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Study of the impact of inflation and GDP growth on property-liability and life insurance premiums over the last 30 years: case of the G7 countries

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In this paper we analyze the fluctuations in underwriting for the life and property-liability insurance segments over a defined period (1950-2007), looking for the macro-economic fundamentals that may explain them and, more specifically, inflation and economic activity, as measured by GDP.

The paper is structured in the following manner. In the first section, we review the principal models discussed in the literature to capture and explain the cyclical nature of the insurance industry (primarily the property-liability segment). In the second section, we offer a brief overview of the empirical results presented in the literature. In section three, we present the data used and the results we obtained regarding the relationship between fluctuations in premium levels and the inflation trend for the G7 countries over the period 1950-2007 for the property-liability and life insurance segments. The final section is devoted to a study of the impact of economic activity, as measured by GDP, on premium trends in both segments.

I.Traditional explanations of the property-liability underwriting cycle

In the literature, it is widely agreed that the property-liability segment obeys a specific underwriting cycle.

Generally, a distinction is drawn between "hard" market and "soft" market phases. Hard market phases correspond to higher premiums due to the adoption of a restricted supply policy on the part of insurers (limited policy renewals, restrictions on new business written, higher deductibles, and so on).

For consumers, the situation is more advantageous during the so-called soft market phases, because underwriting conditions are more relaxed and premiums less costly. But in this case, the solvency of insurers is also less secure.

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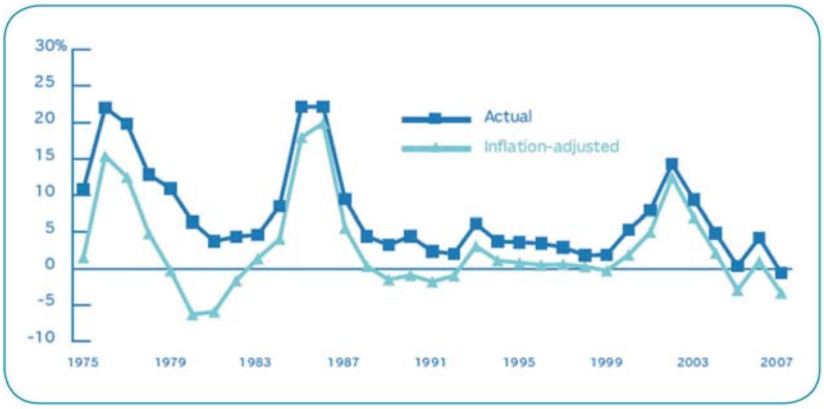
We can examine the following diagram, which shows successive hard and soft phases of the market via trends in the rate of change in net written premiums P/C (net meaning net of reinsurance) in the property-liability insurance segment, with three hard phases of the market, where the growth rate (corrected for inflation) of net premiums is 7.7% from 1975 to 1978, 10.0% from 1984 to 1987, and 6.3% from 2001 to 2004.



Different hypotheses and models have been set forth to explain the cyclicity of insurance underwriting business (primarily in the property-liability segment), as measured trough the fluctuations in the level of premiums or of profits.

Some authors claim that the cycles observed are endogenous and can be explained by the rate-making process of insurers. Cummins and Outreville (1987), for example, claim that data collection, accounting rules and regulatory lags may be the source of the second order autoregressive process of the premium/losses ə series (hence the inverse of the loss ratio). In addition, they concede that past loss experience, interest rate levels and inflation may influence the current level of premiums. They also assume that all of the information relative to these variables is contained in the current value of premiums. It is therefore a question of confirming a second order autoregressive model with coefficients that are positive and negative, respectively, for the first and second lags, conveniently constrained.

Other authors believe that the cyclical fluctuations in premiums may be attributable to exogenous factors—more specifically, factors that are external to the insurance industry. In particular, trends in premiums or profits have been linked, among other things, to interest rates or economic activity. To justify having chosen external factors, these authors refer to different types of hypotheses that lead to different models expressing the premium under this general form:

$$P = \frac{E(L)}{1+r} + R(S, \sigma, r)$$

where L denotes the total claims plus expenses; L is a random variable whose expectation is denoted E(L) ; r is the discount rate (interest rate) and R is a positive function of the surplus S, of the interest rate r and of the volatility of losses L,s.

In the most straightforward model, called the financial pricing (or arbitrage) model, we assume that there are no market imperfections, such that the surplus is easily adjusted through exchanges between insurers and the capital markets, excluding any relationship between a change in capacity and premiums (or margins or profits).

According to this model, which is a long-term pricing model, where the insurer is supposed to be neutral with respect to the risk, the premium is equal to the present value of expected future claims, plus policy administration costs (losses L):

$$P = \frac{E(L)}{1+r}$$

In this case, we expect a positive influence (coefficient) of the amount of claims and the losses paid on the premiums, and a negative influence (coefficient) of the interest rate when we regress, for example, the rate of growth of the premium on the rate of growth of expected losses and the interest rate.

One hypothesis that is often put forth is the capacity constraint (Gron, 1994 a, b; 1995), Higgins and Thistle, 2000, Winter, 1991, 1994, 1998).

The so-called capacity constraint model is considered to be a short-term pricing model. In light of regulations in force, insurers are not allowed to increase their underwriting supply unless they have a regulatory surplus, written as $kS \geq pq$, where S, p and q denote the surplus, the amount of the premium and the number of policies, respectively.

Profit is expressed as $P = pq - c(q) - rS$, where c(q) denotes the expenses of the insurer (including claims settlement costs) inversely related to the interest rate; r is the interest rate or the opportunity cost of the surplus. Profit maximization entails setting the premium in the form $p = c'(q) - \lambda p$, where λ is the price of the surplus constraint.

If this constraint is not saturated, the related implied cost is zero. However, if demand rises sharply and suddenly, or if an adverse shock (catastrophe) diminishes the surplus, the capacity constraint may become active and the implied price of the constraint positive; moreover, since the derivative is strictly negative in the case where the constraint is active, a decrease in the surplus leads to an increase in the implied price λ and hence in the premium. Last but not least, because insurance demand is inelastic, the profits of insurers increase, which serves to exacerbate the constraint. The regulatory requirement to comply with the surplus constraint thus compels insurers to restrict their supply: so they offer $q^*=kS/p$ policies. In addition, due to the imperfections of the capital markets, it is generally admitted that it is more advantageous for insurers to make use of internal capital, obtained by raising premiums, than to turn to external sources of capital in order to increase their surplus and loosen the constraint.

We can then write the premium P in this form:

$$P = \frac{E(L)}{1+r} + R_S(S,\sigma)$$

where $R_S(S,\sigma)$ is a (positive) term resulting from a transitory departure from the long-term equilibrium relationship (where capacity is not constrained). Sign S indicates that the term R is added only temporarily (short term).

In the preceding model, there is a level S^* of the surplus above which the term R is nil. The value S^* is precisely the value of the surplus for which the capacity constraint becomes active, in which case there is a rise in the premium. The premium is, therefore, a decreasing function of the surplus and, in like manner, the variation of the losses/premiums ratio is positively related to the variation in the surplus.

The measurable consequence of the capacity constraint hypothesis is therefore the negative relationship (transitory) between the capacity variation (premium/surplus ratio) and the variation in the level of the premium (or the margin).

We find another type of model, called the financial quality model, which has different long-term implications than those of the arbitrage model. In fact, we assume that policyholders are prepared to pay a higher premium if they believe that the insurer's solvency is better. In this case, the level of surplus (or capacity) becomes an input of the demand function as a yardstick of quality, and long-term profits are positively related to the level of the capacity (Caggle and Harrington, 1995 and Cummins and Danzon, 1997).

In this model, we write:

$$P = \frac{E(L)}{1+r} + R_S(S,\sigma) + R_L(S,\sigma)$$

where $R_S(S,\sigma)$ is a decreasing function of S and $R_L(S,\sigma)$ is an increasing function of S.

On an empirical level, the capacity constraint and financial quality models are the opposite of the financial pricing model (arbitrage) because profits are dependent on capacity for the first two models but not for the latter.

The capacity constraint and financial quality models differ from one another with respect to the long-term impact of the surplus on the premium (nil in the first model and positive in the second).

Finally, the option pricing type models are worth noting.

In these models, policyholders have a short position on a sell option whose exercise price is the amount of the surplus S, such that the premium is equal to the expectation of predicted future losses – the value of the sell option $B(S,r,\sigma)$ (in order to offset the insurer's insolvency risk borne by the policyholders), i.e., by noting q the number of policies:

$$P = \frac{E(L)}{1+r} - \frac{B(S,r,\sigma)}{q}$$

Consequently, the premium P is an increasing function of the surplus S and a decreasing function of the volatility σ of the losses, but the dependency on the interest rate r depends on the pricing model under consideration. If we use the Black and Sholes model as our reference, the premium is a decreasing function of the interest rate.

We might also mention the so-called actuarial models, which characterize premiums as the present value of expected losses, increased by a component linked to the risk (Buhlmann and Straub, 1970). In this case, the premium is positively linked to the variance in losses and negatively linked to the capital (surplus). It is interesting to note that it is this type of model that the CEIOPS has opted to use to assess the solvency level of insurers.

The following table summarizes the various models that are proposed in the literature to characterize the dynamics of the economic loss ratio (ratio of estimated discounted losses to the level of premiums (net of expenses)) with, for each of them, measurable implications. SR and LR mean, respectively, in the short term and the long term and 0 means that the effect is ambiguous.

In the following section, we carry out a brief survey of the empirical studies developed in the literature.

Table 1. Summary of Alternative Models' Implications for Economic Loss Ratio

	Variable					
	Interest Rate		Surplus		Variance	
Model	SR	LR	SR	LR	SR	LR
Actuarial	+	+	+	0	-	0
Capacity Constraint (CCH)	+	+	+	0	-	0
Economic	+	+	+	+	-	-
Financial	+	+	0	0	0	0
Financial Quality (FQH)	+	+	+	-	+ -	+ -
Option Pricing (OP)	+ -	+ -	-	-	+	+

(Excerpt from Choi et al. (2002))

2 Empirical studies of insurance industry business fluctuations

We can classify the various studies in the following manner:

1°) Studies that seek to confirm the **endogenous** or external nature of the cyclicity observed in insurance underwriting, measured either by the level of profits (annual), or by the level of premiums, or ratios, such as the loss ratio (LR) or the combined ratio (CR).

- Either by confirming a second order autoregressive model verifying the constraints required to qualify a behavior as cyclical;

For example, Venezian (1985), who tests the hypothesis of endogenous cyclicity derived from via the naive extrapolation of future claims from past claims. He estimates a second order autoregressive model using US data, confirms the cyclicity of profits in property-liability insurance, and finds that the duration of the cycle is equal to six years.

The article by Harrington and Niehaus (2002) provides a good review of the analyses conducted on the basis of AR(2) processes.

- Or by confirming models that explain the fluctuations of the variable used to characterize underwriting activity, where the predictive factors are variables that are specific to the insurance industry (surplus, capacity, etc.).

For example, Niehaus and Terry (1993) examined the informational content of claims payments and surplus in an exercise aimed at forecasting premium volumes. The predictive character is confirmed.

Cummins (1990) demonstrated that the level of premiums is explained by the expectations of future losses.

2°) Studies that seek to confirm the influence of exogenous factors on the insurance industry and, more specifically, factors that are characteristic of the general condition of the economy as a whole (business activity, inflation) or financial (interest rate, stock market returns) by making reference to one of the models mentioned in the preceding section.

When one makes reference to the determination of the level of premiums as the discounted value of expected future losses (in the arbitrage model, for example), it is only natural to expect an interest rate effect (effect of discounting).

Haley (1993) demonstrated, for example, that there is a long-term relationship between underwriting margins and the short-term yields (interest rates) using US quarterly data covering the period between 1930 and 1989. Doherty and Kang (1988) have established a link between the short-term fluctuations in interest rates and the cyclical trend in insurance industry profits. Fields and Venezian, (1989) estimate that there is a significant relationship between unexpected interest rates and profitability, while Fung et al. (1998) assert that one exists between changes in interest rates and the level of premiums.

Grace and Hotchkiss (1994) establish a more general long-term relationship (cointegration relationship) between the level of the combined ratio and economic activity (real GDP), inflation and an interest rate (rate on 3-month t-bills) estimated within the framework of a cointegrated VAR model, for US quarterly data over the period 1974-1990.

GDP is introduced as an indicator of the trend in potential losses (and as a variable that has a strong influence on demand for insurance). Pricing trends are also important to consider because they have repercussions for the cost of claims and, more particularly, for long-tail business. It is interesting to note that only the error term in the long run relation has an impact on the variation in the combined ratio, since the GDP growth rate, the rate of inflation and the variation in the interest rate turn out to be non-predictive of the variation in the combined ratio. This study thus tends to show that the economic and financial spheres do exercise a real influence on fluctuations in underwriting in the insurance industry, but that it is lasting and not exclusively inscribed within the cycle with, however, an influence that does not lend itself to an error correction mechanism, which is problematic a priori.

Also worth mentioning is the study done by Cutler (2000), which examines the predictive power of economic or financial variables when they are added to variables that are specific to the insurance industry, within the same regression. In fact, Cutler shows that the variables, such as GDP growth rate, the rate of inflation and the interest rate do not improve the explanation of the rate of growth in the loss ratio when the regression includes the growth rate of real profits and the rate of growth of the real surplus. But—and this is a point worth underscoring—this author does not appeal to the cointegration theory and uses regressions that involve variations or growth rates of different variables exclusively. The results he obtains therefore do not, on the face of it, contradict those obtained by Grace and Hotchkiss (1994) concerning the influence of the economic or financial sphere on the insurance industry, contrary to what he claims.

Finally, among the studies that make use of explanatory factors that are both external and internal to the insurance industry, we find work examining the validity of the capacity constraint hypothesis, since this is a question of showing that a variable measuring the capacity of the insurance company (endogenous factor) has a negative impact – in the short term – on premium levels, in a model that brings in the level of inflation, interest rate, etc.

Grøn (1994a,b), for example, looked at the effects of capacity constraint on premium rate-making and postulates a model describing the trend in profits, in essence compatible with the capacity hypothesis since it reveals a significant negative influence of the capacity variable on margin level. However, it should be noted that the regressions were done without considering the problem of the non-stationarity of variables, which can engender fallacious regressions. The explained variable is the margin, which seems to be non-stationary according to the graphs provided, and the explanatory variables are relative capacity (de-trended), the expected rate of inflation, the variation in this expected rate, the difference between expected inflation and observed inflation (for which a negative coefficient is expected) and the difference between the expected rate of inflation and the nominal rate of inflation (also expected), which must be associated with a positive coefficient. The predicted signs are confirmed, but the significativity is not always acquired. In addition, the fact that R2 is as high as it is (0.81) tends to support the suspicion that there is indeed a problem of fallacious regression.

Doherty and Garven (1991) also make reference to the capacity constraint hypothesis when they highlight an effect of a change in the level of the interest rate on the level of profits, while also controlling the effects of changes on the level of outside capital and the value of the shares of the insurance company. These authors demonstrate that adverse shocks on the level of surplus capital (resulting from a change in the level of interest rates) in fact lead to price increases.

The aforementioned empirical studies are all based on linear regression models. This is why it is useful to note the study by Higgins and Thistle (2000), which examines the validity of the capacity constraint hypothesis and that of the financial quality model using a non-linear model that allows for two types of profit dynamics depending on the level of capacity (premium/surplus ratio).

The rate of variation in the profit variable is thus modeled using a second order STAR model (smooth transition autoregressive model) plus the variation in the interest rate (lagging), allowing for a variation in the parameters depending on the capacity level, which is the transition variable at the origin of the regime shift. The cyclical second order autoregressive model is only confirmed in the regime where capacity is not constrained. Note that the authors do not succeed in finding a significant impact of the interest rate variation, regardless of the regime, which rules out the confirmation of the capacity constraint hypothesis and the financial quality model on which the authors have focused.

As we will see, the impact of inflation on the trend in premiums and/or profits (or losses) is rarely studied explicitly in property-liability insurance, even though the price level trends obviously have an impact on the cost of claims, particularly for long-tail business.

The study done by Grace and Hotchkiss (1994), which has been mentioned, suggests that premiums respond positively to a positive variation in the price index.

We can also cite the study by Meier (2006b), which looks at the dynamics of the loss ratio on the basis of corrections for estimated errors over the period 1957-1997 for three countries (the US, Japan and West Germany), demonstrating that price level has a positive impact on the trend in the loss ratio via the long-run relationship, which suggests a persistent positive impact.

In the following sections, we develop an econometric analysis of the influence of inflation and economic activity on premium price trends for the G7 countries over the period 1950-2007.

We consider the nominal premium series over the period 1950-2007 given as logarithms for a group of 16 countries, for the property-liability and life insurance segments.

We begin by studying the influence of inflation by considering the series of consumer price index logarithms; then we examine the impact of economic activity, as measured by GDP.

3 Influence of inflation on premium level trends

In this section, we examine the impact of inflation on premium setting. We distinguish between the property-liability and life insurance segments. First of all, we offer a linear characterization of the dynamic using an error correction model before examining the possibility of regime shift within a non-linear modeling framework.

Indeed, it is not surprising that we run into difficulties if we try to find a single valid model for the entire period under consideration, because the inflation dynamic is not the same throughout the period, as we can see by changes in the slope of the curves representing the trend in consumer price index logarithms (see Appendix). Stability tests of the average growth rates of premiums and consumer prices also reveal instability over the course of time. See Table A1 in the Appendix.

We therefore decided to adopt two approaches: a limited linear study over the most recent time period and beginning around 1985, followed by a non-linear study over a longer period (1965-2007) allowing for a regime shift.

First we present the results of the analysis pertaining to the most recent period (1986-2007).

III.1 Error correction linear modeling

Consumer price series, like insurance premiums – given as logarithms – are persistent. In other words, a shock to these series produces effects several years later.

The series are said to be integrated because if we differentiate them we obtain their growth rates, which are stationary or, equivalently, with a short term memory, which means that the impact of a shock on a growth rate dissipates rapidly.

In order to accurately characterize the dynamics of a set of integrated series, it is necessary to verify whether or not there are cointegration relationships, and to examine the related error correction mechanisms.

Two integrated series can be cointegrated if they share a common tendency[1]. In this case, it can be eliminated through linear combination: a stationary linear combination of integrated series corresponds to a relationship of cointegration between these series.

Here, we are looking at the cointegration property over the entire reference period, trying to confirm the stationarity of the residue $e(t)$ of the regression involving the (Log) price series:

$$\mathrm{Ln\ Prime}_t = c_0 + c_1 \mathrm{LnCPI}_t + e_t$$

The variable $e(t)$ is interpreted as a slack variable added to the so-called long-run relationship:

$$\mathrm{Ln\ Prime}_t = \beta_0 + \beta_1 \mathrm{LnCPI}_t$$

This last relationship, which is theoretical, is only verified approximately (rather than strictly), with a centered and stationary difference $e(t)$ that results from short-term fluctuations.

(1) Si $X_t = aT_t + bC_{X,t}$ et $Y_t = cT_t + dC_{Y,t}$
où $T_t = \Sigma_s \varepsilon_s, C_{X,t}, C_{Y,t}$ sont respectivement une marche aléatoire et deux composantes cycliques stationnaires, les deux séries sont cointégrées : la combinaison linéaire $cX_t - aY_t = Z_t$ définit une série stationnaire.

We can then estimate the so-called error correction equation describing the premium dynamic, which comes into play, for example, in the simple case where we can limit ourselves to a first order lag, in the form:

$$dLn\ Prime(t) = a_0 + a_1 dLnPrime(t\text{-}1) + \gamma_1 e(t\text{-}1)$$

In this equation, we see the intervention of the slack variable added to the long-run relationship $e(t\text{-}1)$. In the case where the coefficients β_1 and γ_1 are significant, and are positive and negative, respectively, we speak of an error correction mechanism. If we presume that $e(t\text{-}1)$ is strictly positive, this case corresponds to the situation where the level of premiums of date t-1, $LnPrime_{t\text{-}1}$ is too high compared with its equilibrium level: $\beta_0 + \beta_1 LnCPI_{t\text{-}1}$; the term $\gamma_1 e(t\text{-}1)$ is thus strictly negative, and exerts a downward influence on the variation $dLnCPI_t$ such that the long-term relationship can be verified on date t.

We cannot confirm the existence of a lasting relationship between prices and premiums over the entire period studied (1950-2007), but we can show (for some countries) that there is a single cointegration relationship over the period 1965-2007. If we limit ourselves to the most recent period beyond 1985-1986, the presence of a cointegration relationship is confirmed, except for Italy and Canada, in the case of life insurance for the latter country.

III.1.1 Case of the property-liability segment

With respect to the impact of inflation on premiums trends in the property-liability segment, we obtain results that are relatively uniform for all G7 countries except for Japan and Italy (the latter was ultimately removed from our sample), i.e.:

- The impact of inflation on premium trends cannot be revealed via short-term fluctuations except over a recent period (after 1985 or so): in other words, when we do a regression of the rate of growth of premiums on past values and on past inflation values, the lagged rate of inflation (by a period of one year) is associated with a significant coefficient only over a recent period.

- The same is true when we introduce the levels of (log) prices and (log) premiums into the model, by estimating a cointegration relationship between these variables. We can highlight a persistent influence of consumer prices on premium level as well as a transitory impact over a recent period – generally after 1985.

- It is interesting to note that the estimations of the coefficient of LOG(CPI) in the long-run relationship, when one exists, have values that are similar for various countries (around 2).

2.03 (US), 2.2 7(UK), 2.84 (France), 1.96 (Germany), (2.9) (Canada),

- Finally, if we concentrate our focus on this recent period, where a short-term and/or long-term impact of consumer prices on the level of premiums is observed, we can confirm an overreaction of the growth rate in premiums to an inflation shock, except in the specific case of Germany.

Before offering the results obtained for other G7 countries, we provide details below on the case of France over the period 1986-2007. The results are detailed in the appendix, in table A2.

In the case of France, for the period 1986-2007 we find:

- *a long-term relationship* with a long-term coefficient of the LOG(CPI) equal to 2.31

$$lpnvfr_t = 15{,}78 + 2{,}31\ lcpifr_t + \varepsilon_t$$

- *and an error correction equation:*

$$dlpnvfr_t = 0{,}93*dlpnvfr_t\ \text{-}1 + 0{,}80*dlcpifr_t\text{-}1\ 0{,}53*\varepsilon_t\text{-}1 + u_t$$

We observe a dual impact of prices on premiums: a persistent impact transmitted by the long-term relationship and characterized by a coefficient equal to 0.53x2.31, as well as a short-term impact, with a coefficient equal to 0.80. This yields a total effect measured by the coefficient of 0.53x2.31+0.80=2.02, which is greater than 1 and which therefore indicates an overreaction on the part of premiums to inflation.

The results obtained in the case of the other countries are summarized in Table 1 below. In the second column, the cointegration relationship is given if it has been confirmed; in the second and third columns the long- and short-term coefficients are given when they are significant. These coefficients measure the long- and short-term effects, respectively, of consumer prices on premiums. The measurement of the total impact is reported in the last column. It is interesting to note that the estimations of the coefficient of the LOG(CPI) in the long-term relationship, when they do exist, have values that are roughly similar for the US (2.02), the UK (2.34), France (2.31) and Germany (1.99), and are stronger for Canada and Japan (3.08 and 5.03, respectively). Finally, we observe a persistent impact of the level of consumer prices on premium levels for all of the countries under consideration, which is reflected specifically in the overreaction of the rate of growth in premiums to an inflation shock. It was therefore worthwhile to study the relationship between the levels of prices and premiums to highlight this overreaction mechanism.

Table 1: Impact of inflation on property-liability premium growth rates over the period 1986-2007

Pays	Effet de long terme	Effet de court terme	Effet global
France	2,31 x 0,53	0,80	2,02
Allemagne	1,99 x 0,70	0	1,37
Royaume-Uni	2,34 x 0,49	0	1,47
Canada	3,08 x 0,71	0	2,87
Japon	5,03 x 0,30	2,05	3,56
États-Unis	2,04 x 0,24	1,31	1,96

Let's now turn to the life insurance segment.

III.1.2 Case of the life insurance segment

The findings for the life insurance segment are fairly comparable, with an impact that remains persistent (except in the case of Canada) and only rarely a transitory impact of prices on the premiums.

We detail the results obtained in the case of the United States, where the global effect of prices on premiums is the result of both persistent and transitory effects.

For the period 1985-2007, this is what we find for the US:

1°) *a long-term relationship (unique):*

$\text{lpnvus}_t = 15{,}86 + 2{,}35 \ln \text{cpus}_t + e(t)$

2°) *with, in the error correction mode,*

$\text{dlpnvus}_t = 0{,}4122{*}\text{dlpnvus}_{t-1} + 0{,}840{*}\text{dlncpus}_{t-1} - 0{,}326{*}\, e_{t-1} + u_t$

with a coefficient equal to -0.326 for the error in the long run relation e_{t-1} and a coefficient of 0.840 for the inflation rate value, lagging by a period dlncpus_{t-1}, which gives us a total effect of 2.35x0.326+0.840 = 1.60

Results for the other countries are summarized in Table 2 below. For all of these countries, we observe the mechanism of the overreaction of growth in life insurance premium growth rates to inflation, except for Canada, where inflation seems to have no impact at all—short- or long-term.

Table 2: Impact of inflation on premium growth rate; life insurance segment, recent period

	Effet de long terme	Effet de court terme	Effet global
France 1983-2007	4,64 x 0,47	0	2,19
Allemagne	2,79 x 0,764	0	2,13
Royaume-Uni	3,23 x 0,34	0	1,10
Japon	7,85 x 0,35	0	2,74
USA	2,35 x 0,326	0,84	1,60

To complete the preceding analysis, done on a sample of limited size, it is worthwhile to examine the results that can be obtained over a longer period, by allowing a regime shift.

III. 2 Error correction model with gradual regime shift

We adopt a model describing a gradual regime shift with long-term relationship and an error correction mechanism. (STECM: smooth transition error correction model). The dynamic allows just one and the same estimated long-term relationship over the entire period we are studying (in this case, 1967-2007), but the intensity of the error correction mechanism differs depending on the regime we are considering. In addition, the transition from one regime to the next is gradual (or smooth).

More precisely, the STECM specification is the following:

$$\text{dlprimes}_t = (a_0 + a_1\, \text{dlprimes}_{t-1} + a_2\, \text{dlcpi}_{t-1} + \gamma_1\, \varepsilon_{t-1}) + F(\text{dlcpi}_{t-2})(b_0 + b_1\, \text{dlprimes}_{t-1} + b_2\, \text{dlcpi}_{t-1} + \gamma_2\, \varepsilon_{t-1}) + u_t$$

where $$F(z) = \frac{1}{1+\exp(-\gamma(z-s))} \quad \text{avec } \gamma > 0$$

ε_{t-1} always denotes the slack variable added to the long-run relationship.

The function F describes a gradual shift from one regime to the other $0 \le F(z) \le 1$; the transition is governed by a variable z which is chosen from among other variables as that which offers the best explanation for the transition. As we will see, this variable is the two-period lagging rate of inflation in our case. When the transition variable z exceeds the threshold s, $(z - s)$ acquires a high positive value and $F(z)$ tends toward 1; the dynamic thus obeys the second regime. Conversely, if the transition variable z is significantly lower than the threshold s, $(z - s)$ becomes very negative and $F(z)$ tends toward 0, and the dynamic obeys the first regime.

First we consider the results obtained for the property-liability segment.

First, we detail the results obtained in the case of the United States, before commenting on the principal results obtained for the other countries. All of the results are provided in Table A3 of the Appendix.

In the case of the United States, here are the findings for the period 1965-2007:

- the cointegration relationship:

$lpnvus_t = 19{,}23^* + 1{,}64\ lncpus_t + \varepsilon_{t-1}$

- the error correction equation:

$dlpnvus_t = 0{,}83^*\ dlpnvus_{t-1} + 0{,}36^*\ dlncpus_{t-1} - 0{,}12^*\ \varepsilon_{t-1}$

- the regime shift equation:

$dlpnvus_t = (0{,}41^*\ dlpnvus_{t-1} + 1{,}41^*\ dlcpius_{t-1} - 0{,}20^*\ \varepsilon_{t-1}) + F(dlcpius_{t-2})(1{,}51\ dlpnvus_{t-1} - 0{,}24\ dlcpius_{t-1} - 0{,}12\ \varepsilon_{t-1}) + u_t$

where the coefficient γ involved in the characterization of the transition function is 28 and the threshold is equal to 0.06

The coefficient of the residue ε_{t-1} is only significant in the first regime (i.e., -0.20), reflecting an error correction mechanism in this regime, which corresponds to the most recent period (the rate of inflation is less than 0.06). Similarly, the short-term coefficient associated with the rate of inflation (i.e., 1.413) is only significant in the first regime.

Accordingly, when inflation (lagging by 2 periods) is low (lower than $s = 0{,}06$), which corresponds to the most recent period (t>1984), inflation has a significant impact on the level of premiums over the short and long run: 0.1984x1.64+1.41 (i.e., greater than 1) is indicative of the phenomenon of overreaction already observed in the estimation of the model limited to a recent sub-period (1986-2007).

The main results for other countries are as follows: for Canada and Germany, we cannot confirm the STECM specification. As for the United Kingdom, while there is no long-run relationship over the entire period of the study we see that inflation has a significant short-term impact over the most recent period exclusively. In addition, we see that in this case premiums overreact to price trends (coefficient of 1.533>1). Conversely, inflation has no impact on the variation in premiums over the earliest period.

For Japan, we see overreaction of premiums to inflation over the most recent period, but a persistent negative reaction over the earliest period. For France, allowing for a deterministic trend in the long-run relationship, we observe an overreaction mechanism.

Now we will briefly comment on the results obtained for life insurance.

We cannot confirm the existence of a long-run relationship except for the United States, Canada and Japan, and an STECM specification for the United States only. For the US, the impact of prices on premiums is only significant over the most recent period; but we cannot confirm the overreaction mechanism observed when we limit the estimation of the error correction model to the most recent period. The results are presented in detailed fashion in Table A4 of the Appendix.

In the following section, we examine the impact of business activity as measured by GDP on the trend in the level of premiums.

IV. Study of the influence of business activity as measured by GDP

Here we examine the influence of GDP on premium trends in the case of the property-liability segment. Our focus is on the United States and France. The system is limited to two GDP and Premium series, given as logarithms.

First we consider the case of the property-liability insurance segment.

IV.1 Property-liability insurance

We begin by looking at the period 1967-2007, before focusing on the most recent period. The results are reported in the appendix, Table A5. We only see a cointegration relationship for two countries, France and United States.

In the case of the United States, we find a cointegration relationship over the period 1965-2007:

$Lnprus_t = 4{,}256 + 1{,}043 Lpibus_t + e_t$

with the error correction equation:

$dLnprus_t = 0{,}763(^{**})\ dLnprus_{t-1} - 0{,}377(^{**})\ e_{t-1} + u_t$

Corresponding to an R2 equal to 0.72

In the case of France, we also find a cointegration relationship over the same period:

$Lnprf\ r_t = 1{,}902 + 0{,}95 Lpibf\ r_t + e_t$

with the error correction equation:

$dLnprf\ r_t = 0{,}461(^{**})\ dLnprf\ r_{t-1} - 0{,}299(^{**})\ e_{t-1} + u_t$

Associated with an R2 of 0.819

For the other countries, there is therefore no cointegration but a GDP impact on premiums, relayed only by the so-called short-term dynamic, i.e., that of the growth rates of the two series. We can see that the autoregressive effect appears only in the case of Germany. The R2 coefficients have values that are significantly lower than before, except in the case of Canada. The results are provided in the following table.

Table 3: Effect of GDP on premium trends in the property-liability insurance segment

Variable	Canada	Japon	Royaume-Uni	Allemagne
$dlpn_{t-1}$	0,137	0,162	-0,015	**0,475**
	(0,880)	(1,006)	(-0,094)	**(3,366)**
$dlpib_{t-1}$	**0,683**	**0,879**	**0,937**	**0,382**
	(2,076)	**(3,512)**	**(3,057)**	**(2,525)**
c	0,022	0,010	0,022	0,012
	0,7591	(0,614)	(0,795)	(1,326)
R^2	0,759	0,497	0,220	0,554

The estimation of a STECM model, when this specification is confirmed (i.e., for the United States, Japan, Germany and France), shows a stronger effect of GDP on premiums for regime 1, which is the most recent period (the transition variable still being the rate of inflation lagging by two periods). The detailed results are reported in Table A5 of the Appendix.

Let's look now at the case of life insurance.

IV.2 Life insurance

For the life insurance segment, and still considering the 1965-2007 period, a relationship of cointegration is confirmed for every country except Japan and the United Kingdom.

The results are detailed in table A6 in the appendix.

The results of the estimated coefficients of cointegration relationships are indicated in the table below:

Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
$lpib_t$	1,058	1,089	-	-	1,143	0,940
c	4,379	5,787	-		1,143	-

As for the equations describing the dynamics of the rate of growth of premiums, we observe an error correction mechanism when there is a cointegration relationship. In this case, the effect of GDP on premiums is exclusively transmitted via the long-term relationship. The effect is systematically positive, as expected. For example, here is the error correction equation we find for France:

$$dLnprf\ r_t = -\ 0{,}076(^{**})\ e_{t-1} + u_t$$

$$e_t = Lnprf\ r_t - 0{,}940\ Lnpibf\ r_t$$

The results of the estimations are provided in the table below:

Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
z_{t-1}	**-0,089**	**-0,310**	-	-	**-0,274**	**-0,076**
	(-1,956)	**(-4,241)**			**(-4,741)**	**(-2,973)**
$dlpn_{t-1}$	**0,255**	0,066	**0,269**	0,158	-0,187	0,233
	(1,801)	(0,438)	**(1,717)**	(1,022)	(-1,425)	(1,621)
$dlpib_{t-1}$	-0,111	(-0,269)	**0,606**	**0,649**	0,0686	-0,837
	(-0,227)	(-0,781)	**(2,387)**	**(1,952)**	(0,243)	(-1,339)
c	0,242	-	0,025	0,046	0,400	-
	(-0,227)		(1,164)	(1,302)	(0,243)	
R^2	0,242	0,321	0,292	0,127	0,401	0,201
AIC	-3,136	-2,935	-1,982	-1,933	-3,074	-1,984
BIC	-3,010	-2,810	-1,857	-1,808	-2,948	-1,859

We therefore conclude that there is in fact a systematically positive effect of GDP growth rates on premium growth rates, with a significant error correcting mechanism (significant and negative coefficient for et-1), as has been observed when the impact of inflation on premium growth has been studied. When we estimate a STECM model, it is confirmed for three countries, the United States, Japan and Germany; the positive effect of GDP appears to be stronger over the recent period (regime 1) and in contrast with a negative effect observed for the second regime (See table A6).

Conclusion

In this paper, we have examined the fluctuations in premiums over the period 1965-2007 for a set of six countries (France, Germany, the United States, the United Kingdom, Canada and Japan), in the life and property-liability insurance segments. We have looked at macro-economic determinants, excluding variables that are characteristic of the insurance business, and more specifically consumer prices and GDP. All of these series, given as logarithms, present stochastic tendencies when we examine the period 1950-2007, which indicates that their dynamic has a persistent character. We then searched for the lasting relationships between them, in the form of cointegration relationships, still interpreted as long-run relationships. In doing so, we align ourselves with a small body of literature, since most studies develop empirical analyses based on growth rates in order to make estimations within a stationary framework, where inference is typical practice.

We began by studying the impact of price trends on premium price trends. We saw that while it was not possible to confirm the existence of long-run relationships throughout the period under review; it was for most of the specifications over a more recent period (1965-2007) and almost always over the most recent period (1986-2007). In fact, if the existence of a long-run relationship is established, the power of the corresponding back moving force toward equilibrium is not really significant except for the most recent period. For this most recent period, we also observe an overreaction of premium growth rates to inflation, as a result of transitory and persistent effects. It turns out that the behavior of inflation changed sometime around 1985. This regime shift was confirmed using an adapted model, non-linear, allowing for a gradual modification of the intensity of the back moving force depending on the greater or lesser proximity of one or the other of the two extreme regimes. One of the regimes in fact corresponds to the most recent period, since we show that it is active when the rate of inflation is sufficiently low. The effect of GDP on the level of premiums is confirmed, positive and significant over the period 1965-2007; but the confirmation of the existence of a long-run linkage or relationship between the GDP and Premium series, given as logarithms, is less systematic than in the case of the Premium and Price series. The explanatory power of inflation is generally greater than that of GDP in the linear error correction models and, for one and the same fundamental, price or GDP, the explanatory performance of the model is much greater for the property-liability segment compared to the results obtained for the life insurance segment. The comparison of various models demonstrates the importance of integrating the relationships among levels of variables when these relationships are stable enough - i.e., when the series are cointegrated, because the explanatory performance of the model is much greater.

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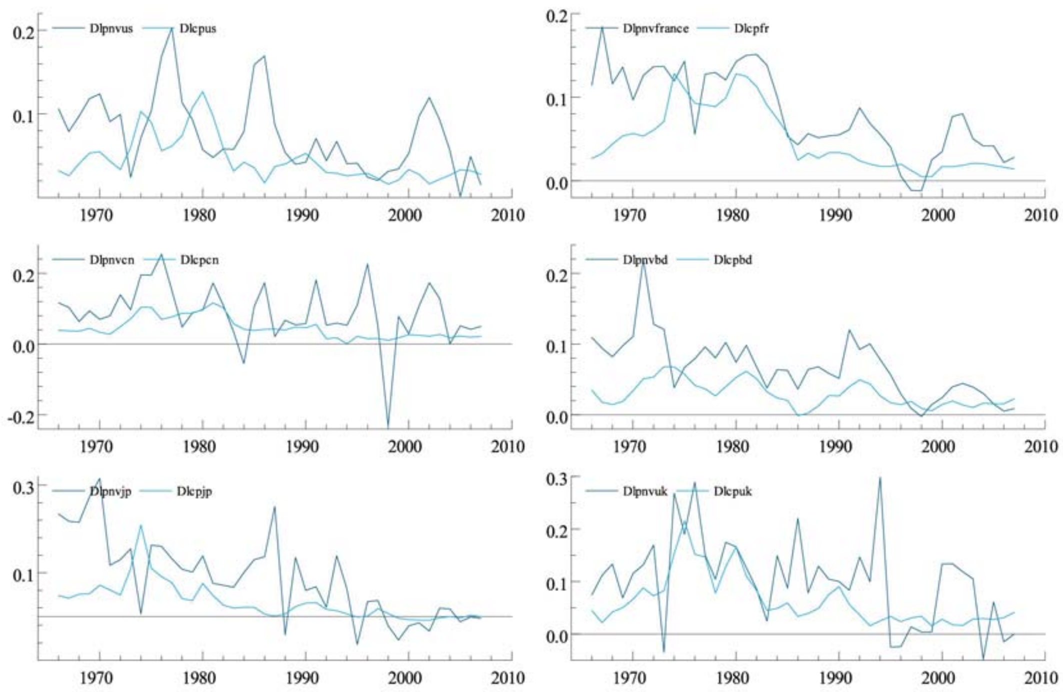
Appendix

DLog premiums_DLog cpi relationship (property-liability insurance)



Trend in logarithms of consumer price indices for G7 countries

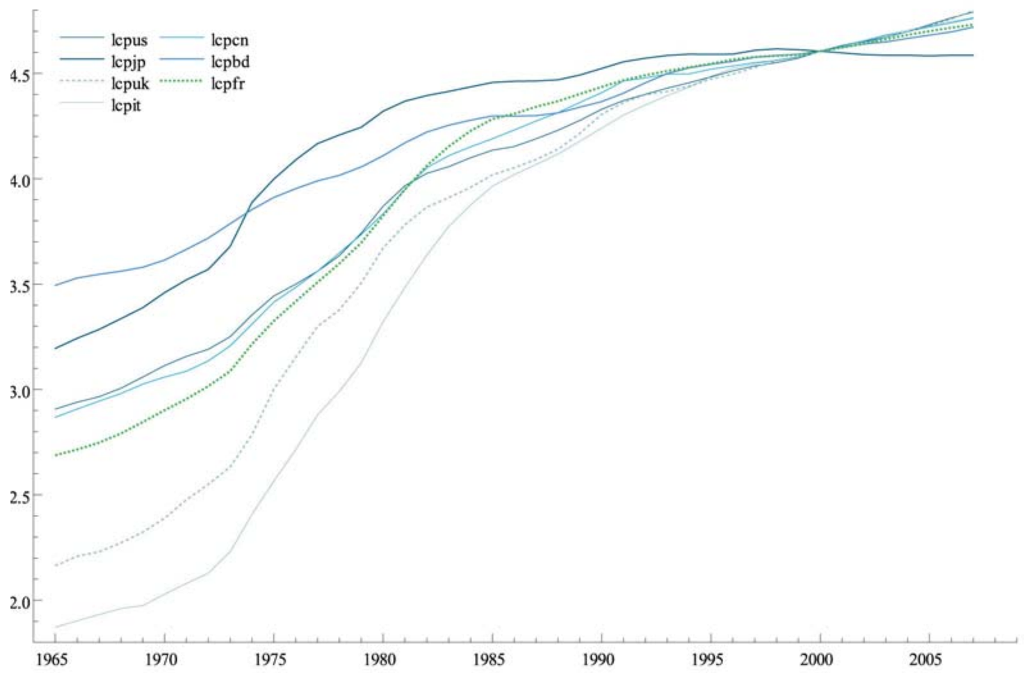


Table A1: Study of the stability of the mean of the series and determination of structural breaks (Bai and Perron Test (1998, 2003)

Taux de croissance des primes assurance Non-Vie	$\hat{T}_1, \hat{T}_2$	δ_1	δ_2	δ_3
$dlpnvus_t$	1987	0,100	0,050	-
$dlpnvcn_t$	-	-	-	-
$dlpnvjp_t$	1987	0,150	0,016	-
$dlpnvuk_t$	1994	0,133	0,036	-
$dlpnvbd_t$	1995	0,085	0,021	-
$dlpnvfr_t$	1984	0,128	0,044	-
Taux de croissance des primes assurance Vie				
$dlpnvus_t$	-	-	-	-
$dlpnvcn_t$	1990	0,107	0,057	
$dlpnvjp_t$	1993	0,145	-0,006	
$dlpnvuk_t$	-	-	-	-
$dlpnvbd_t$	1987	0,098	0,046	
$dlpnvfr_t$	1994	0,163	0,065	
Taux d'inflation				
$dlpnvus_t$	1973, 1981	0,043	0,090	0,032
$dlpnvcn_t$	1973, 1982			
$dlpnvjp_t$	1973, 1981			
$dlpnvuk_t$	1973, 1981			
$dlpnvbd_t$	1983			
$dlpnvfr_t$	1973, 1984	0,050	0,104	0,022
Taux de croissance du PIB				
$dlpnvus_t$	1984	0,089	0,055	-
$dlpnvcn_t$	1981, 1989			
$dlpnvjp_t$	1980, 1991			
$dlpnvuk_t$	1992			-
$dlpnvbd_t$	1973, 1981, 1990			-
$dlpnvfr_t$	1984	0,118	0,043	-

Table A2: Study of the Log premiums-Log cpi relationship over the period 1986-2007
Property-liability insurance

Estimation of long-run relationship

Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne (1988-2007)	France
lcp_t	2,046	3,077	5,035	2,345	1,987	2,308
c	17,463	10,167	6,957	13,660	16,549	-15,784

Estimation of VECM

Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
z_{t-1}	**-0,237**	**-0,714**	**-0,297**	**-0,487**	**-0,700**	**-0,531**
	(-2,930)	**(-2,501)**	**(2,028)**	**(-1,838)**	**(-3,912)**	**(-5,379)**
$dlpn_{t-1}$	**0,785**	0,317	**-0,433**	**0,443**	**0,676**	**0,933**
	(3,992)	(1,278)	**(-2,142)**	**(1,956)**	**(2,972)**	**(7,395)**
$dlpn_{t-2}$		-0,035		**0,408**	0,079	
		(-0,136)		**(1,662)**	(0,328)	
$dlcp_{t-1}$	**1,318**	-0,140	**2,051**	-1,668	-0,554	**0,796**
	(2,082)	(-0,072)	**(2,167)**	(-1,342)	(-0,737)	**(2,808)**
$dlcp_{t-2}$		-0,874		1,779	0,695	
		(-0,450)		(1,251)	(1,207)	
c	-0,032	**0,074**				
	(-1,268)	**(1,607)**				
R^2	0,522	0,406	0,349	0,453	0,846	0,830
AIC	-4,646	-1,865	-3,115	-2,234	-5,217	-5,862
BIC	-4,447	-1,567	-2,966	-1,986	-4,970	-5,713
σ_L						

Table A2: Study of the Log premiums-Log cpi relationship over the period 1965-2007
Property-liability insurance

Estimation of long-run relationship

Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
lcp_t	1,640	-	0,748	-	-	1,160
c	19,230	-	26,795	-	-	21,270

Estimation of VECM

Variable	Etats-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
z_{t-1}	**-0,120**	-	**-0,108**	-	-	-0,089
	(-2,360)		**(-4,920)**			(-3,980)
$dlpn_{t-1}$	**0,831**	0,114	0,015	-0,034	0,711	0,371
	(8,143)	(0,683)	(0,103)	(-0,197)	(4,940)	(2,616)
$dlcp_{t-1}$	**0,358**	**0,731**	-0,295	0,751	-0,043	0,264
	(2,289)	**(1,612)**	(-0,989)	(2,550)	(-0,129)	(1,716)
c	-	**0,044**	-	0,059	0,019	-
		(1,860)		(2,642)	(1,799)	
R^2	0,505	0,110	0,606	0,170	0,480	0,751
AIC	-3,928	-2,170	-2,739	-2,176	-4,007	-4,434
BIC	-3,802	-2,044	-2,614	-2,051	-3,882	-4,309
σ_L						

Estimation of STECM

	Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
Régime 1	z_{t-1}	**-0,198**	-	**-0,349**	-	-	**-0,053**
		(-3,483)		**(-2,534)**			**(-1,782)**
	$dlpn_{t-1}$	**0,412**	-	**-0,770**	0,237	-	**0,431**
		(3,487)		**(-2,031)**	(1,22)		**(2,476)**
	$dlcp_{t-1}$	**1,413**	-	2,542	**1,533**	-	**0,293**
		(3,008)		(1,247)	**(2,67)**		**(1,608)**
	c	0,0028	-	**-0,058**		-	
		(0,105)		**(-1,881)**			
Régime 2	z_{t-1}	-0,115	-	**0,276**	-	-	**-0,1523**
		(-0,494)		**(1,854)**			**(-2,507)**
	$dlpn_{t-1}$	**1,506**	-	0,880	**-0,862**	-	**-0,547**
		(2,634)		(1,547)	**(-2,123)**		**(-1,731)**
	$dlcp_{t-1}$	-0,240	-	-2,871	0,363	-	
		(-0,196)		(-1,374)	(0,492)		
	c	-0,161	-	**0,094**		-	
		(-1,206)		**(1,835)**			
	Υ	28		20,97	99		86
	s_t	$dlcp_{t-2}$= 0,060		$dlcp_{t-2}$= 0,016	$dlcp_{t-2}$= 0 ,069		$dlcp$= 0,06
	R^2	0,707		0,689	0,214		0,790
	AIC	-6,911		-5,487	-4,890		-7,328
	BIC	-6,489		-5,065	-4,637		-7,033
	σ_{NL}	0,0284		0,058	0,081		0,024

Table A4: Study of the Log premiums-Log cpi relationship over the period 1965-2007
Life insurance

Estimation of long-run relationship

Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
lcp_t	1,571	1,745	1,563	-	-	-
c	20,003	16,349	24,361	-	-	-

Estimation of VECM

Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
z_{t-1}	**-0,091**	**-0,170**	**-0,105**	-	-	-
	(-3,302)	**(-3,463)**	**(-3,816)**			
$dlpn_{t-1}$	**0,227**	0,161	0,116	0,165	-0,119	0,182
	(1,609)	(1,044)	(0,786)	(1,045)	(-0,740)	(1,140)
$dlcp_{t-1}$	-0,212	0,173	-0,419	0,435	**1,350**	**0,817**
	(-0,570)	(0,438)	(-0,968)	(1,434)	**(2,439)**	**(2,103)**
c				**0,0744**	0,042	**0,067**
				(2,625)	(2,204)	**(2,384)**
R^2	0,259	0,112	0,428	0,088	0,135	0,167
AIC	-3,159	-2,668	-2,195	-1,890	-2,708	-1,943
BIC	-3,033	-2,542	-2,069	-1,765	-2,582	-1,817
σ_L						

Estimation of STECM

	Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
Régime 1	z_{t-1}	**-0,162**	-	-	-	-	
		(-2,977)					
	$dlpn_{t-1}$	0,106	-	-	-	-	-0,263
		(0,566)					(-0,881)
	$dlcp_{t-1}$	-0,099	-	-	-	-	**3,954**
		(-0,277)					**(1,769)**
	c	-0,046	-	-	-	-	
		(-1,587)					
Régime 2	z_{t-1}	-5,315	-	-	-	-	
		(-0,099)					
	$dlpn_{t-1}$	-5,852	-	-	-	-	0,872
		(-0,1137)					(2,589)
	$dlcp_{t-1}$	-5,140	-	-	-	-	-3,102
		(-0,040)					(-1,369)
	c	-6,106	-	-	-	-	
		(-0,107)					
	γ	2,648					2397
	s_t	$dlcp_{t-3}$ = 0,137					$dlcp_{t-2}$ = 0,020
	R^2	0,533					0,222
	AIC	-6,045					-4,671
	BIC	-5,619					-4,417
	σ_{NL}						

Table A5: Study of the Log premiums_Log GDP relationship over the period 1965-2007
Property-liability insurance

1 Estimation of long-run relationship

Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
$Lpib_t$	1,043	-	-	-	-	0,951
c	4,256	-	-	-	-	1,902

2 Estimation of error correction equation

Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
z_{t-1}	**-0,377**	-	-	-	-	**-0,299**
	(-4,688)					**(-5,153)**
$dlpn_{t-1}$	**0,763**	0,137	0,162	-0,015	**0,475**	**0,461**
	(6,050)	(0,880)	(1,006)	(-0,094)	**(3,366)**	**(4,512)**
$dlpn_{t-2}$	-0,012	-	-	-	-	-
	(-0,079)					
$dlpib_{t-1}$	0,118	**0,683**	**0,879**	**0,937**	**0,382**	0,078
	(0,528)	**(2,076)**	**(3,512)**	**(3,057)**	**(2,525)**	(0,635)
$dlpib_{t-2}$	-0,253	-	-	-	-	-
	(-1,257)					
c	-	0,022	0,010	0,022	0,012	-
		0,7591	(0,614)	(0,795)	(1,326)	
R^2	0,720	0,759	0,497	0,220	0,554	0,819
AIC	-4,369	-2,211	-2,493	-2,238	-4,16	-4,752
BIC	-4,158	-2,085	-2,368	-2,113	-4,037	-4,627
σ_{NL}						

3 Estimation of STECM

	Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
Régime 1	z_{t-1}	**-0,301**	-	-	-	-	-0,272
		(-2,907)					**-2,837**
	$dlpn_{t-1}$	0,383	-	0,015	-	**0,494**	0,224
		(1,588)		(0,069)		**(2,449)**	(1,234)
	$dlpn_{t-2}$	0,032	-		-	-	-
		(0,154)					
	$dlpib_{t-1}$	**0,679**	-	**1,506**	-	**0,805**	-0,174
		(2,412)		**(4,638)**		**(3,659)**	(-0,449)
	$dlpib_{t-2}$	0,052	-		-	-	-
		(0,190)					
	C	-0,026	-	-0,002	-	-	-
		(-1,239)		(-0,166)			
Régime 2	z_{t-1}	**-1,056**	-	-	-	-	-0,087
		-3,156					(-0,438)
	$dlpn_{t-1}$	-0,639	-	-0,728	-	0,138	-0,529
		(-1,638)		(-0,735)		(0,562)	(-1,549)
	$dlpn_{t-2}$	0,693	-		-	-	-
		(1,566)					
	$dlpib_{t-1}$	0,484	-	-2,465	-	**-0,644**	0,045
		(0,536)		(-1,259)		**(-2,358)**	(0,061)
	$dlpib_{t-2}$	0,564	-		-	-	-
		(0,754)					
	c	**-0,22**	-	0,326	-	-	0,097
		(-1,673)		(0,745)			(0,881)
	Υ	923,1		122,2		57	7
	s_t	$dlcp_t = 0,055$		$dlcp_{t-1} = 0,0718$		$dlcp_{t-1} = 0,037$	$dlpib_{t-1} = 0,0954$
	R^2	0,8154		0,675		0,687	0,85497
	AIC	-7,137					
	BIC	-6,540					
	σ_{NL}	0,0246					

Table A6: Study of the Log premiums-Log GDP relationship over the period 1965-2007 Life insurance

1 Estimation of long-run relationship

Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
$lpib_t$	1,058	1,089	-	-	1,143	0,940
c	4,379	5,787	-	-	5,945	-

2 Estimation of error correction equation

Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
z_{t-1}	**-0,089**	**-0,310**	-	-	**-0,274**	**-0,076**
	(-1,956)	**(-4,241)**			**(-4,741)**	**(-2,973)**
$dlpn_{t-1}$	**0,255**	0,066	**0,269**	0,158	-0,187	**0,233**
	(1,801)	(0,438)	**(1,717)**	(1,022)	(-1,425)	**(1,621)**
$dlpib_{t-1}$	-0,111	(-0,269)	**0,606**	**0,649**	0,0686	-0,837
	(-0,227)	(-0,781)	**(2,387)**	**(1,952)**	(0,243)	(-1,339)
c	0,242	-	0,025	0,046	0,400	-
	(-0,227)		(1,164)	(1,302)	(0,243)	
R^2	0,242	0,321	0,292	0,127	0,401	0,201
AIC	-3,136	-2,935	-1,982	-1,933	-3,074	-1,984
BIC	-3,010	-2,810	-1,857	-1,808	-2,948	-1,859
σ_L						

3 Estimation of STECM

	Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
Régime1	z_{t-1}	0,069	-	-	-	**-0,477**	-
		(0,917)				**(-6,337)**	
	$dlpn_{t-1}$	-0,259	-	0,101	-	**-1,585**	-
		(-0,551)		(0,572)		**(-5,364)**	
	$dlpib_{t-1}$	**2,296**	-	**3,412**	-	0,752	-
		(1,948)		**(2,696)**		(1,209)	
	c		-		-		-
Régime2	z_{t-1}	**-0,390**	-	-	-	**0,313**	-
		(-3,813)				**(2,463)**	
	$dlpn_{t-1}$	0,4351	-	0,4821	-	**1,854**	-
		(0,738)		(1,381)		**(3,745)**	
	$dlpib_{t-1}$	**-4,593**	-	**-3,035**	-	-0,629	-
		(-3,625)		**(-2,385)**		(-0,934)	
	c		-		-		-
	Υ	5,761		8,754		99	
	s_t	$dlpib_{t-1}$ = 0,057		$dlpib_{t-1}$ = 0,052		$dlpib_{t-1}$ = 0,050	
	R^2	0,559		0,400		0,669	
	AIC						
	BIC						
	σ_{NL}						

Attempt at a 3 series Log premiums_Log cpi_Log GDP system over the period 1965-2007 for property-liability insurance

1 Estimation of long-run relationship

Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
lcp_t	0,345	-	-2,651	-	1,073	-0,818
$lpib_t$	0,848	-	3,109	-	0,613	1,465
c	0,086	-	62,719	-	3,829	13,646

2 Estimation of error correction equation

Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
z_{t-1}	**-0,350**		**0,137**		**-0,215**	**-0,298**
	(-4,905)		**(1,837)**		**(-1,734)**	**(-6,186)**
$dlpn_{t-1}$	**0,807**		-0,090		**0,576**	**0,301**
	(7,505)		(-0,469)		**(3,620)**	**(2,777)**
$dlcp_{t-1}$	0,112		-0,412		-0,116	**0,595**
	(0,562)		(-0,974)		(-0,380)	**(2,839)**
$dlpib_{t-1}$	0,198		**0,968**		**0,360**	**-0,531**
	(0,874)		**(2,314)**		**(2,382)**	**(-2,398)**
c	-0,006		**0,040**		0,009	**0,068**
	(-0,450)		**(1,778)**		(0,996)	**(5,373)**
R^2	0,677		0,559		0,590	0,853
AIC	-4,258		-2,526		-4,150	-4,859
BIC	-4,049		-2,317		-3,940	-4,650
σ_{NL}						

3 Estimation of STECM

	Variable	États-Unis	Canada	Japon	Royaume-Uni	Allemagne	France
Régime 1	z_{t-1}	**-0,382**	-	-	-	-	-0,373
		(-5,956)					(-1,556)
	$dlpn_{t-1}$	**0,327**	-	-	-	-	0,5628
		(3,543)					(1,274)
	$dlcp_{t-1}$	**0,732**	-	-	-	-	-0,167
		(2,665)					(-0,099)
	$dlpib_{t-1}$	**0,378**	-	-	-	-	0,4765
		(1,728)					(0,751)
	c	-0,005	-	-	-	-	0,0360
		(-0,447)					(0,8946)
Régime 2	z_{t-1}	-1,074	-	-	-	-	0,011
		(-1,556)					(0,060)
	$dlpn_{t-1}$	**1,331**	-	-	-	-	-0,675
		(3,564)					(-1,429)
	$dlcp_{t-1}$	1,842	-	-	-	-	0,572
		(1,363)					(0,337)
	$dlpib_{t-1}$	0,143	-	-	-	-	-0,436
		(0,249)					(-0,649)
	c	**-0,336**	-	-	-	-	0,027
		(-2,081)					(0,615)
	Υ	21					59
	s_t	$dlcpus_{t-2} = 0{,}074$					$dlcpfr_t = 0{,}019$
	R^2	0,832					0,875
	AIC	-3,370					-7,597
	BIC	-6,863					-7,090
	σ_{NL}	0,022					0,020

The cointegration relationship is not confirmed for Canada and the United Kingdom.

In the case of the United States, we continue to observe the positive impacts of GDP and prices on the trend in premiums, with a reinforcement of these effects on regime 1 — and so for the most recent period.

In the case of Germany and Japan, the short- and long-term impacts give a global result that is positive for the two variables. However, the STECM specification is not confirmed.

Finally, in the case of France the effects of GDP and prices seem to be neutralized.