How Do Hurricanes Affect Life Insurance Premiums? The Effects of Financial Constraints on Pricing

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Abstract

I identify effects of financial constraints on firms' real activities, using a sample of insurance groups (conglomerates) that contain both life and P&C (property & casualty) subsidiaries. Following losses in P&C subsidiaries, financial constraints in the overall group are exacerbated. I present a model in which life insurance pricing is affected by shocks to the P&C affiliate's financial condition. In this model, following adverse P&C shocks, premiums should fall for life policies that increase statutory capital and rise for policies that decrease capital. Using a sample of 207 life insurance companies between 1999 and 2013, I find that P&C losses lead to changes in life insurance premiums as the model predicts. The effects are concentrated in more financially constrained firms, which are more likely affected by shocks to financial conditions. I also find that life insurers make more transfers to the rest of the group following larger P&C losses. Moreover, these results hold instrumenting for losses using state-level data on the value of weather-related damages, suggesting that losses to P&C affiliates do cause changes in life insurance premiums and internal capital transfers. Overall, these findings suggest that firms' financial constraints affect firms' real activities.

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1 Introduction

The way in which imperfections in capital markets affect firms' activities is an important research topic in finance. One way such imperfections affect firms is through financial constraints. Yet, measuring the real effects of financial constraints can be problematic. A firm's financial condition is determined jointly with its real activities, so one cannot easily identify whether an observed change in real activities is a cause or a consequence of financial constraints. This paper identifies the causal impact of financial constraints on firms' real activities, using a shock to firms' financial strength that is unlikely correlated with firms' business conditions.

The life insurance industry is a unique setting to study how shocks to financial constraints affect firm behavior. Many insurance companies are organized into groups of commonly owned affiliated companies. Some groups contain both life and P&C (property & casualty) insurance subsidiaries, which are subject to unrelated shocks. For example, a hurricane can have a large impact on a P&C business but not directly on a life insurance business. However, losses to a P&C subsidiary can affect the financial strength of the life insurer in the same group because of capital transfers within the group. Insurance companies report internal capital transfers, which allow me to observe the transmission of shocks. In this setting, I can identify shocks to life insurance companies that are exogenous to their own decisions.

Life insurers' pricing strategies reflect their financing and investment behavior. Life insurers immediately increase capital by selling some policies (analogous to raising funds), while immediately decrease capital by selling some other policies (analogous to making investments). Thus, the way in which life insurers change premiums for each of the two types of policies has implications on how firms change their financing and investment behavior. In addition, a number of life policies do not have a service component and are highly comparable over time and across firms (Brown and Goolsbee, 2002).

This paper estimates the effect of affiliated P&C losses on life insurance premiums. But some endogenous factors (e.g. poor managerial ability) can potentially affect both P&C

losses and life insurers' pricing behavior. To address this concern, I construct an instrument for P&C losses, using data on the value of state-level damages due to weather events (e.g. hurricanes), as well as individual P&C firms' lagged market share in each state. Variations in the severity of weather events, arguably hard to control or predict, offer exogenous shocks to the financial strength of the P&C affiliates. Thus, the P&C losses related to weather damages provide exogenous shocks to the life insurers' financial constraints.

I measure the impact of financial constraints on life insurance premiums, using a sample containing more than 390,000 life insurance price quotes from 207 life insurers between 1999 and 2013. I study both permanent and 10-year term life policies with fixed annual premiums. My sample contains 49 insurance groups with both P&C and life divisions.

Life insurance prices affect both the economic profits and statutory capital of life insurers. To understand how financial constraints will affect life insurance pricing, I first present a model. My model features a group with one life and one P&C division. The life insurer decides on its capital transfer to the P&C affiliate, and the life insurance premium, to maximize the group value. Statutory capital (assets relative to statutory liabilities) is important for the insurance industry for two reasons, which the model takes into account. First, regulators can seize control of an insurer, when assets are deemed too low to meet liabilities. In the model, I require the statutory capital exceed a lower bound for each division. The second reason for the importance of capital is that customers prefer better capitalized life insurers. I model the demand for life insurance as a function of the premium and insurers' capital. In this paper, insurers' capital mostly refers to statutory capital.

The model has four predictions. The first two concern how life insurance premiums change with affiliated P&C losses, depending on whether selling the policies immediately increases or decreases capital. For life policies that increase capital in the short term, premiums should fall. For this type of policies, the annual premium usually exceeds the upfront costs of issuing the policy, bringing immediate capital inflow at issuance. Intuitively, with elastic demand, by lowering premiums, life insurers sell more policies, and attract more capital inflow.

In contrast, premiums should rise with P&C losses, for life policies that reduce capital in the short term. The initial issuing costs exceed the annual premium for these policies. Selling these policies can be seen as investments by life insurers. If capital becomes more costly, raising the premium lowers the initial capital expenditure (initial costs minus premium) and increases the capital payoff (premium minus costs in later years), thus, increases insurers' returns on these investments. Indeed, insurers will sell fewer policies as a result of higher premiums. But they achieve the goal of reducing capital outflow by selling fewer policies.

The third prediction is that life insurance premiums should change more if the insurance group is more financially constrained. The same P&C losses presumably have a larger impact on the financial strength, if the group is ex ante more financially constrained.

Fourth, life insurers will transfer more capital to P&C affiliates when P&C affiliates suffer larger losses. With larger losses, P&C insurers need more capital to satisfy the capital requirement. In addition, due to the reduction in capital, P&C insurers have to forgo some profitable investments, e.g., paying inspectors to evaluate potential policyholders' homes. Therefore, the value of additional capital for P&C affiliates rises. Consequently, the optimal allocation of capital requires transfers from life to P&C divisions.

I first test the model predictions on life insurance premiums. To do so, I need to identify capital-increasing and capital-reducing policies. I consider permanent life policies to be capital-increasing, since the issuing cost is usually lower than the premium for these policies. In contrast, I consider 10-year term life policies to be capital-reducing, since the issuing cost usually exceeds the premium in the first policy year for these policies.

The results on premium changes are consistent with the model's predictions. First, for capital-increasing products, the permanent life policies, premiums fall with affiliated P&C losses. Second, for capital-reducing products, the 10-year term policies, premiums increase with P&C losses. Third, the effect of P&C losses on life insurance premiums is stronger for groups that are ex ante more financially constrained. I then test the model prediction on internal capital transfers. I find that, when P&C losses are larger, life insurers make more transfers to the rest of the group, and P&C insurers receive more transfers from the rest of the group. All the empirical results hold when I instrument P&C losses with state-level data on both weather-related damages and P&C insurers' lagged market share.

This paper highlights the importance of statutory capital for insurers, the important form of financial resource for the insurance industry. Life insurers change prices of their products following negative shocks to their P&C affiliates, likely due to the two reasons why capital is important for the insurance industry. First, regulatory capital requirements and improved investment opportunities on the P&C side motivate life insurers to make transfers to P&C affiliates to avoid regulatory intervention of the P&C business. Second, potential policyholders prefer better capitalized life insurers. Thus, life insurers need to replenish their own capital following transfers to P&C affiliates, to ensure demand for their products do not suffer. These two forces drive the importance of capital, and thus, distort insurers' behavior.

My results on how financial constraints affect premiums can be generalized to other industries. For capital-reducing life policies, selling them involves initial investment, since the issuing cost usually exceeds the premium in the first year. This is analogous to industries in which it takes initial expenditure to produce goods (e.g., to purchase machines and raw material). The quantity to produce can be limited by producers' liquidity constraints, so the market-clearing price will increase. In contrast, the result on capital-increasing policies can be applied to industries in which customers pay before marginal production costs are incurred. Lowering prices leads firms to deviate from short-term profit maximization, but helps it gain more liquidity that can potentially help in the future.

This paper goes beyond merely documenting that financial constraints can affect firms' real activities. First, the literature on internal capital markets has documented that some divisions' cash flows affect other divisions' investments (see Lamont 1997, Shin and Stulz 1998, and the literature spawned by these two papers; see Powell, Sommer and Eckles 2008 for an application to insurance industry). This paper shows that, when adverse financial shocks affect some divisions, the unaffected divisions change their real activities beyond investments, to help mitigate financial constraints in the affected divisions. (Some other papers also study firms' real activities beyond traditional measures of investments in the context of internal capital markets, e.g., Khanna and Tice 2001, Campello 2002 and Boutin et al 2013. But they focus on divisions directly affected by shocks, and show access to internal capital markets helps affected divisions mitigate adverse shocks.)

Second, this paper adds new insights to the literature on how firms' financial conditions affect pricing.[1] To the best of my knowledge, this paper is the first to employ idiosyncratic and exogenous shocks to firms' financial constraints in this literature, suggesting a causal effect of financial constraints on pricing. Moreover, this paper can help reconcile different findings in the literature. On one hand, I show that prices increase with financial constraints, for capital-reducing products, consistent with Chevalier (1995). On the other hand, I also show that prices fall, for capital-increasing products, consistent with Zingales (1998) and Busse (2002). By studying different products in the same industry, I characterize the mechanism in which financial constraints affect pricing—prices change in a way that helps alleviate financial constraints. The way in which different products affect capital in the short term is a potential avenue to reconcile different findings in the literature.

Third, this paper characterizes the precise manner in which financial constraints limit investment. The literature has documented investment reduction due to financial constraints, but not explored the nature of the reductions, or characteristics of the forgone and remaining investments. This paper finds that, for the capital-reducing policies, firms raise premiums and thus returns on these investments (in terms of capital), when becoming more constrained. By using granular data on pricing, this paper shows that firms reduce total investment and raise returns on the remaining investments when financial constraints tighten.

Fourth, my results have implications on firms' financing behavior under financial constraints. Insurers can obtain financing by issuing capital-increasing policies, which are claims on insurers' future cash flows. By lowering premiums, insurers sell more policies, and can attract more capital inflow from policyholders.[2] When firms are badly in need of capital,

[1] Both theoretical and empirical papers in this literature so far mainly examine situations with a small number of sellers or a highly concentrated market. The market of term life insurance is best characterized by the theoretical pricing model of Stahl (1989) (Brown and Goolsbee, 2002). Stahl (1989) allows a large number of identical sellers, and predicts dispersion of prices for a homogeneous good with asymmetric search costs of the buyers. Given the relatively large number of sellers in the term life insurance industry, an idiosyncratic shock to a particular life insurer should not cause competitors to respond strongly in terms of pricing. Therefore, in both the theoretical and empirical analyses, I abstract away from the competitive considerations of the life insurers, other than assuming that the demand decreases with price.

[2] One may argue that potential policyholders perceive higher default risk of the life insurers, and demand

but face financing frictions, they sell financing instruments at a discount. This implication is analogous to the theory of fire sales (see Shleifer and Vishny 1992, and Koijen and Yogo 2015 for an application to insurance). While unlike usual examples of fire sales, insurers sell financial claims rather than physical assets, the idea in the fire sales literature is a general one applying to all firms facing financing frictions.

A closely related paper is Koijen and Yogo (2015). They show that during the financial crisis, with severe external financial frictions, life insurers lowered premiums for permanent life insurance policies and annuities.[3] Consistent with their findings, this paper suggests that life insurers lower premiums for permanent life policies, when insurers are more financially constrained. While they document the effect of market-wide financing frictions, I study the effect of financial constraints faced by individual firms due to idiosyncratic shocks.

Another related paper is Koijen and Yogo (2016). They argue that, with shadow insurance, insurers can transfer liabilities to unregulated and unrated entities through reinsurance agreements, and thus, hold lower reserves. They suggest that, without shadow insurance, premiums of 10-year term life policies would increase, since selling them would involve more capital as input. My results on 10-year term life policies are consistent with their conclusion. In this paper, the amount of statutory capital needed to produce life insurance does not change, but shadow cost of capital for life insurers increases due to exogenous shocks.

The remainder of the paper proceeds as follows. Section 2 presents the model. Section 3 describes the data. Section 4 presents empirical results. Section 5 concludes.

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lower prices of permanent life policies. However, the fact that 10-year term policies' prices increase alleviates this concern. Additional tests suggest that P&C losses do not negatively affect affiliated life insurers' ratings.

[3] In their model, how shadow cost of capital changes prices depends on the relationship between the reserve and actuarial values of policies. By lowering prices, as long as above reserve value, firms will generate gain in statutory capital. In my framework, when insurers focus on the very short term, the first several years, lowering prices for permanent policies will bring in more capital (regardless of the relation between reserve and actuarial value), as long as the price of these products exceeds the reduction in capital from the sale. The reserve value does not play a role in my framework, because it is zero in the first two years of each policy studied in this paper.

2 Model

The model features an insurance group with a life and a P&C insurance division.[4] Capital can flow freely between the two subsidiaries. Since this paper mainly concerns the behavior of the life insurer, I do not explicitly model the operations of the P&C insurer. There are three periods. The life insurer sells one kind of policies in both Periods 1 and 2. Life policies are in effect for two periods, from Period 1 to 2 or from Period 2 to 3.

Since the model studies the life insurer's response to the affiliated P&C insurer's losses, I assume the P&C insurer incurs losses in the beginning of Period 1. The life insurer maximizes expected group value, J_0, which is the sum of the Period-1 profits of the P&C and life insurers, (π_1^{PC} and π_1^{LF}), the discounted value of the Period-2 and Period-3 profits, (π_2^{PC} and π_2^{LF}) and (π_3^{PC} and π_3^{LF}). PC stands for P&C, and LF for life insurance division. In the beginning of Period 1, the life insurer first decides on the amount of capital to transfer to the P&C affiliate, $k^{LF\rightarrow PC}$. Transfers are allowed to go from the P&C to the life division, in which case $k^{LF\rightarrow PC}$ will be negative. It then chooses the life insurance premium, P_1^{LF}. The optimization problem for the life insurer is

$$\underset{\left\{k^{LF\rightarrow PC},\ P_1^{LF}\right\}}{Max} J_0 = \pi_1^{PC} + \pi_1^{LF} + \beta\left(\pi_2^{PC} + \pi_2^{LF}\right) + \beta^2\left(\pi_3^{PC} + \pi_3^{LF}\right) \tag{1}$$

where β is the discount factor.

I define statutory capital as the difference between assets and liabilities, recorded according to statutory accounting rules. Liabilities include statutory reserves set aside to pay for future policy claims. Capital is particularly important for insurers, because their capital by law must meet a minimum requirement based on the risks of its assets and liabilities. The model simplifies this constraint and requires that the statutory capital exceeds a lower bound for

[4] I do not consider the headquarters in the model or the empirical analysis. However, the headquarters can take actions to alleviate financial constraints faced by the subsidiaries. If headquarters are powerful at relaxing the group's financial constraints, the life insurers are less likely to change their pricing strategies. Thus, the omission of the headquarters should work against me finding an effect of P&C losses on life insurance pricing.

each division,

$$K_0^{PC} \geq \tau_0^{PC},\ K_0^{LF} \geq \tau_0^{LF},\ K_1^{PC} \geq \tau_1^{PC},\ K_1^{LF} \geq \tau_1^{LF}\ , K_2^{PC} \geq \tau_2^{PC},\ K_2^{LF} \geq \tau_2^{LF}$$

where K stands for capital and τ the lower bound.[5] Note that at the end of Period 3, the insurers have no more liabilities. The non-negative capital in Period 2 makes sure that the insurers can pay off claims in Period 3 in expectation.

Combining Equation (1) and the constraints above, the optimization problem can be written as the following Lagrangian:

$$\begin{aligned} \underset{\left\{k^{LF\to PC},\ P_1^{LF}\right\}}{Max} L =& \pi_1^{PC} + \pi_1^{LF} + \beta\left(\pi_2^{PC} + \pi_2^{LF}\right) + \beta^2\left(\pi_3^{PC} + \pi_3^{LF}\right) + \\ & \lambda_0^{PC}\left(K_0^{PC} - \tau_0^{PC}\right) + \lambda_0^{LF}\left(K_0^{LF} - \tau_0^{LF}\right) + \\ & \lambda_1^{PC}\left(K_1^{PC} - \tau_1^{PC}\right) + \lambda_1^{LF}\left(K_1^{LF} - \tau_1^{LF}\right) + \\ & \lambda_2^{PC}\left(K_2^{PC} - \tau_2^{PC}\right) + \lambda_2^{LF}\left(K_2^{LF} - \tau_2^{LF}\right), \end{aligned} \tag{2}$$

where $\lambda_0^{PC},\ \lambda_0^{LF},\ \lambda_1^{PC},\ \lambda_1^{LF},\ \lambda_2^{PC}$ and λ_2^{LF} are Lagrange multipliers.[6]

Below I specify the evolution of capital and the profit functions. Before Period 1 begins, after the life insurer makes transfer to the P&C affiliate, each insurer's capital is

$$K_0^{LF} = K_e^{LF} - k^{LF\to PC}, \tag{3}$$

$$K_0^{PC} = K_e^{PC} + k^{LF\to PC}, \tag{4}$$

where K_e^{LF} and K_e^{PC} are the capital endowments of the life and P&C insurer, respectively.

Besides the regulatory requirements, capital is important for insurers for another reason: customers prefer better capitalized life insurers. Thus, I model the demand for life insurance as a function of both the premium and the life insurer's capital from the end of the previous period, $Q_t^{LF}\left(P_t^{LF},\ K_{t-1}^{LF}\right)$.

In Period 1, the life insurer sells $Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right)$ policies at the premium P_1^{LF}, where

[5] This constraint assumes that the group has infinite disutility from having the regulators control the operation of a division in an event of not meeting the regulatory constraint. However, in practice, parents can choose not to inject additional capital in the subsidiary, when the cost of avoiding regulatory intervention is too high. For simplification, the model ignores such scenario.

[6] The profits, as well as accounting equities, throughout the model section are expected profits, because the realization of losses is uncertain ex ante. However, for convenience, the expectation signs are omitted.

K_0^{LF} is the initial statutory capital of the life insurer. The life insurer incurs variable issuing costs, C, which includes costs to obtain health information of potential policyholders, hourly wages of underwriters, etc.. Policyholders' survival rate in Period 1 is s_1. The insurer pays out death benefits, B, per policy, if the policyholder dies. The profits of the life insurer in Period 1 are

$$\pi_1^{LF} = \left\{P_1^{LF} - \left[C + B\left(1 - s_1\right)\right]\right\} \cdot Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right). \tag{5}$$

At the end of Period 1, the life insurer records statutory reserve, V^R per policy, for the $s_1 \cdot Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right)$ policies still in effect. It is recorded as liability and reduces statutory capital. Regulations require the reserve and specify its computation. At the end of Period 1, the statutory capital of the life insurer is the value of capital at the beginning of Period 1, plus the gain from selling insurance, minus the transfer to the P&C insurer,

$$K_1^{LF} = RK_0^{LF} + \pi_1^{LF} - V^R s_1 \cdot Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right), \tag{6}$$

where R is the exogenous return on capital.

In Period 2, the life insurer collects premiums again from the $s_1 \cdot Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right)$ surviving policyholders. It pays out death benefits, $\left(1 - s_2\right) \cdot Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right)$, where s_2 is the policyholders' survival rate of the second period. The profits in Period 2 from policies sold in Period 1 are $\left[P_1^{LF} - B\left(1 - s_2\right)\right] s_1 \cdot Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right)$. The life insurer also sells new policies at premium P_2^{LF}. The profits in Period 2 from these new policies are $\left\{P_2^{LF} - \left[C + B\left(1 - s_1\right)\right]\right\} \cdot Q^{LF}\left(P_2^{LF},\ K_1^{LF}\right)$. The life insurer's total profits in Period 2 are

$$\pi_2^{LF} = \left[P_1^{LF} - B\left(1 - s_2\right)\right] s_1 \cdot Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right) + \left\{P_2^{LF} - \left[C + B\left(1 - s_1\right)\right]\right\} \cdot Q^{LF}\left(P_2^{LF},\ K_1^{LF}\right). \tag{7}$$

The first order condition of Equation (2) with respect to the transfer, $k^{LF \to PC}$, is

$$\begin{aligned} &\frac{\partial \pi_1^{LF}}{\partial K_0^{LF}} + \beta R \frac{\partial \pi_2^{LF}}{\partial K_1^{LF}} + \beta^2 R \frac{\partial \pi_3^{LF}}{\partial K_1^{LF}} + \lambda_0^{LF} + \lambda_1^{LF} R + \lambda_2^{LF} R \frac{\partial K_2^{LF}}{\partial K_1^{LF}} \\ =&\frac{\partial \pi_1^{PC}}{\partial K_0^{PC}} + \beta R \frac{\partial \pi_2^{PC}}{\partial K_1^{PC}} + \beta^2 R \frac{\partial \pi_3^{PC}}{\partial K_1^{PC}} + \lambda_0^{PC} + \lambda_1^{PC} R + \lambda_2^{PC} R \frac{\partial K_2^{PC}}{\partial K_1^{PC}} \equiv \lambda. \end{aligned} \tag{8}$$

Higher K_0^{LF} and K_1^{LF} can increase future profits of the life insurer, since potential policyholders prefer life insurers with stronger capitalization. Higher K_0^{PC} and K_1^{PC} can increase future profits of the P&C insurer, since the P&C insurer can undertake more profitable investments. Let i be either LF or PC. The sum of $\frac{\partial \pi_1^i}{\partial K_0^i}$, $\beta R \frac{\partial \pi_2^i}{\partial K_1^i}$, and $\beta^2 R \frac{\partial \pi_3^i}{\partial K_1^i}$ are the marginal contribution of insurer i's statutory capital at the beginning of Period 1 to the group value, through the contribution to insurer i's profit in each period. λ_0^i, $\lambda_1^i R$ and $\lambda_2^i \frac{\partial K_2^i}{\partial K_1^i}$ are the shadow value of i's statutory capital in relaxing i's minimum capital requirements constraint at the beginning of each period. The summation of these six terms, defined as λ, is the total shadow value of capital at the beginning of Period 1. The intuition from Equation (8) is that capital will flow between the two subsidiaries until the shadow value of capital equalizes between the two.

When the P&C insurer suffers significant losses, λ will most likely increase, because the shadow value of capital in relaxing P&C division's capital constraint is higher (λ_1^{PC} is higher). In addition, the shadow value of capital in boosting future profits is also higher. The reason can be related to the phenomenon often referred to as P&C insurance crisis (see, e.g. Gron (1994)). After substantial losses to certain product lines in certain geographic regions, P&C insurance premiums in those lines and regions increase dramatically, before declining back. Many papers explaining this phenomenon argue that the increase in price is due to financial constraints of P&C insurers resulting in limited supply of insurance. As the investment opportunities for P&C insurers become more lucrative, the shadow value of capital in increasing profits, $\frac{\partial \pi_1^{PC}}{\partial K_0^{PC}} + \beta R \frac{\partial \pi_2^{PC}}{\partial K_1^{PC}} + \beta^2 R \frac{\partial \pi_3^{PC}}{\partial K_1^{PC}}$, also increases. Thus, λ will increase. Across groups, λ should increase more for groups that are more financially constrained. Capital will flow from the life to the P&C division until the shadow value of capital equalizes between the two.

The first order condition of Equation (2) with regard to P_1^{LF} is

$$\frac{\partial \pi_1^{LF}}{\partial P_1^{LF}} + \beta \frac{\partial \pi_2^{LF}}{\partial P_1^{LF}} = \lambda \frac{\partial K_1^{LF}}{\partial P_1^{LF}}. \tag{9}$$

From Equation (9), we can interpret λ as the shadow cost of capital, the amount of profit that the life insurer sacrifices to gain one unit of capital, by changing prices. Recall that in Equation (8), λ also equals the shadow value of capital.

Combining Equations (5), (6), (7) and (9), the optimal life insurance premium is

$$P_1^{*LF} = (1 - \frac{1}{\epsilon^{LF}})^{-1}(1 + \beta S_1 + \lambda)^{-1}(1 + \lambda)[C + B(1 - s_1)] + \beta B s_1(1 - s_2) + \lambda s_1 V^R, \quad (10)$$

where $\epsilon^{LF} = -\frac{\partial log Q^{LF}}{\partial log P^{LF}}$ is the demand elasticity.

The optimal life insurance premium in Period 1, P_1^{*LF}, changes with the shadow cost of capital, λ, as follows.

$$\frac{\partial P_1^{*LF}}{\partial \lambda} = (1 - \frac{1}{\epsilon^{LF}})^{-1}(1 + \beta S_1 + \lambda)^{-2} s_1 \beta \left\{ [C + B(1 - s_1) + s_1 V^R] - [B(1 - s_2) - \frac{1}{\beta} V^R] \right\}. \quad (11)$$

assuming ϵ^{LF} does not change in P_1^{LF}.

Since life insurance products are highly comparable across insurers and many insurers offer similar products, I assume demand is elastic and ϵ^{LF} is greater than one. Koijen and Yogo (2016) estimate the elasticity to be 2.18. Because β and s_1 are both positive, the sign of $\frac{\partial P_1^{*LF}}{\partial \lambda}$ depends on the term in the curly brackets in Equation (11). $[C + B(1 - s_1) + s_1 V^R]$ is the capital cost for each policy in the first period. $[C + B(1 - s_1)]$ is the real economic cost. $s_1 V^R$ is the capital that needs to be recorded as reserve under liabilities, which reduces capital. $[B(1 - s_2) - \frac{1}{\beta} V^R]$ is the capital cost for each active policy in Period 2. $B(1 - s_2)$ is the real economic cost. $\frac{1}{\beta} V^R$ is the value of the reserve at the end of the second period, which is released from liabilities and adds to capital. Thus, $\frac{1}{\beta} V^R$ offsets the real economic cost, and $[B(1 - s_2) - \frac{1}{\beta} V^R]$ is the net capital outflow in Period 2 for each active policy.

The model generates different predictions on life insurance premiums based on the relationship between Period-1 and Period-2 capital costs. When statutory capital cost in Period 1 is lower than Period 2, one can prove that the optimal premium is strictly higher than capital cost in Period 1. Issuing these policies generate gain in capital at the beginning, and reduction in capital in later years. Equation (11) predicts that premiums will fall for these policies, when shadow cost of capital increases. Intuitively, the insurer will lower prices to sell more policies to attract more capital inflow.

If the capital cost in Period 1 is higher than that in Period 2, the optimal premium is largely bounded between these two costs. This case is analogous to products that have initial capital cost higher than the premium.[7] Issuing these policies can be seen as investments, with net capital outflow in the first year, and inflow in later years. The initial net capital outflow, cost minus premium, can be seen as the initial investment. The subsequent net capital inflow, premium minus cost, can be seen as the payoff of the investment. Equation (11) predicts that premiums will rise for these policies, when shadow cost of capital increases. Increasing the premium of the life policy raises the marginal return of capital, with lower initial investment (costs in the first year minus premium), and higher payoff (premium minus costs in the remaining years). Since demand decreases with price, the life insurers will sell fewer policies, effectively reducing the investment quantity.

2.1 Testable Predictions of the Model

The model generates the following four testable predictions. First, life insurance premiums should decrease with the losses to the affiliated P&C insurers, for policies that bring capital inflow at issuance. Second, life insurers will raise premiums for policies that cause capital outflow at issuance. Third, more financially constrained groups will change premiums more. Fourth, life insurers will increase transfers to P&C affiliates when the P&C losses are larger.

3 Data

3.1 Financial Data

Financial data on insurance companies are from the National Association of Insurance Commissioner (NAIC) (downloaded from SNL) and A.M. Best. Most of the financial variables used are available from 1995 to 2013, while those at the quarterly level and those from A.M. Best are limited to 2004 to 2013. Insurers with negative assets or net premium written smaller than $10,000 are excluded. If a firm changes ownership in year t, this firm is excluded for

[7] In this case, the optimal price multiplied by $\left(1 - \frac{1}{\epsilon^{LF}}\right)$ will be strictly higher than Period-2 capital cost, and strictly lower than Period-1 capital cost. The case where price is higher than Period-2 (thus, also Period-1) capital cost is not realistic, since practically, selling a policy usually does not bring in gain to statutory capital each period, due to competition, due to competition.

both t and $t+1$. All financial variables, other than variables related to losses and ratings, are winsorized at the 1% and 99% levels. Rating information is from A.M. Best. A.M. Best ratings reflect the financial strength of the insurers and their ability to meet the policy and contract obligations. Ratings range from A++ (superior) to D (poor).

Figure 1 shows the sample coverage. The larger circle represents the sample of 207 life insurers with life insurance prices. The smaller circle represents the sample with P&C affiliates, for which I have data on internal capital transfers from Schedule Y of the financial statements. For the 97 life insurers and 49 groups in the smaller circle, I have data on both internal transfer data and life insurance prices. The change of the sample size over time is presented in Table 1.

In Panel A of Table 2, Columns (1) through (3) report the statistics on the financial data of all the life insurers, for which I have data on policy premiums. These life insurers' assets have a mean of 9.1 billion, and a median of 0.9 billion. Their mean leverage ratio is around 78%, and median 89%. The median A.M. Best Rating is A for these insurers. Columns (4) through (6) present the statistics for the subsample of life insurers that also belong to groups, which also contain P&C divisions. Firms in this subsample are larger, have higher leverage, and better median rating than the whole sample.

Panel B of Table 2 summarizes the financial data aggregated at the group level of the P&C companies affiliated with the life insurers, whose life insurance premiums are available. The sum of total assets of P&C companies within each group has a mean of \$4.6 billion, and a median of \$0.3 billion. The leverage ratio has a mean of 56%, and a median of 61%. Panel C provides the summary statistics for individual P&C companies.

3.1.1 P&C Losses Measures

3.1.1.A Reported P&C Losses

I refer to the first measure of P&C losses as reported *P&C Losses*, when needing to distinguish it from the other measure of P&C losses described below. In most of my empirical analyses, P&C insurers are aggregated at the group level, with net underwriting gain aggregated at the group level, scaled by lagged total assets of all the P&C firms in the group. If net underwriting gain is negative, *P&C Losses* is the absolute value of net underwriting gain. If net underwriting gain is positive, the reported *P&C Losses* is set to be zero. Life insurers unaffiliated with P&C insurers, when included in regressions, are assigned *P&C Losses* equal to zero. Effectively, *P&C Losses* equals (losses incurred + loss expenses incurred + other underwriting expenses incurred + aggregate write-ins for underwriting deductions) - (premiums earned + net income of protected cells), or zero if the first bracket is smaller than the second bracket. Losses incurred is losses paid less salvage from direct business, plus losses from reinsurance assumed, minus losses from reinsurance recovered. In robustness checks, I also let *P&C Losses* equal negative of underwriting gain, scaled by lagged assets.

3.1.1.B Instrument for P&C Losses using Weather Data

To examine the effect of financial constraints on pricing in my context, an obvious way is to test for correlations between life insurance premiums and losses to P&C affiliates. However, some unobservable factors might affect both the losses to the P&C subsidiaries and life insurance premiums. For example, poor management quality across the entire group may cause unfavorable performance in the P&C divisions (e.g. by offering dangerous drivers low premiums, or incurring high expenses), and changes in life insurance premiums. To mitigate such concern, I use the IV (instrumental variable) method by predicting losses using P&C firms' exposure to weather-related events. I then analyze the relationship between the predicted losses of P&C affiliates and the subsequent life insurance premiums. Weather-related events are potentially highly correlated to P&C losses, while should not otherwise affect life insurance business relative to competitors.

The Spatial Hazard Events and Losses Database for the United States (SHELDUS) provides information on damages related to weather-related events. SHELDUS' main data source is National Centers for Environmental Information. The event types covered include hurricanes, thunderstorms, floods, wildfires, tornados, etc.[8] The database includes every natural

[8] Other event types included are avlanche, coastal, drought, earthquake, fog, hail, heat, landslide, lightning, tsunami/seiche, volcano, wind, and winter weather.

hazard event that caused death or property/farm damages since 1960 in mainland US. The data offer estimated monetary damages to properties and farms. Hurricanes account for the largest share of damages, 32%, followed by flooding, 20%. Dessaint and Matray (2016) argue that hurricanes are highly unpredictable, citing a number of studies. To the extent that weather events are out of insurers' control and hard to predict, they serve as exogenous shocks to the financial conditions of insurance groups. Admittedly, firms can choose their market share in different areas, and some regions are more prone to some weather events (e.g., the coastal states are more often struck by hurricanes than other states). However, I explore the within-firm variation in losses arising from variations in severity of the weather events, and the severity of events like hurricanes is difficult to predict.

I use weather-related damages and each firm's lagged market share at the state-quarter level to measure P&C losses due to weather events. First, I aggregate the dollar amount of weather damages to properties and farms (from SHELDUS) at the state-quarter level, naming the aggregated variable $Weather\ Damages_{s,t}$. Panel D in Table 2 reports summary statistics of this variable.

Second, I construct each P&C insurer i's lagged market share in state s, quarter t, as the i's direct premium written in state s over the four preceding quarters, divided by that of the sum of each company j operating in state s:

$$Lag\ Mkt\ Share_{i,s,t} = \frac{\sum_{q=t-4}^{t-1} Premium_{i,s,q}}{\sum_j \sum_{q=t-4}^{t-1} Premium_{j,s,q}}$$

Third, I multiply $Weather\ Damages_{s,t}$ by the $Lag\ Mkt\ Share_{i,s,t}$, to obtain an approximated share of losses due to weather events at the firm-state-quarter level. The resulting $Weather\ Damages_{s,t} \cdot Lag\ Mkt\ Share_{i,s,t}$ are then summed over all the states for each company. The summation,

$$P\&C\ Weather\ Loss_{i,t} = \sum_s \left(Weather\ Damages_{s,t} \cdot Lag\ Mkt\ Share_{i,s,t}\right),$$

approximates company i's share of all the weather damages in quarter t.

When the analysis uses group-level P&C losses, I aggregate $P\&C\ Weather\ Loss_{i,t}$ at the group level, scaled by the sum of assets at the end of the year before the previous year, to obtain $P\&C\ Weather\ Loss$ at the group-quarter level. When the analysis uses individual firm-level P&C losses, I scale $P\&C\ Weather\ Loss_{i,t}$ by the firm's lagged assets.

Data on internal capital transfers are available only on an annual basis. Therefore, for the analyses on internal capital transfers, I reconstruct the instrument by replacing the quarterly variable with their annual equivalent.

3.2 Life Insurance Price Data

Data on life insurance prices come from *CompuLife*, a company selling insurance agents a software that searches for life insurance quotes. The data contain monthly updated premiums. Life insurance premiums differ based on policyholder's gender, age, health, the length of the policy, and the face value. To compare premiums over time and across firms, I focus on several common policies that are easily comparable. In particular, I focus on two kinds of life policies with fixed premium. If the policyholder dies within the policy duration, the beneficiary obtains the death benefits. The two kinds of policies have very different short-term impact on insurers' statutory capital as discussed below.

The first type of policies I study is permanent life policies, for which the data are collected by Koijen and Yogo (2015) from *CompuLife*.[9] The policy is in effect as long as the policyholder is alive (until the age of 120) and pays the fixed premium each period. The insurer pays out death benefit to the beneficiary upon the death of the policyholder. This subsample covers products with a death benefit of $250,000, for both male and female aged between 30 and 80 (every ten years in between) in the regular health category. Each combination of these product characteristics is defined as a product type in this paper. Thus, there are 12 different product types each month. My sample contains price data for these products in each month between January 2005 and July 2011. Panel A in Table 3 describes this sample of permanent life policies. There are more than 28,000 policies in this sample. The mean of the markup is -4.0%, the median -5.8%, and the standard deviation 15.0%.

The second type of policies I use is the 10-year term life policy. I use an automation

[9] I am very grateful to Ralph Koijen and Motohiro Yogo for their generosity for making the data available.

process to extract these price data from *CompuLife* software. The policyholder pays a fixed premium each period. Beneficiaries collect the death benefit if the policyholder dies within the 10 years of policy duration. The 10-year term policies have two different sizes of death benefit, $250,000 and $500,000, for male aged 30 to 80 (every ten years in between), and three health categories (preferred plus, preferred and regular). Each combination of these product characteristics is defined as a product type in this paper, so there are 36 different product types each month. My sample contains price data for each of these product types in each month between March 1999 and December 2013, except September 2001. Panel B in Table 3 describes this sample of life policies. There are more than 361,000 policies in this sample. The mean of the markup is 35.2%, the median 20.6%, and the standard deviation 56.0%. The average standard deviation of markups within each product type-month-insurers' rating category is 10% for the permanent policies and 27% for the 10-year term policies. The substantial standard deviations of the markups offer evidence for customers' search frictions.

The 10-year term life policies have substantially higher markup than the permanent life policies. This difference is likely due to the following reason. The markups calculated in Table 3 do not take into account the underwriting expenses, which are more substantial relative to the premium for the 10-year term than permanent life policies, since the latter has higher premium than the former.[10]

4 Empirical Analysis

4.1 Life Insurance Premiums

The model predicts that for policies that immediately increase capital, insurers will lower premiums, while for policies that immediately reduce capital, insurers will raise premiums. A candidate for the capital-increasing policies is the permanent life policies. Panel A in

[10] Another reason could contribute to the difference in the markups between the two types of policies. The sample for 10-year term life policies starts in 1999, while that for permanent policies starts in 2005. In my sample, the mean markup for 10-year term policies has declined monotonically from 60.3% in 1999 to 14.6% in 2013. Thus, the sample for 10-year term life policies contains an early period with higher markups.

Table 4 provides an example showing how such a policy brings net capital gain at issuance. The example features a policy with $250,000 of death benefit, for a 40-year-old male in the regular health category. The median annual premium, $2,103, exceeds the sum of estimated expenses and actuarial value, bringing a net capital inflow of $241 in the first policy year. By lowering premiums, life insurers sell more policies, and can attract more capital inflow, as the shadow cost of capital increases.

A candidate for the capital-reducing policy is the 10-year term life policy. Panel B in Table 4 presents an example showing how such a policy causes net capital outflow at issuance. The example features a policy also with $250,000 of death benefit, for a 40-year-old male in the regular health category. In the first year, the median premium, $394, is lower than the sum of estimated expenses and actuarial value, bringing a net capital outflow of $614. By increasing premiums, insurers reduce capital outflow in the near term.

Table A2 shows how each of the 48 different products impacts life insurers' balance sheet in the first policy year. The 12 different permanent life policies, other than two exceptions, all have a positive first year impact on life insurers' capital. 26 of the 36 10-year term policies have a negative impact on statutory capital in the first policy year, using the mean premium. The 10 policies that bring a 1st-year net capital inflow are for policyholders aged 70 or 80. They are offered by a small number of companies, and constitute a small portion of my sample.

Additional evidence supports the prediction on how premiums change for these two kinds of products, when cost of capital increases. During the financial crisis, markups of the permanent life policies declined (Koijen and Yogo 2015), while premiums of the 10-year term policies increased. Practitioners attributed the increase of 10-year term policies' premiums to the rising cost of capital.[11]

Figure 2 offers an overview of the relationship between life insurance premiums and affiliated P&C losses. The figure only includes data of life insurers with P&C affiliates. Life

[11] "ReliaStar and other ING subsidiaries are raising term-life insurance rates an average of 5% this year, Mr. Britton says, 'primarily driven by our cost of capital, which is much, much more difficult to get and more expensive than it was a year ago and prior.'" Britton was the chief executive officer of ING's U.S. insurance division. "Insurers Raise the Premiums on Term Life", Wall Street Journal, June 9, 2009, http://www.wsj.com/articles/SB124450333064895949.

insurance premiums specific to product type-firm-month are matched with reported P&C losses of the same group, aggregated over the previous four quarters. I demean the life insurance premiums, by subtracting the product type-firm averages and the product type-month averages. I also demean the affiliated P&C losses, by subtracting the group averages and month averages. I then sort the demeaned life insurance premiums into quintiles, based on the demeaned affiliated P&C losses. In Figure 2, the horizontal axis presents the P&C losses quintiles, "1" stands for the smallest, and "5" the largest. The dashed line plots the average demeaned premiums of each P&C losses quintile, for the permanent policies, and the solid line for the 10-year term policies. The dashed line shows that premiums for permanent policies decrease monotonically with affiliated P&C losses. The solid line shows that premiums for 10-year term policies increase monotonically with affiliated P&C losses. The relationship between life insurance premiums and P&C losses in Figure 2 is consistent with the model predictions.

4.1.1 Premiums of Permanent Life Policies

To examine the impact of P&C losses on premiums of the permanent policies, Columns (1) and (2) of Panel A in Table 5 estimate the following specification.

$$Life\ Policy\ Premium_{p,i,m} = \beta \cdot P\&C\ Loss_{g,(q-4,q-1)} + \gamma_1 \cdot Cntrls_{i,y-2} + \gamma_2 \cdot Cntrls_{g,y-2} + FE_{p,i} + FE_{p,m} + u_{p,i,m}.$$

where p indexes the product type, i the individual life insurance company, m the month within quarter q of year y. *P&C Losses* are aggregated at the group level and over the preceding four quarters, scaled by the sum of assets at the end of year $y-2$. The dependent variable is the monthly life insurance premium in dollars. Product types are defined by a combination of two characteristics, age and gender of the policyholders. The permanent policies in my sample have the same health category and face value. The regression controls for company-product type fixed effects, $FE_{p,i}$, and month-product type fixed effects, $FE_{p,m}$. The company-product type fixed effects control for potentially different time-series average premiums across company-product type pairs. For example, company A may always set the price of a certain product type higher than the average price of that product type across firms. The month-product fixed effects control for the different cross-section average premiums over time for each product type. For example, in a certain month, the average price for a certain product type could be higher than other months. Since the variation of the *P&C Losses* is at the group-quarter level, the standard errors are corrected for clustering of observations at the group-quarter level in all regressions of life insurance prices.

Column (1) of Panel A, Table 5, only includes *P&C Losses* as the main independent variable. Column (2) includes additional controls, which Koijen and Yogo (2015) argue are likely to affect the elasticity of demand of life insurance. In both Columns (1) and (2), the coefficient on *P&C Losses* is negative and statistically significant, suggesting that premiums of permanent life insurance are negatively correlated with P&C losses.

Columns (3) and (4) provide results using the IV method. Column (3) reports the first-stage result. In the first stage, *P&C Losses* is assumed to be affected by *P&C Weather Losses*. The coefficient on the instrumental variable, *P&C Weather Losses*, is positive and statistically significant, suggesting that the weather events and P&C insurers' exposure to them affect the losses P&C insurers suffer. Column (4) reports the second-stage result. The coefficient on the instrumented P&C losses is negative and statistically significant. These results indicate that the changes in premiums are likely results of adverse shocks to the financial condition of the insurance group.[12]

The results in Panel A of Table 5 are consistent with the prediction that, for permanent life policies, premiums decrease with P&C affiliates' losses. This result supports the idea that, when the shadow cost of capital increases, premiums fall if the products immediately bring

[12] To ensure the consistency of the estimates resulting from the IV method, the instrument needs to be "strongly" correlated with the endogenous variable, the reported P&C losses. Most of the statistics designed to test the strength of the instrument depend on assumption that the error terms are i.i.d.. Since life policies within the same group share the same group-quarter-level P&C losses, the error terms cannot be assumed to be i.i.d.. To address this issue, I take the average of life policy premiums for one type of policies, and the averages of other financial control variables, all at the group-quarter level, and redo the regression at the group-quarter level in Table A3 in the Appendix. The type of policy used is the permanent life policy for a 40-year-old male, in regular health category, with $250K of death benefits. The t-statistics in the first stage of the coefficient on *P&C Weather Losses* is more than 13, and the Cragg-Donald Wald F-statistic is more than 172, much higher than the Stock-Yogo 10% threshold of 16, suggesting that the instrument is sufficiently strong. Since within a group, prices of a certain product is not always available in my data, taking the group/quarter average prices might introduce a lot of noise that prevents the second stage to show statistically significant results.

capital inflow. Again, the fall in premiums help attract more capital from new policyholders. According to Column (1), one standard deviation increase in *P&C Losses*, 3% of lagged assets or \$36 million (based on median assets), is associated with an average price decrease by \$50. This is 1.3% of the median price of \$3,712, or 0.8% of the mean price of \$6,129. The magnitude of the effect of *P&C Losses* on life insurance premiums is similar with the IV method.

Panel B of Table 5 presents robustness checks, reporting second-stage results with the IV method. Column (1) uses the natural log of premiums as the dependent variable. Koijen and Yogo (2015) document that markups for these policies decreased drastically during the financial crisis. One may be concerned that the patterns documented here are driven by insurance groups that suffered P&C losses during the financial crisis, when external financial frictions were severe. To address this concer, Column (2) excludes all months from July 2008 to December 2009. Column (3) only includes policies for new customers between 20 and 50 years old, who are more likely to buy life insurance policies than older people. Column (4) uses only one type of policies, those for a 40-year-old male, in the regular health category, with death benefits of \$250K. Column (5) only includes life insurers with P&C affiliates. The reported P&C losses in Column (5) are simply negative of underwriting income scaled by lagged assets, instead of being set as zero when underwriting income is positive. In untabulated first-stage results, the coefficients on *P&C Weather Losses* are all positive and statistically significant. In the second stage, as shown in Panel B, the coefficients on *P&C Losses* are negative and statistically significant in each column, meaning the premiums decrease with P&C losses.

One potential alternative explanation is that when life insurers transfer capital to P&C affiliates that suffer losses, the financial strength of the life insurers weakens. Since potential policyholders prefer financially stronger life insurers, prices of the permanent policies decline. Table A4 tests whether the ratings of life insurers become worse following losses to the P&C affiliates, with different measures of rating and different specifications. The results suggest that life insurers' ratings do not suffer following P&C losses.

4.1.2 Premiums of 10-Year Term Policies

The model predicts that, for policies that reduce capital in the short term, the premiums of life insurance will increase with P&C losses. When P&C losses are larger, the shadow cost of capital is higher. Life insurers raise premiums of the capital-reducing products to increase the return on capital, by lowering the initial investment (initial costs minus price), and increasing the payoff later (price minus costs in the remaining years). To test this prediction, I re-estimate the specification in Table 5 with the sample of 10-year term policies, and present the results in Table 6.

In Panel A of Table 6, Columns (1) and (2) use the reported $P\&C\ Losses$ as the main independent variable. The coefficients on $P\&C\ Losses$ are positive and significant in both columns. These results suggest that insurers charger higher premiums for 10-year term policies, if P&C affiliates' losses in the preceding four quarters are larger. Columns (3) and (4) in Table 6 report results using the IV method. Column (3) reports the first-stage result. The coefficient on the instrumental variable, $P\&C\ Weather\ Losses$, is positive and statistically significant. Columns (4) and (5) present the second-stage results. The coefficient on the instrumented $P\&C\ Losses$ is positive and statistically significant. This result suggests that the price changes documented for these policies are likely results of adverse shocks to the insurance group's financial condition.

The results are consistent with the prediction that, premiums increase with P&C losses, for the capital-reducing policies. Column (1) indicates that a one standard deviation of $P\&C\ Losses$, 3% of lagged assets or \$36 million (based on median assets), is associated with an average price increase of \$20. This is a 2.5% increase over the median price, \$798, and 1% increase over the mean price, \$2,483. In Column (2), with additional controls, the magnitude of price changes triples. In Column (4) with the IV method, the marginal effect of $P\&C\ Losses$ on premiums becomes six times as large as in Column (1).

Panel B of Table 6 presents robustness checks, using 10-year term policies, repeating Panel B of Table 5. In untabulated first-stage results, the coefficients on $P\&C\ Weather\ Losses$ are all positive and statistically significant. In the second stage, as shown in Panel B, the coefficients on *P&C Losses* are positive in all columns, and statistically significant in all columns other than Column (4).

One concern is that when P&C losses are large after weather-related events in certain regions, the demand for life insurance may increase in these regions. If life insurers operate in the same regions as their P&C affiliates, life insurers increase premiums of 10-year policies potentially as a response to increased demand. However, Section 4.1.1 suggests that premiums of permanent life policies decrease with P&C losses. Thus, it is unlikely that life insurers increase premiums of 10-year policies due to demand increase.

4.1.3 Change in 10-Year Term Life Premiums and Financial Constraints

The model predicts that, with the same P&C losses, more financially constrained groups will experience a larger increase in the shadow cost of capital than less constrained groups. Therefore, P&C losses should have a larger impact on life insurance premiums for more constrained than less constrained groups. I test this prediction in Table 7 using 10-year term life policies, because the number of life insurers affiliated with P&C insurers is 97 for the 10-year term policy sample, and only 35 for the permanent life policy sample.

I estimate the equation below in Table 7,

$$\begin{aligned} Life\ Policy\ Premium_{p,i,m} =& \beta_1 \cdot P\&C\ Loss_{g,(q-4,q-1)} \cdot Constrained + \beta_2 \cdot P\&C\ Loss_{g,(q-4,q-1)} \\ &+ \gamma_1 \cdot Cntrls_{i,y-2} + \gamma_2 \cdot Cntrls_{g,y-2} + FE_{p,i} + FE_{p,m} + u_{p,i,m}. \end{aligned}$$

I use three different proxies for the group's prior level financial constraints. The first one is group-level leverage lagged by two years. In Columns (1)-(2), *Constrained* equals one if the group's leverage two years prior exceeds or equals the median in that year, zero otherwise. In Columns (3)-(4), *Constrained* equals one if the group's underwriting income in year $y-2$ scaled by assets in year $y-2$ is lower than the median in that year, zero otherwise. If a group had a recent experience of low income, it should be more affected by another negative shock due to P&C losses. In Columns (5)-(6), *Constrained* equals one if, in year y, the life insurer belongs to a group whose holding company or any subsidiary was never publicly traded, zero otherwise. If a group is public, presumably it can more easily raise capital to mitigate a negative shock.[13]

In Columns (1)-(2), the coefficients on the interaction term, $P\&C\ Losses \cdot Constrained$, is positive and statistically significant, indicating statistically significant difference between groups with higher leverage and an average group. Column (1) uses the reported *P&C Losses*, and Column (2) presents the second-stage results of the IV method. In Column (1), the impact of the *P&C Losses* on the life insurance premiums for the more constrained groups is 3.4 times larger than for an average group, and in Column (2), 8.5 times larger. Based on Column (1), for more constrained groups, a one standard deviation of *P&C Losses* is associated with an average price increase of $65. This is 8.1% of the median price, $798, and 2.6% of the mean price, $2,483. The coefficients on $P\&C\ Losses \cdot Constrained$ are positive in all columns but (4), and statistically significant in all columns but (4) and (5).

In summary, Table 7 suggests life insurance prices respond more strongly to P&C losses in the more constrained groups than in the less constrained. This result supports that the life insurance price changes associated with P&C losses are due to tightening financial constraints.

4.2 Transfers from Life Insurers to P&C Affiliates

The model predicts that, under financial constraints, when shadow value of capital for P&C insurers increases due to losses, capital will flow from life to P&C insurers. Each insurer is required to report net transfer in certain forms from the parent and affiliates in Schedule Y of its statutory filing. The transfer variables in Schedule Y include seven different items, e.g., capital contributions received, which refers to reallocation of assets from one entity to another.[14] A negative number means net outflow to the parent and affiliates. The data do not offer detailed transfers between two specific entities, but provide the net amount an

[13]In untabulated results, I also use the group-level risk-based capital ratio as a proxy for financial constraints. The ratio equals to the sum of total adjusted capital, divided by the sum of authorized control level capital, both summing over all the P&C and life insurers in the group. Constrained equals one if this ratio is lower than the median in that year, zero otherwise. The coefficient on the interaction term between Constrained and *P&C Losses* is not statistically significant.

[14]The other six items are: shareholder dividends received through ownership by the parent or affiliates (to owners of the company's equity within the group), income incurred in connection with guarantees or undertakings for the benefit of any affiliates, amount received for management agreements and service contracts, any other material activity not in the ordinary course of the insurer's business, income incurred under reinsurance agreements, payable under reinsurance agreements.

insurer receives from the rest of the group. Thus, it is not possible to identify direct transfers from life to P&C divisions. In addition, transfers between life and P&C divisions can also be indirect. Life insurers may first transfer capital to the headquarters or another non-insurance subsidiary, which then passes transfers to P&C divisions. To study the transfer from life to P&C divisions, I examine the net transfer made by life insurers to the rest of the group, and the net transfer received by P&C insurers from the rest of the group. I take the negative of the net inflow reported in Schedule Y to obtain the net outflow of the life insurers.

To examine how P&C losses affect internal capital transfers, it is natural to examine the net total transfer. But some components of the transfer might be automatically correlated with P&C losses. For example, when P&C losses are larger, P&C insurer may get more inter-division services from life affiliates to help process claims. P&C insurer may also receive larger reinsurance reimbursement according to inter-division reinsurance agreements. Thus, components related to inter-subsidiary service and reinsurance may be mechanically related to P&C losses. Capital contributions and shareholder dividends are less likely to be automatically correlated with P&C losses, and are also most frequently reported among all the components of transfers. However, if a life insurer pays dividends to transfer capital to the rest of the group, dividends will also flow out to shareholders outside of the group, if the life insurer is not a wholly owned subsidiary. Since insurers did not report detailed stock ownership information until 2010, I cannot identify the wholly owned life insurers for most of the sample period. Therefore, in my analysis below, I focus on capital contribution as a way for life insurers to transfer capital to the rest of the group, while also confirm the results with total transfer.

4.2.1 Transfers from Life Insurers to the Rest of the Group

4.2.1.A Transfers from Life Insurers

In this section, I test whether transfers made by life insurers increase as P&C affiliates suffer larger losses. I estimate the following equation.

$$Net\ Trnsfr\ frm\ Life_{i,t} = \beta \cdot P\&C\ Loss_{g,t-1} + \gamma_1 \cdot Cntrls_{i,t-2} + \gamma_2 \cdot Cntrls_{g,t-2} + FE_i + FE_t + u_{i,t}.$$

where i indexes the individual life insurer, g group, and t year.[15]

In Panel A of Table 8, Columns (1) and (2) present results using reported *P&C Losses*. The dependent variable is net capital contribution in Column (1), and net total transfers in Column (2), both scaled by statutory capital from year $t-2$. The relationship between P&C losses and transfers from life insurers to the rest of the group is positive and statistically significant in both columns. The results suggest that net capital contribution and net total transfer from life divisions both increase when the P&C divisions suffer larger losses.

Columns (3) through (5) present results using the IV method. Column (3) presents the first-stage result, corresponding to Column (4). Columns (4) and (5) present the second-stage results. The dependent variable is net capital contribution in Column (4), and net total transfer in Column (5). In the first stage, weather-related P&C losses are again statistically significantly and positively related to the reported losses. The coefficient on *P&C Losses* in the second stage is positive and statistically significant in both Columns (4) and (5), suggesting that life insurers make more transfers to the rest of the group, following larger weather-related P&C losses.

Based on Column (2), one standard deviation of *P&C Losses*, 3% of lagged assets, is

[15] For four reasons, I test the relation between transfers in t and P&C losses in t-1, instead of losses in t. First, this helps avoid some of the concerns that transfers received by P&C divisions affect their strategy and thus, losses. Second, adjustment needs to be made to enlarge the capital stock after a negative shock, if the group is financially constrained. Such adjustments, e.g., raising statutory capital by changing prices charged by other subsidiaries, can take time. Third, regulatory barriers prevent internal transfers from being made quickly. For example, many states require that transfers within 12 months do not exceed a percentage of assets or statutory capital. Fourth, P&C losses will not have an immediate impact on insurers' ratings following losses, as long as the rating agency expects transfers from the rest of the group. ("The implicit or explicit support of a parent or affiliate can affect an insurer's financial strength and therefore its Best's Credit Rating." (A.M. Best, 2009).)

associated with an increase of seven percentage points in the net total transfer (as a percentage of lagged statutory capital) by the life insurers. This magnitude is significant, given the mean is 9%, median 5% and standard deviation 27%. Using the median size of the sample firms, $36 million increase in P&C losses is associated with $4 million increase in net total transfers from a median-sized life insurer to the rest of its group. With the IV method, the marginal effect of P&C losses on total transfers becomes eight times as large.

Panel A of Table 8 suggests that life divisions transfer more to the rest of the group, after larger losses incurred to P&C divisions. This result is consistent with the idea that P&C losses affect life insurance premiums, through tightening financial constraints for the life insurers.

4.2.1.B Transfers from Life Insurers and Financial Constraints

If the life insurer makes transfers to the rest of the group to relieve financial constraints exacerbated by losses in the P&C divisions, transfers should be more responsive to P&C losses if the group is more constrained, controlling for the level of financial constraints of the life insurer. Panel B of Table 8 tests this prediction using the following specification.

$$
\begin{aligned}
Net\ Trnsfr\ frm\ Life_{i,t} = & \beta_1 \cdot P\&C\ Loss_{g,t-1} + P\&C\ Loss_{g,t-1} \cdot (\beta_2 \cdot Grp\ Lev_{g,t-2} + \\
& \beta_3 \cdot Grp\ At_{g,t-2} + \beta_4 \cdot Life\ Income_{i,t-2} + \beta_5 \cdot Life\ Lev_{i,t-2} + \\
& \beta_6 \cdot Life\ At_{i,t-2}) + \gamma_1 Cntrls_{i,t-2} + \gamma_2 Cntrls_{g,t-2} + FE_i + FE_t + u_{i,t}
\end{aligned}
$$

where *Grp* and g denotes for the group, and *Life* and i the individual life division. I use leverage and assets to proxy for financial constraints, both at the group and individual life division levels. The group or firm is likely more constrained if leverage is higher and assets are smaller. I include interaction terms between *P&C Losses* and the proxies for financial constraints. I also include an interaction term between *P&C Losses* and life insurers' income, since the performance of the life insurer likely affects how it responds to P&C affiliates' losses.

Panel B of Table 8 presents the results, using the reported *P&C Losses*. The dependent variable is net capital contribution received in Column (1), and net total transfer received in Column (2), both scaled by statutory capital in year $t-2$. β_2 is statistically significant and positive in both columns, while none of β_3 through β_6 is statistically significant in either column. β_2 being positive and statistically significant means that life divisions' transfer to the rest of the group responds more to P&C losses when the group is more constrained, controlling for the financial constraints of the individual life insurer. This result suggests that life insurers use transfers to relax the financial constraints in response to P&C losses. This result is also consistent with Table 7, which suggests life insurers change premiums more drastically in response to P&C losses if the group is more financially constrained.

4.2.2 Transfers Received by P&C Insurers

Table 8 implies life insurers transfer more to the rest of the group following larger P&C losses. Data do not allow us to directly tell where within the group, the increased transfers end up. This section presents results suggesting that P&C insurers receive more transfers from the rest of the group following larger losses, to further support the idea that it is P&C losses that trigger the increase in capital transfers out of the life insurers.

Table 9 presents the results of the following estimation.

$$Net\,Trnsfr\ to\ P\&C_{i,t} = \beta_1 \cdot P\&C\ Loss_{i,t-1} + \gamma_1 \cdot Cntrls_{i,t-2} + \gamma_2 \cdot Cntrls_{g,t-2} + FE_i + FE_t + u_{i,t},$$

where i indexes the individual P&C insurer, and g the group.

Columns (1) and (2) in Table 8 use the reported P&C losses as the main independent variable. The dependent variable is the net capital contribution received by the P&C insurers in Column (1), and the net total transfer received in Column (2), both scaled by statutory capital in $t-2$. The coefficients on the reported *P&C Losses* are positive and statistically significant, suggesting that both net capital contributions and total transfers received by P&C divisions increase with P&C losses.

Columns (3) through (5) present results using the IV method. Column (3) presents the first-stage result, corresponding to Column (4). Columns (4) and (5) present the second-stage results. The dependent variable is net capital contribution in Column (4), and net total transfer in Column (5). In the first stage, the reported P&C losses are again positively and statistically significantly correlated with weather-related P&C losses, at the individual P&C division level. Columns (4) and (5) present results of the second stage. In both columns, the coefficients on the instrumented *P&C Losses* are positive and statistically significant, indicating that net transfers received by P&C divisions increase with the P&C losses related to natural hazard events.

Based on Column (2), one standard deviation increase (7.6% of assets) in *P&C Losses* is associated with a 7.8 percentage points increase in the net total transfer (in percentage of lagged statutory capital). This magnitude is substantial, considering that the median net transfer is -4%, mean -37%. Using the median size of the P&C insurers, one standard deviation increase in *P&C Losses*, \$1.9 million, is associated with an increase of \$0.9 million in net total transfers received from the rest of the group. With the IV method, this magnitude becomes half the size.

To summarize the findings on internal capital transfers, following larger P&C losses, life insurers make larger net transfer to the rest of the group (Panel A of Table 8); life insurers' transfers respond more strongly to P&C losses if the group is more financially constrained (Panel B of Table 8); and P&C insurers receive more net transfer with larger losses (Table 9). These results suggest that capital flows from the life insurers to the P&C divisions that suffered losses, to relax the financial constraints of the latter.

5 Conclusion

When financially constrained firms suffer from adverse cash flow shocks, the tightening financial constraints will distort firms' behavior. However, it is hard to study how financial constraints affect firms' behavior, since it is difficult to observe the decisions firms would have made had they not been constrained.

This study uses the life insurance industry to examine how financial constraints affect firms' behavior, namely the pricing decision. My study setting finesses the difficulty mentioned above. Exogenous shocks affect life insurers' financial constraints when their affiliated P&C

insurers suffer from losses. These P&C losses can be due to weather-related events like hurricanes. Such exogenous shocks to the life insurer can increase its shadow cost of capital, but do not change the economics of their business. In addition, certain life policies are highly comparable. Therefore, intertemporal and cross-sectional comparisons enable me to identify the effect of financial constraints on life insurers' pricing behavior.

I first present a model of life insurance pricing in the presence of financial constraints, featuring a group consisting of one life and one P&C insurer. The life insurer decides on its capital transfer to the P&C affiliate and the life insurance price, to maximize the value of the group. Demand for insurance is a function of both price and the insurers' capital. Each insurer faces the constraint that the capital has to meet minimum requirements.

The four main empirical findings are consistent with the predictions of the model. First, for permanent life policies, which increase insurers' capital at issuance, premiums decline with affiliated P&C losses. By lowering premiums, life insurers sell more policies, and are able to attract more capital inflow, as the shadow cost of capital increases.

Second, for 10-year term life policies, which reduce insurers' capital at issuance, premiums rise with affiliated P&C losses. By increasing premiums, life insurers are effectively increasing the marginal return on capital, by lowering the initial investment (initial costs minus premium) and increasing the payoff later (premium minus costs in the remaining years). Third, this effect is stronger for insurance groups that are more financially constrained.

Fourth, following larger P&C losses, affiliated life insurers increase the transfers to the rest of the group, and P&C insurers receive more transfers. These findings suggest the transmission of adverse shocks from P&C to life divisions within the same group.

The four findings above are robust to the IV method, where P&C losses are instrumented by losses due to weather events. The exogenous variation in the severity of such events offers a natural experiment, where the financial strength of the insurance groups suffers exogenous adverse shocks, while such shocks should not otherwise affect the life insurance business.

The results are consistent with the idea that financial constraints can distort firms' behavior. When financial constraints tighten and shadow cost of capital increases, firms will change behavior to increase capital in the short term by forgoing long-term profits. The results on how financial constraints affect pricing behavior should be generalizable to other industries: when selling products realizes immediate increase in liquidity, premiums will fall; when selling products involves initial reduction in liquidity, premiums will rise.

Other implications of this paper can also be generalized across industries. First, when adverse financial shocks affect some divisions, the unaffected divisions change their real activities, to help mitigate financial constraints in the affected divisions. Second, this paper can help reconcile different findings in the literature on how firms' financial conditions affect pricing. The way in which different products affect capital in the short term is a potential avenue to reconcile different findings in the literature. Third, when financial constraints tighten, firms not only reduce total investment, but also raise returns on the remaining investments. Fourth, when firms are badly in need of capital, but face financing frictions, they may sell financing instruments at a discount.

This study also has implications on our understanding of the insurance industry. Statutory capital is important for insurers, likely due to both regulatory requirements and consumers' preference for better capitalized insurers. The results imply that, on average, insurance groups are constrained relatively to their desired level of capitalization. In addition, despite regulations trying to limit the transfers from one subsidiary to the other, this paper shows evidence that substantial contagion of adverse cash flow shocks exists within insurance groups.

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Figure 1: Sample Sizes

This figure depicts the coverage of the internal capital transfer data from Schedule Y filings and life insurance price data. The larger circle represents the sample with life insurance premiums. The smaller circle represents the sample with P&C affiliates, for which I have data from Schedule Y filings on internal capital transfers.

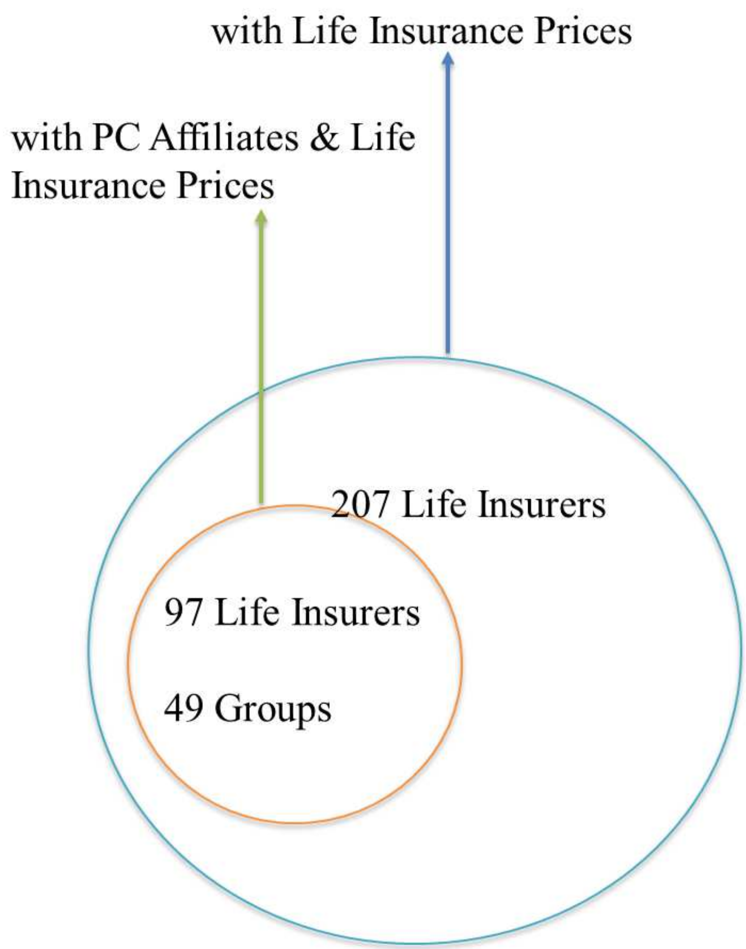

Figure 2: Life Insurance Premiums and Affiliated P&C Losses

This figure offers an overview of the relationship between life insurance premiums and affiliated P&C losses. I first subtract the product type-firm averages from the life insurance premiums. Then I subtract the product type-month averages of these demeaned prices from these demeaned prices. Each price quote for a certain product type, life insurer and month has a corresponding affiliated P&C losses measure. I use a similar procedure with the group-level P&C losses. First, I subtract the group-level averages from the affiliated P&C losses. I then subtract the monthly averages of these demeaned P&C losses from these demeaned P&C losses. I then sort the twice-demeaned life insurance premiums into quintiles, based on the twice-demeaned affiliated P&C losses. The horizontal axis presents the P&C losses quintiles, "1" stands for the smallest, and "5" the largest. The dashed line plots the average demeaned premiums of each P&C losses quintile, for the permanent life policies (corresponding to the horizontal axis on the left-hand-side), and the solid for the 10-year life term policies (corresponding to the horizontal axis on the right-hand-side).

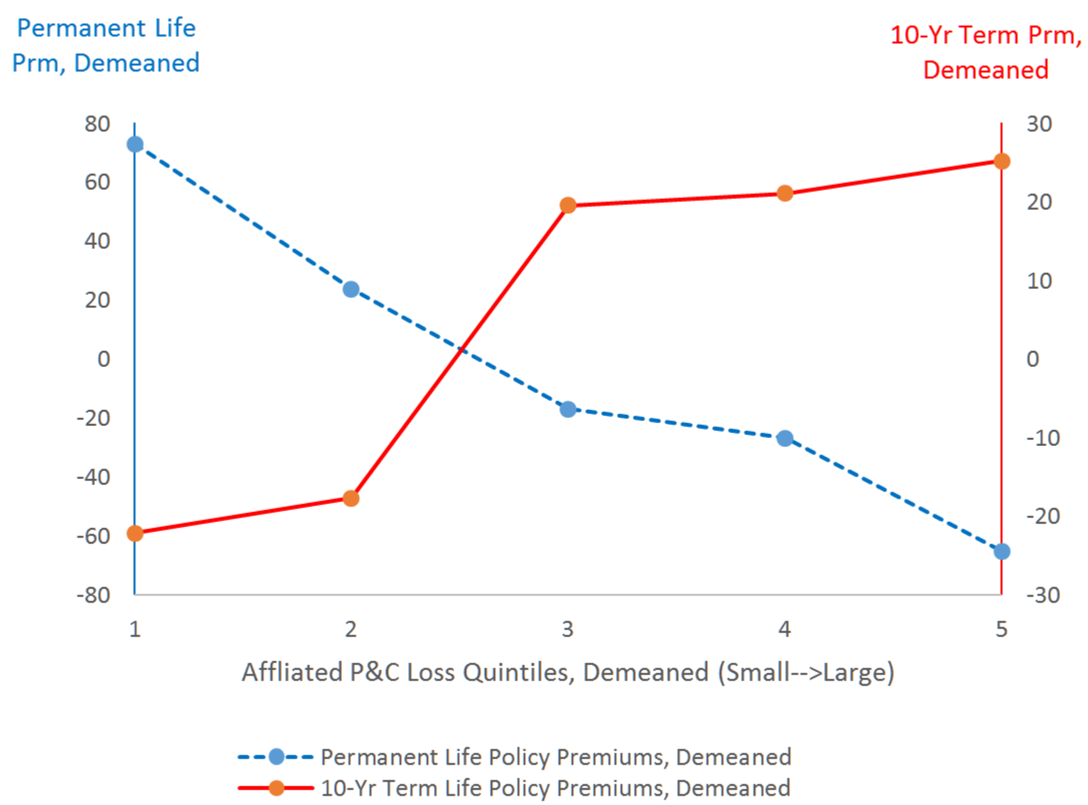

Table 1: Number of Insurance Companies

This table presents the number of insurers and groups in the sample. Column (1) shows number of life insurers included. To be included in the sample, life insurers need to have pricing information available for at least two months.

	(1)	(2)	(3)	(4)
	Life Insurers	Groups with Life & P&C	Life Firms w/in Groups(2)	P&C Firms w/in Groups(2)
1996˜1998	Transfer Data Available, Pricing Data Unavailable			
1999	109	27	36	355
2000	114	31	45	328
2001	116	28	48	289
2002	93	23	36	245
2003	98	23	40	233
2004	112	25	46	230
2005	100	22	41	228
2006	99	21	38	234
2007	100	21	38	232
2008	100	23	41	228
2009	90	16	27	231
2010	82	13	24	229
2011	89	17	29	211
2012	76	15	25	212
2013	71	16	23	185
Total	207	49	97	482

Table 2: Summary Statistics of Financial Data of Insurance Companies

Table 2 presents summary statistics of the financial data of the insurers. For variable definitions, see Table A1 in Appendix A. Panel A is on life insurers. Columns (1) to (3) in Panel A report the summary statistics on the financial data of the life insurers affiliated with P&C insurers, for which I have data on Schedule Y transfers. Columns (4) to (6) in Panel A report the statistics on the financial data of the life insurers, for which I have data on their life insurance premiums. Panel B presents statistics on P&C insurers aggregated at the group level. Assets are the sum of assets of P&C insurers within each group. Leverage is the ratio between total liabilities and total assets, both of which are summed over all P&C insurers within each group. Panel C presents statistics on individual P&C insurers. Panel D reports summary statistics of $Weather\ Damages_{s,t}$.

Panel A: Life Insurers

	Whole Sample: Life Insurers w/ Price			Subsample: Life Insurers w/ P&C Affiliates		
	(1)	(2)	(3)	(4)	(5)	(6)
	Mean	Median	Std Dev	Mean	Median	Std Dev
Assets (Billion)	9.1	0.9	20.8	12.6	2.0	22.8
Leverage (%)	78.0	88.8	25.0	81.5	90.2	20.2
Rating		A			A+	
Net Total Transfer Paid out (% of statutory surplus)	9.4	5.4	27.4	9.9	6.0	26.8
Net Capital Contribution Paid out (% of statutory surplus)	-2.0	0.0	12.3	-2.1	0.0	12.9

Panel B: P&C Insurers Aggregated at the Group Level

	Mean	Median	Std Dev
Assets (Billion)	8.6	1.2	16.2
Leverage (%)	56.0	60.8	22.0
Rating		A-	
Reported P&C Losses (% of Lag Assets), Quarterly	1.3	0.0	2.6

Panel C: Individual P&C Insurers

	Mean	Median	Std Dev
Assets (Billion)	0.4	0.03	2.3
Leverage (%)	53.0	58.5	23.3
Rating		B++	
Reported P&C Losses (% of Lag Assets), Annually	2.9	0.6	7.6
Net Total Transfer Received (% of surplus)	-37.2	-3.5	490.6
Net Capital Contribution Received (% of surplus)	6.8	0.0	141.1

Panel D: Weather Damages

	Mean	Median	Std Dev	33th Pctl	67th Pctl
Weather Damages (State, Quarter) ($000)	104,737	2,704	1,305,440	682	8376

Table 3: Life Policies Markups

This table describes markups of life policies. Markup is defined as the difference between present value of the payments and that of the actuarial value, as a percentage of latter. The present value of premium payments are calculated as $\left(1 + \sum_{m=1}^{N-n-1} \frac{\prod_{l=0}^{m-1} \sigma_{n+l}}{R_t(m)^m}\right) \cdot P$, where P is the premium, $R_t(m)$ is the zero-coupon Treasury yield at maturity m at time t, and σ_n is the probability of survival in one year at age n based on mortality tables published by the American Society of Actuaries. These mortality tables are based on life insurers' experience. They come in three health categories for nonsmoker male: preferred select, preferred, and residual standard. Following the literature, I define the actuarial value of per dollar of death benefit of a life policy for someone at age n as $\left(1 + \sum_{m=1}^{N-n-1} \frac{\prod_{l=0}^{m-1} \sigma_{n+l}}{R_t(m)^m}\right)^{-1} \cdot \left(\sum_{m=1}^{N-n} \frac{(1-\sigma_{n+m-1}) \prod_{l=0}^{m-2} \sigma_{n+l}}{R_t(m)^m}\right)$. This actuarial value is set to be a constant annual value over the policy duration, which is analogous to the constant annual payment of premium. The standard deviation reported is the average of the standard deviations within each year.

Panel A: Permanent Life Policy

Sample Period	Affiliation w/ P&C	# of Pice Quotes	Mean(%)	Median(%)	Std Dev(%)
Mar. 1993 - Jul. 2011	All	28,180	-4.0	-5.8	15.0
	Unaffiliated w/ P&C	13,972	-3.7	-5.5	15.4
	Affiliated w/ P&C	14,208	-4.3	-6.1	14.6

Panel B: 10-Year Term Life Policy

Sample Period	Affiliation w/ P&C	# of Pice Quotes	Mean(%)	Median(%)	Std Dev(%)
Mar. 1993 - Dec. 2013	All	361,858	35.2	20.6	56.0
	Unaffiliated w/ P&C	221,667	36.3	22.1	56.9
	Affiliated w/ P&C	140,191	33.4	18.4	54.5

Table 4: How Policies Change Capital Over Time -- Numerical Example

This table presents numeric examples for how statutory capital is affected by selling life policies. Panel A describes a permanent life policy, and Panel B a 10-year term life policy. Both policies are for a 40-year old male in regular health category, seeking $250,000 death benefit. Reserve is calculated according to the Standard Valuation Law. Commissions are assumed to be 50% of the premium.[16] Assumptions on other expenses are based on Tables 8 and 9 in Segel (2002).[17] Mortality tables used are 2001 Commissioner's Standard Ordinary (CSO) tables.

Panel A: Permanent Life Policy

	Capital Gain	Capital Outflow				
			Underwriting Expenses			
Year	Premium	Reserve	Commission	Other Expenses	Actuarial Value	Net Change in Capital
1	2103	0.0	1051.5	603.5	207.5	240.5
2	2103	0.0	0.0	43.6	262.5	1797.0
3	2103	2893.7	0.0	43.6	310.0	-1144.2
4	2103	5871.2	0.0	43.6	355.0	-4166.7
5	2103	8932.1	0.0	43.6	412.5	-7285.2
6	2103	12073.9	0.0	43.6	487.5	-10501.9
7	2103	15294.1	0.0	43.6	570.0	-13804.6
8	2103	18599.9	0.0	43.6	645.0	-17185.4
9	2103	21991.8	0.0	43.6	712.5	-20644.9
10	2103	25497.8	0.0	43.6	785.0	-24223.4
...	...	...	...	...	...	...

[16]"Insurance Fees, Revealed", Wall Street Journal, March 30, 2012: http://www.wsj.com/articles/SB10001424052702304177104577305930202770336

[17]I take the average between the estimates of branch and non-branch firms in Segel (2002). The permanent life policies are similar to whole life policies, for which the maintenance costs (in this table, other expenses after first year) are assumed to be higher, because of many potential customer actions w.r.t. the savings component of the whole life policies Segel (2002). However, the permanent life policies studied here do not have such savings component. Thus, I apply the estimates for term life policies from Segel (2002) to the permanent life policies. However, the using the estimates for whole life policies in Segel (2002) will not change the implications of this table.

Panel B: 10-Year Term Life Policy

	Capital Gain	Capital Outflow				
			Underwriting Expenses			
Year	Premium	Reserve	Commission	Other Expenses	Actuarial Value	Net Change in Capital
1	394	0.0	197.0	603.5	207.5	-614.0
2	394	0.0	0.0	43.6	262.5	87.9
3	394	182.8	0.0	43.6	310.0	-142.4
4	394	328.4	0.0	43.6	355.0	-333.0
5	394	427.6	0.0	43.6	412.5	-489.7
6	394	478.5	0.0	43.6	487.5	-615.6
7	394	469.1	0.0	43.6	570.0	-688.7
8	394	391.7	0.0	43.6	645.0	-686.3
9	394	238.1	0.0	43.6	712.5	-600.2
10	394	0.0	0.0	43.6	785.0	-434.6

Table 5: Permanent Life Insurance Premiums Decreases with P&C Losses

This table presents results on the relationship between permanent life insurance premiums and P&C losses. The dependent variable is monthly life insurance premiums by company and product. All independent control variables on life insurers' financials are from year $t-2$. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. For variable definitions, see Table A1 in Appendix A. Standard errors are corrected for clustering of observations at the group-quarter level.

Panel A

In Panel A, t-statistics are reported in parentheses in Columns (1) through (3), and z-statistics are reported in parentheses in Column (4).
$Life\ Policy\ Premium_{p,i,m} = \beta{\cdot}P\&C\ Loss_{g,(q-4,q-1)} + \gamma_1 \cdot Cntrls_{i,y-2} + \gamma_2{\cdot}Cntrls_{g,y-2} + FE_{p,i} + FE_{p,m} + u_{p,i,m}$, where p indexes the product type, i the individual life insurance company, m the month within quarter q of year y.

	OLS		IV	
Dependent Vairable:	Premium		P&C Losses	Premium
	(1)	(2)	(3)	(4)
1st Stage:P&C Weather Loss(q-4 to q-1)			0.58***	
			(6.75)	
P&C Loss(q-4 to q-1)	-16.76***	-18.22***		-19.42**
	(-3.45)	(-3.61)		(-2.08)
Log(Life Assets)		98.33*	-0.83	-54.61
		(1.71)	(-1.41)	(-0.71)
Life Rating A++,A+		15.96	0.08	-21.56
		(0.44)	(0.19)	(-0.35)
Life Asset Grth		-0.04	0.02***	-1.81**
		(-0.11)	(2.87)	(-2.11)
Operating Return on Equity		1.11***	-0.00	5.60***
		(3.62)	(-0.40)	(6.44)
Leverage		8.95***	-0.08	4.64
		(4.31)	(-1.24)	(0.64)
Capital Adequacy Ratio		-0.49**	-0.01**	0.91
		(-2.00)	(-2.09)	(1.46)
Current Liquidity		0.72***	0.00	-4.29***
		(3.12)	(0.17)	(-3.60)
Company-Product FE	Yes	Yes	Yes	Yes
Month-Product FE	Yes	Yes	Yes	Yes
N	28180	27676	13896	13896

Panel B

Panel B presents robustness checks, reporting second-stage results with the IV method. The first-stage coefficients on *P&C Weather Losses* are all positive and statistically significant. Column (1) uses the natural log of premiums as the dependent variable. Column (2) excludes months from Jul. 2008 to Dec. 2009. Column (3) only includes policies for those between 20 and 50 years old. Column (4) uses only one type of policies, those for a 40-year-old male, in the regular health category, with death benefits of $250K. Column (5) only includes life insurers with P&C affiliates, and the reported *P&C Losses* are the negative of the underwriting income, aggregated at the group level, scaled by lagged assets. Additional controls include all controls in Panel A. For variable definitions, see Table A1 in Appendix A. Z-statistics are reported in parentheses. Standard errors are corrected for clustering of observations at the group/quarter level.

Dependent Variable:	Log(Premium)	Premium			
		Exclude Crisis	Age 30,40,50	Age 40, Regular Health, 250K	Affiliated with P&C
	(1)	(2)	(3)	(4)	(5)
P&C Loss(q-4 to q-1)	-0.003**	-25.29**	-7.93**	-10.22**	-23.78**
	(-2.27)	(-2.27)	(-2.36)	(-2.44)	(-2.00)
Additional Controls	Yes	Yes	Yes	Yes	Yes
Company-Product FE	Yes	Yes	Yes	Yes	Yes
Month-Product FE	Yes	Yes	Yes	Yes	Yes
N	13896	11414	7076	1178	12854

Table 6: 10-Year Term Life Insurance Premiums Increases with P&C Losses

This table presents results on the relationship between 10-year term life insurance premiums and P&C losses. The dependent variable is monthly life insurance premiums by company and product. All independent control variables on life insurers' financials are from year $t-2$. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. For variable definitions, see Table A1 in Appendix A. Standard errors are corrected for clustering of observations at the group/quarter level.

Panel A

In Panel A, t-statistics are reported in parentheses in Columns (1) through (3), and z-statistics are reported in parentheses in Column (4).
$Life\ Policy\ Premium_{p,i,m} = \beta{\cdot}P\&C\ Loss_{g,(q-4,q-1)} + \gamma_1 \cdot Cntrls_{i,y-2} + \gamma_2{\cdot}Cntrls_{g,y-2} + FE_{p,i} + FE_{p,m} + u_{p,i,m}$, where p indexes the product type, i the individual life insurance company, m the month within quarter q of year y.

	OLS		IV	
Dependent Vairable:	Premium		P&C Losses	Premium
	(1)	(2)	(3)	(4)
1st Stage:P&C Weather Loss(q-4 to q-1)			0.20***	
			(2.87)	
P&C Loss(q-4 to q-1)	6.55***	19.02***		39.83***
	(2.61)	(5.22)		(2.65)
Log(Life Assets)		11.70	0.15*	-30.30**
		(0.76)	(1.82)	(-2.14)
Life Rating A++,A+		67.72***	-0.46***	82.11***
		(7.21)	(-3.21)	(4.81)
Life Asset Grth		-0.32**	0.003*	-0.13
		(-2.46)	(1.78)	(-0.72)
Operating Return on Equity		-0.25	-0.00	-0.12
		(-1.09)	(-1.44)	(-0.42)
Leverage		3.55***	0.01	-0.90
		(4.41)	(1.64)	(-1.46)
Capital Adequacy Ratio		0.12**	-0.00	0.09
		(2.39)	(-0.81)	(1.06)
Current Liquidity		0.33***	0.00**	-0.05
		(4.75)	(2.56)	(-0.54)
Company-Product FE	Yes	Yes	Yes	Yes
Month-Product FE	Yes	Yes	Yes	Yes
N	361858	239975	239975	239975

Panel B

Panel B presents robustness checks, reporting second-stage results with the IV method. The first-stage coefficients on *P&C Weather Losses* are all positive and statistically significant. Column (1) uses the natural log of premiums as the dependent variable. Column (2) excludes months from Jul. 2008 to Dec. 2009. Column (3) only includes policies for those between 20 and 50 years old. Column (4) uses only one type of policies, those for a 40-year-old male, in the regular health category, with death benefits of $250K. Column (5) only includes life insurers with P&C affiliates, and the reported *P&C Losses* are the negative of the underwriting income, aggregated at the group level, scaled by lagged assets. Additional controls include all controls in Panel A. For variable definitions, see Table A1 in Appendix A. Z-statistics are reported in parentheses. Standard errors are corrected for clustering of observations at the group-quarter level.

Dependent Variable:	Log(Premium)	Premium			
		Exclude Crisis	Age 30,40,50	Age 40, Regular Health, 250K	Affiliated with P&C
	(1)	(2)	(3)	(4)	(5)
P&C Loss(q-4 to q-1)	0.004***	41.93**	6.49**	5.92	71.06***
	(3.43)	(2.28)	(2.03)	(1.56)	(2.65)
Additional Controls	Yes	Yes	Yes	Yes	Yes
Company-Product FE	Yes	Yes	Yes	Yes	Yes
Month-Product FE	Yes	Yes	Yes	Yes	Yes
N	239975	82174	53209	3196	87714

Table 7: 10-year Term Life Insurance Premiums, P&C Losses, and Financial Constraints

Panel A presents results on the relationship between 10-year term life insurance premiums and P&C losses. *Constrained* equals one if the group leverage two years prior exceeds the median of that year in (1)-(2), if group underwriting income in year $y-2$ scaled by assets in year $y-2$ is lower than the median in (3)-(4), if in year y the life insurer belongs to a group that never had an entity within (including theneither the holding company) nor any subsidiary that was publicly traded in (5)-(6), and zero otherwise. In Columns (1) through (4), only life insurers with P&C affiliates are included, so that the group leverage and group income are comparable across groups. Additional controls include all controls in Panel A of Table 6, as wel as the dummary variable *Constrained*. T-statistics are reported in parentheses in Column (1), and z-statistics are reported in parentheses in Column (2). Standard errors are corrected for clustering of observations at the group-quarter level. For variable definitions, see Table A1 in Appendix A. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

$$\begin{aligned}Life\ Policy\ Premium_{p,i,m} =& \beta_1 \cdot P\&C\ Loss_{g,(q-4,q-1)} \cdot Constrained + \beta_2 \cdot P\&C\ Loss_{g,(q-4,q-1)} \\ &+ \gamma_1 \cdot Cntrls_{i,y-2} + \gamma_2 \cdot Cntrls_{g,y-2} + FE_{p,i} + FE_{p,m} + u_{p,i,m}.\end{aligned}$$

Dependent Variable:	Premium					
	Constrained= High Grp Lev(y-2)		Constrained= Low Grp Income(y-2)		Constrained= Private(y)	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Loss(q-4 to q-1) *Constrained	15.34**	79.22**	16.30***	-4.13	0.06	152.83**
	(2.35)	(2.45)	(3.18)	(-0.06)	(0.01)	(2.46)
P&C Loss(q-4 to q-1)	6.31	5.68	4.34	76.58	18.91***	-95.64
	(1.25)	(0.16)	(1.39)	(0.88)	(8.17)	(-1.60)
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes
Company-Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Month-Product FE	Yes	Yes	Yes	Yes	Yes	Yes
N	85712	85712	83194	83194	239975	239975

Table 8: Transfer from Life Insurers to the Rest of the Group Increases with P&C Losses

This table presents results on the relationship between P&C losses and the net transfer from life insurers to the rest of the group. In Panel A, Column (3) is the first stage associated with Column (4). In Panel A, t-statistics are reported in parentheses in Columns (1) through (3), and z-statistics are reported in parentheses in Columns (4) and (5). In Panel B, t-statistics are reported in parentheses. Standard errors are corrected for clustering of observations at the group level in both Panels A and B. For variable definitions, see Table A1 in Appendix A. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A

$Net\ Trnsfr\ frm\ Life_{i,t} = \beta \cdot P\&C\ Loss_{g,t-1} + \gamma_1 \cdot Cntrls_{i,t-2} + \gamma_2 \cdot Cntrls_{g,t-2} + FE_i + FE_t + u_{i,t}$, where i indexes the individual life insurer, g group, and t year.

	OLS		IV		
Dependent Variable:	Capital Contribution (1)	Total Transfer (2)	P&C Losses(t-1) (3)	Capital Contribution (4)	Total Transfer (5)
1st Stage: P&C Weather Loss(t-1)			0.15**		
			(2.12)		
P&C Loss(t-1)	0.59***	0.89**		1.72**	7.24***
	(3.84)	(2.51)		(2.15)	(2.75)
log Life Assets(t-2)	7.67***	7.62*	-0.02	1.36	1.25
	(2.75)	(1.73)	(-0.07)	(1.55)	(0.41)
Life Leverage(t-2)	-0.07	-0.19	-0.00	-0.11**	-0.38
	(-1.06)	(-1.27)	(-0.16)	(-2.02)	(-1.63)
Life Net Income(t-2)	-2.49	31.89	-11.69*	-1.81	114.79
	(-0.29)	(0.78)	(-1.78)	(-0.10)	(1.50)
log Group Assets(t-2)	0.31	-4.85**	-0.15	0.76	3.72
	(0.24)	(-1.97)	(-0.79)	(0.65)	(1.07)
Group Leverage(t-2)	0.07***	0.12**	-0.004**	0.05***	0.08
	(2.78)	(2.26)	(-2.26)	(2.62)	(1.47)
Firm FE, Year FE	Yes	Yes	Yes	Yes	Yes
N	1024	1024	715	715	715

Panel B

$Net\ Trnsfr\ frm\ Life_{i,t} = Net\ Trnsfr\ frm\ Life_{i,t} = \beta_3 \cdot Grp\ At_{g,t-2} + \beta_4 \cdot Life\ Income_{i,t-2} + \beta_5 \cdot Life\ Lev_{i,t-2} + \beta_6 \cdot Life\ At_{i,t-2}) + \gamma_1 Cntrls_{i,t-2} + \gamma_2 Cntrls_{g,t-2} + FE_i + FE_t + u_{i,t}$. Other controls include: Group Leverage(t-2), log Group Assets(t-2), log Life Assets(t-2), Life Leverage(t-2), and Life Net Income (t-2).

Dependent Variable:	Capital Contribution	Total Transfer
	(1)	(2)
P&C Losses(t-1)	0.28	1.21
	(0.14)	(0.25)
P&C Losses(t-1)*	0.004*	0.02***
Group Leverage(t-2)	(1.67)	(2.71)
P&C Losses(t-1)*	-0.05	-0.08
log Group Assets(t-2)	(-0.39)	(-0.28)
P&C Losses(t-1)*	0.02	-0.12
log Life Assets(t-2)	(0.14)	(-0.36)
P&C Losses(t-1)*	0.01	0.02
Life Leverage(t-2)	(1.00)	(0.53)
P&C Losses(t-1)*	1.55	2.96
Life Net Income (t-2)	(0.50)	(0.53)
Other Controls	Yes	Yes
Firm FE, Year FE	Yes	Yes
N	1024	1024

Table 9: Transfer to P&C Insurers from the Rest of the Group Increases with P&C Losses

This table presents results on the relationship between P&C losses and the net transfer to P&C insurers from the rest of the group. T-statistics are reported in parentheses in Columns (1) through (3), and z-statistics are reported in parentheses in Columns (4) and (5). Standard errors are corrected for clustering of observations at the firm level. For variable definitions, see Table A1 in Appendix A. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

$Net\ Trnsfr\ to\ P\&C_{i,t} = \beta_1 \cdot P\&C\ Loss_{i,t-1} + \gamma_1 \cdot Cntrls_{i,t-2} + \gamma_2 \cdot Cntrls_{g,t-2} + FE_i + FE_t + u_{i,t}$, where i indexes the individual P&C insurer, and g the group.

	OLS		IV		
Dependent Variable:	Capital Contribution (1)	Total Transfer (2)	P&C Losses(t-1) (3)	Capital Contribution (4)	Total Transfer (5)
1st Stage: P&C Weather Loss(t-1)			0.15***		
			(7.37)		
P&C Loss(t-1)	0.55**	1.12***		0.32***	0.54***
	(2.03)	(2.66)		(2.92)	(3.09)
log P&C Assets(t-2)	-12.88**	-17.23***	0.31	7.72	3.78
	(-2.37)	(-2.64)	(0.52)	(0.53)	(0.25)
P&C Leverage(t-2)	0.42**	0.10	0.02	-0.13	-0.39
	(2.08)	(0.59)	(0.80)	(-0.42)	(-1.07)
log Group Assets(t-2)	0.42	0.02	0.46	0.17	-1.71
	(0.43)	(0.02)	(1.15)	(0.17)	(-1.17)
Group Leverage(t-2)	0.33	0.33	-0.01	0.64	0.78
	(1.50)	(1.59)	(-0.19)	(1.27)	(1.43)
Firm FE, Year FE	Yes	Yes	Yes	Yes	Yes
N	6233	6233	1881	1881	1881

Appendix

Table A1: Variable Definitions

Variable	**Definition**
P&C Losses (Reported)	Set to zero if net underwriting gain is positive, and the negative of net underwriting gain if net underwriting gain is negative. Net underwriting gain is available on Statement of Income in the statutory filings. To break it down, P&C Losses = (losses incurred + loss expenses incurred + other underwriting expenses incurred + aggregate write-ins for underwriting deductions) - (premiums earned + net income of protected cells), and set to 0 if the first bracket is smaller than the second bracket.
Leverage	Total liabilities (including policy reserves) divided by admitted assets.
Ordinal Rating	Cardinal numbers to index the ratings. 1 for A.M. Best rating of A++, 2 for A+, 3 for A, 4 for A-, 5 for B++, 6 for B+, 7 for B, 8 for B-, 9 for C++, 10 for C+, 11 for C, 12 for C-, and missing for ratings below or missing. Lower number means better rating.
Cardinal Rating	Following Koijen and Yogo (2016), cardinal measure between 0 and 175 based on AM Best rating guidelines. Higher number means better rating.
Group Assets	The sum of admitted assets of all the life, P&C companies, and the holding company within a group, if reported to NAIC or A.M. Best
Group Leverage	The sum of liabilities of all the life, P&C companies, and the holding company within a group (if reported), divided by Group Assets (%).
P&C Assets	The sum of admitted assets of all the P&C companies within a group. In Table 9, it refers to individual P&C company's assets.
P&C Leverage	Liabilities of a P&C company divided by its assets (%).
Life Assets	The admitted assets of the life insurer. The sum of the assets of all the life insurers within a group in Table 8.
Life Leverage	Total liabilities over total assets of the life insurance company (%). The sum of liabilities, divided by the assets of all the life insurers within a group in Table 8 (%).
Life Rating A++,A+	A dummy variable that equals to one if the life insurance company has an A.M. Best rating of either A++, or A+, zero otherwise.
Life Asset Grth	The admitted assets of the life insurer in year (t - 1) minus that in year (t - 2), scaled by the latter (%).
Life Operating Return on Equity	Operating return on equity of the life insurance company.

Capital Adequacy Ratio	A.M. Best's Capital Adequacy Ratio of the life insurance company.
Current Liquidity	A.M. Best's Current Liquidity measure of the life insurance company.
Net Income	Net income scaled by assets.
Reserve Value	The amount a life insurer needs to record as liabilities on balance sheet for the policies written.
Actuarial Value	The present value of the expected death benefit payment for life policies.
Statutory Surplus	Total assets minus total liabilities.

Table A2: Life Policies' 1st Year Net Impact on Capital

This table presents how statutory capital is affected by selling life policies. Panel A describes a permanent life policies, and Panel B 10-year term life policies. Commissions are assumed to be 50% of the premium. Assumptions on other expenses are based on Tables 8 and 9 in Segel (2002). Mortality tables used are 2001 Commissioner's Standard Ordinary (CSO) tables.

Panel A: Permanent Life Policies

				1st Year Net Impact on Capital ($)	
Face Value ($000)	Health Category	Age	Gender	Using Mean Price	Using Median Price
250	Regular	30	Female	-112	-126
250	Regular	40	Female	96	80
250	Regular	50	Female	363	320
250	Regular	60	Female	912	833
250	Regular	70	Female	1696	1550
250	Regular	80	Female	2405	2192
250	Regular	30	Male	-29	-42
250	Regular	40	Male	240	209
250	Regular	50	Male	599	540
250	Regular	60	Male	1311	1236
250	Regular	70	Male	2456	2299
250	Regular	80	Male	3747	3566

Panel B: 10-Year Term Life Policies

Face Value ($000)	Health Category	Age	Gender	1st Year Net Impact on Capital ($)	
				Using Mean Price	Using Median Price
250	Pref+	30	Male	-593	-595
500	Pref+	30	Male	-622	-626
250	Pref	30	Male	-594	-595
500	Pref	30	Male	-625	-629
250	Regular	30	Male	-590	-594
500	Regular	30	Male	-617	-624
250	Pref+	40	Male	-625	-627
500	Pref+	40	Male	-689	-699
250	Pref	40	Male	-625	-627
500	Pref	40	Male	-689	-700
250	Regular	40	Male	-614	-626
500	Regular	40	Male	-673	-696
250	Pref+	50	Male	-644	-653
500	Pref+	50	Male	-735	-751
250	Pref	50	Male	-640	-648
500	Pref	50	Male	-731	-751
250	Regular	50	Male	-617	-642
500	Regular	50	Male	-695	-729
250	Pref+	60	Male	-586	-605
500	Pref+	60	Male	-637	-676
250	Pref	60	Male	-569	-590
500	Pref	60	Male	-610	-656
250	Regular	60	Male	-489	-549
500	Regular	60	Male	-479	-566
250	Pref+	70	Male	-170	-241
500	Pref+	70	Male	133	-29
250	Pref	70	Male	-61	-155
500	Pref	70	Male	331	149
250	Regular	70	Male	146	59
500	Regular	70	Male	712	542
250	Pref+	80	Male	1811	1504
500	Pref+	80	Male	3937	3400
250	Pref	80	Male	1906	1449
500	Pref	80	Male	4105	3137
250	Regular	80	Male	2334	2059
500	Regular	80	Male	4818	4512

Table A3: Group/Quarter Average Permanent Policy Premiums and P&C Losses

This table presents results on the relationship between permanent life insurance premiums and P&C losses. The dependent variable is the average permanent life policy premiums by group/quarter, using one type of policies—permanent life policy for a 40-year-old male, in regular health category, with $250K of death benefits. Column (1) shows the first-stage result, Column (2) the second-stage. All independent control variables on life insurers' financials are from year t-2, and also the average at the group/quarter level. Additional controls include all controls in Table 5. For variable definitions, see Table A1 in Appendix A. T-statistics are reported in parentheses in Columns (1), and z-statistics are reported in parentheses in Columns (2). The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable:	P&C Losses (q-4 to q-1)	Avrg. Premium (Group/Quarter)
	(1)	(2)
1st Stage: P&C Weather Loss(q-4 to q-1)	0.55***	
	(13.13)	
P&C Loss(t-4 to t-1)		-11.2*
		(-1.94)
Other Controls	Yes	Yes
Group FE	Yes	Yes
Quarter FE	Yes	Yes
N	485	485

Cragg-Donald Wald F statistic is 172.37.

Table A4: Life Insurers' Ratings and P&C Losses

This table presents test results on whether the ratings of life insurers become worse following losses to the P&C affiliates. Columns (1)-(4) use Ordinal Rating, which is an index for ratings. 1 for A.M. Best rating of A++, 2 for A+, 3 for A, 4 for A-, etc. Lower number means better rating. Columns (5)-(6) use Cardinal Rating, which follows Koijen and Yogo (2016). It is a cardinal measure between 0 and 175 based on AM Best rating guidelines. Higher number means better rating. Columns (1)-(2) use multinomial logit, and Columns (3)-(6) OLS. For variable definitions, see Table A1 in Appendix A. Standard errors are corrected for clustering of observations at the group/quarter level. Z-statistics are reported in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Multinomial Logit		OLS			
Dependent Variable:	Ordinal Rating (Lower number, better rating)		Ordinal Rating (Lower number, better rating)		Cardinal Rating (Higher number, better rating)	
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Losses (t-1)	-0.07*	-0.07	-0.01	-0.01	0.12	0.05
	(-1.65)	(-1.43)	(-0.62)	(-1.00)	(1.35)	(0.60)
log P&C Assets (t-2)		-0.05		-0.09		0.76
		(-0.14)		(-0.98)		(0.61)
P&C Leverage (t-2)		1.49		0.40		-9.76**
		(0.87)		(0.66)		(-1.99)
Life Net Income (t-2)		-11.82**		-0.47		12.61
		(-2.49)		(-0.41)		(1.09)
log Group Assets (t-2)		-0.96***		0.04		-1.05**
		(-2.74)		(1.08)		(-2.21)
Group Leverage (t-2)		3.38***		0.33		-6.39***
		(3.68)		(1.61)		(-2.88)
Firm FE, Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	1980	748	1980	748	1980	748