default risk may need to be more fully considered. Second, the results of this study are limited by the frequency of data that were available; research based on quarterly data rather than annual data only may increase the accuracy and power of the results. Future research undoubtedly can continue to explore the factors that produce the differences in the fair underwriting profit margin across business lines.

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Notes

1. In this paper, the fair underwriting profit margin and fair net premium are also called the expected underwriting profit margin and the expected net premium.

2. For example, if the premium is retained within a firm for half a year before it is paid for claims, then k equals 0.5. Please see section 3.1 for the detailed description.

3. Expenses and other taxes are combined into a single parameter here because all taxes except corporate income tax are categorized into the expense items in the annual financial reports. Please see section 3 for details.

4. The Canadian Property and Casualty (P&C) Insurance industry pays both federal tax and provincial tax. At the federal level, the major taxes imposed upon the Canadian P&C Insurance industry include the federal corporate income tax and the federal capital tax. At the provincial level, the major taxes include provincial corporate income tax, provincial capital tax (in Manitoba and Nova Scotia only), premium tax, fire tax (expect Alberta, Newfoundland, and Quebec), and sales tax (in Quebec, Ontario and Newfoundland only). All together the major taxes include corporate income tax, capital tax, premium tax, fire tax, and sales tax. *(Taxation of P&C Insurance: A Comparison between Canada and other G-7 Countries, 2003)*. P&C insurers also are obligated for payroll tax, business tax, and property taxes in the same manner as other employers and property owners. Sales tax is not included in the expense-and-other-taxes estimate in this paper because, where imposed, that sales tax is paid by the policyowners rather than the insurers and does not directly affect premium rates. So, while sales tax may affect the consumer perception of the price of insurance, insurers do not take sales tax into account when setting premium rates.

In P&C insurers' income statements, these taxes other than corporate income tax are categorized as follows: premium tax and fire tax are included in acquisition expenses; payroll tax, capital tax and business tax are included in general expenses; and property tax is included in investment expenses. Some taxes are interrelated, e.g., although the capital tax is not deductible in computing income for income tax purposes, it is reduced by the corporation's federal income tax liability, net of any federal surtax claimed against the Part 1.3 tax liability. (for more information see: General Accepted Accounting Principles and the Annual Return Instruction of the Office of the Superintendent Financial Institutions). Because of the interaction between different types of taxes, this paper adopts "effective tax rate" as the variable for examination rather than the marginal rate.

5. In the smallest sample–the FUPM & FNP estimation sample, the total net premium earned in the FUPM and NFNP estimation sample in year 1999 to 2005 made up 46%, 56%, 74%, 47%, 84%, and 86% of the Canadian P&C insurance industry's total net premium earned in that year respectively. Except in year 2003, the percentage was increasing. The trend shows that more and more insurers and also larger insurers reported detailed data for distinct business lines over the sample period.

6. This volatility could reflect the fact that auto insurance premiums tend to be regulated in many provinces while premiums in other lines are not. It could also be related the fact that losses can be driven by auto property (physical damage) claims in some periods and by auto liability claims in other periods.

7. The parameters' values in parentheses in the examples are based on the aggregated values over year 1999-2005 of all combined lines of the FUPM and FNP estimation sample.