How Do Financial Constraints Affect Product Pricing? Evidence from Weather and Life Insurance Premiums

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Abstract

I identify effects of financial constraints on firms' product pricing decisions, using a sample of insurance groups (conglomerates) that contain both life and P&C (property & casualty) subsidiaries. P&C subsidiaries' losses can tighten financial constraints for the life subsidiaries through internal capital markets. I present a model that predicts following P&C losses, premiums should fall for life policies that initially increase insurers' statutory capital, and rise for policies that initially decrease capital. Empirically, I find that P&C losses cause changes in life insurance premiums as my model predicts. The effects are concentrated in more financially constrained groups. Evidence also indicates that life subsidiaries increase capital transfers to P&C subsidiaries following larger P&C losses. These results hold when instrumenting for P&C losses using data on weather damages, implying that P&C losses do cause changes in life insurance premiums and internal capital transfers. My findings suggest that when financial constraints tighten, firms change product prices to relax the constraints, and how prices change depends on the products' initial impact on firms' financial resources.

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1 Introduction

The way in which imperfections in capital markets affect firms' real activities is a topic of fundamental importance in finance. Such imperfections can lead to firms having financial constraints, which raise their cost of financing. Because financial constraints and firms' activities can affect each other and can both be affected by business conditions, it is difficult to identify the causal effects of financial constraints on firms' activities. This paper identifies such causal effects using exogenous shocks to firms' financial conditions that are unlikely a result of firms' activities or general business conditions. I study how financial constraints affect firms' product pricing decisions, which are important decisions of all firms. Since product prices directly affect revenues and thus internal resources, firms are likely to change pricing decisions under tighter financial constraints.

I use the insurance industry as a laboratory for four reasons. First, many insurance companies are organized into groups of commonly owned affiliated companies. Some groups contain both life and P&C insurance subsidiaries, which are subject to unrelated shocks. For example, an unusually severe hurricane can cause unusual losses to some P&C insurers, but the hurricane is unlikely to directly affect life insurers within the same group more than it affects other life insurers. However, losses to a P&C subsidiary can affect the financial strength of affiliated life insurers because of capital transfers within the group. Insurers report internal capital transfers, which makes it possible to observe the transmission of shocks and identify financial shocks to life insurers that are exogenous to their pricing decisions.

The second reason for using the insurance industry is that some life policies are relatively homogeneous, and are therefore comparable over time and across firms (Brown and Goolsbee, 2002). Third, life insurers initially increase capital by selling some policies (analogous to raising funds), while decrease capital by selling some other policies (analogous to making investments). This feature allows me to test whether firms change prices differently for products that have different short-term financial effects. In addition, the way life insurers change premiums for each of the two kinds of policies has implications on how firms change

their financing and investment. The fourth reason is that the insurance industry is important. It helps households and businesses hedge major risks. Its importance is also reflected in its size, with total liabilities exceeding $7.4 trillion, substantial relative to the $9.6 trillion savings deposits at U.S. depository institutions (Federal Reserve, 2017 Q1). Adding to our understanding of this industry is valuable.

To study how firms change product prices when financial constraints worsen, I estimate the effect of affiliated P&C losses on life insurance premiums. Some endogenous factors (e.g., poor management) can potentially affect both P&C losses and life insurers' pricing behavior. Because of this issue, I construct an instrument for P&C losses using individual P&C firms' lagged market share in each state, as well as state-level data on unusual weather damages. I subtract historical averages from weather damages to obtain unusual damages. Variations in the severity of weather events offer exogenous shocks to the financial strength of P&C subsidiaries. Thus, P&C losses related to unusual weather damages provide exogenous shocks to life affiliates' financial constraints.

In the empirical analysis, I use a sample of 0.4 million monthly life insurance price quotes from 209 life insurers between 1999 and 2013. 96 of the life insurers belong to groups that also contain P&C subsidiaries. I study both permanent and 10-year term life policies with fixed annual premiums. Each premium quote is for a certain policy type from a specific life insurer, for example, Insurer A's 10-year term policy for a 40-year old non-smoking male, in the "regular" health category, with a death benefit of $250,000.

To understand how financial constraints affect life insurance pricing, I first present a model that features an insurance group with one life and one P&C division. The P&C division suffers unusual losses. The life division transfers capital to the P&C division and decides on the price of life policies to maximize the group value. Capital, defined here as assets relative to statutory liabilities, is important for the insurance industry for two reasons, both of which the model takes into account. First, regulators can seize control of an insurer when assets are deemed too low to meet liabilities. The model captures such friction by imposing that statutory capital must exceed a lower bound for each division. The second reason for the

importance of capital is that customers prefer better-capitalized insurers. Thus, I model demand for insurance as a function of premium, as well as insurer's statutory capital.

The model has four main predictions. The first two concern how life insurers change premiums following affiliated P&C losses, depending on whether selling the policies initially increases or decreases capital. For life policies that increase capital in the short term, premiums should fall. For these policies, the annual premium is usually higher than the initial capital costs, bringing a net capital inflow in the short run. By lowering premiums, life insurers sell more policies and, with elastic demand, attract more capital inflow.

Second, in contrast, premiums should rise with P&C losses for life policies that reduce capital in the short term. For these policies, the annual premium is usually lower than the initial capital costs, bringing a net capital outflow in the short run. Selling these policies can be seen as investments by life insurers. By raising premiums, life insurers will sell fewer such policies and reduce capital outflow. Life insurers also lower the initial capital expenditure (initial costs minus premium) and raise the future payoff (premium minus costs in later years) of each policy, thus, increasing returns on these investments, both in terms of statutory capital and economic value.

The third prediction is that life insurance premiums should change by a larger magnitude, if the insurance group is more financially constrained. Intuitively, the same P&C losses have a larger impact on a group's financial strength if the group is ex ante more 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, future demand increases with insurers' capital and more so when insurers' capital is low. Hence, the value of additional capital for P&C affiliates rises when they suffer larger losses. Consequently, the optimal capital allocation requires larger transfers from life to P&C divisions.

To test the model predictions on life insurance premiums, I classify policies as capital-increasing or capital-decreasing. I consider a class of permanent life policies to be capital-increasing, since the annual premium is usually higher than the initial capital costs for these

policies. In contrast, I consider 10-year term life policies to be capital-decreasing, since the annual premium is usually lower than the issuing cost.

The results 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-decreasing products, the 10-year term policies, premiums rise with P&C losses. Third, life insurers change premiums more if the groups 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.

To further address the endogeneity concern, I instrument for P&C losses with state-level data on unusual weather damages and P&C insurers' lagged market share in each state. All the empirical results hold. In addition, I also test the model's other predictions on premiums, which exploit different sizes of death benefits and the difference between 10-year and 20-year term policies. Results are consistent with the predictions.

This paper has five main implications. First, it contributes to the literature on how firms' financial conditions affect pricing. This is one of the few studies that use idiosyncratic and exogenous shocks to firms' financial constraints, establishing a causal effect of financial constraints on pricing.

Moreover, this paper suggests how financial constraints cause firms to change product prices depends on the product's short-term impact on firms' financial flexibility. My results can generate predictions for other industries, and could potentially help reconcile different findings in the literature. The result on capital-increasing policies could generate predictions for "liquidity-increasing" products, for which customers pay before firms incur marginal production costs (e.g., to purchase raw material). By lowering prices, firms could sell more and, with elastic demand, gain more liquidity in the short term. I show that prices fall for capital-increasing products. Firms cutting prices when more constrained is consistent with Zingales (1998) studying the trucking, as well as Busse (2002) the airline industry.[1] If firms

[1]Different from Busse (2002), Kim (2017) finds that airlines with more cash respond to intensified competition by pricing more aggressively.

incur marginal production costs after collecting revenues in these industries, it is analogous to the capital-increasing life policies in that firms initially gain financial resources.

In contrast, the result on capital-decreasing policies can generate predictions for "liquidity-decreasing" products by industries where customers pay after firms have incurred marginal production costs. The quantity firms produce can be limited by their liquidity. Thus, in imperfect product markets, firms should raise prices to clear the limited supply. I show that prices increase with financial constraints for capital-decreasing products. Firms raising prices when more constrained is consistent with Chevalier (1995a) and Chevalier and Scharfstein (1996) studying the grocery industry, Khanna and Tice (2005) the discounter industry, as well as Campello (2003) 20 manufacturing industries. If firms pay suppliers before collecting revenues in these industries, it is analogous to the capital-decreasing life policies in that firms initially incur outflows of financial resources. By studying different products in the same industry, I characterize the mechanism in which financial constraints affect pricing, which can potentially reconcile different findings in the literature.[2]

The second implication is on the insurance industry. I find that life insurers change policy prices differently for different products in a way that is consistent with preserving statutory capital. Among different measures of ex ante financial constraints, I find that capitalization perceived by regulators and the insurance rating agency is the most important in affecting life insurers' response to P&C losses. Both regulators and the rating agency rely heavily on insurers' statutory capital. Therefore, this paper suggests that statutory capital is an important form of financial resource for the insurance industry likely due to two main reasons: regulatory capital requirements and customers' preference for better-rated insurers.

Third, this paper contributes to our knowledge of internal capital markets. This literature has documented that some divisions' cash flows affect other divisions' investments, e.g., Lamont (1997), Shin and Stulz (1998), and the literature spawned by these two papers.[3] I

[2]Phillips (1995) shows contrasting results among four industries, and Campello (2006) documents that the relation between financial constraints and competitive conduct is non-monotonic. Other papers study the effects of financial constraints on product market competition without using data on pricing. On one hand, Hadlock and Sonti (2010) find that more constrained firms compete more aggressively. On the other hand, Chevalier (1995b), Kovenock and Phillips (1997), Khanna and Tice (2000), Grullon, Kanatas and Kumar (2006), Fresard (2010), as well as Cookson (2017) show that more constrained firms compete less aggressively.

[3]In the insurance industry, Powell and Sommer 2007, Powell, Sommer and Eckles 2008, and Cummins

show that when adverse financial shocks affect some divisions, other divisions change their real activities beyond traditional measures of investment. This paper focuses on pricing decisions, while several other papers study employment and advertising. Giroud and Mueller (2015, 2017) find that internal capital markets also reallocate labor. Fee, Hadlock and Pierce (2008) show that foreign divisions' cash flows affect firms' advertising spending in the US.[4]

The fourth implication is on the way in which financial constraints limit investment. The literature has documented that firms reduce investment when they are more constrained, but limited studies have explored the nature of the investment reductions or characteristics of the forgone and remaining investments. This paper finds that for the capital-decreasing policies, insurers raise premiums, which can lower the initial capital outflow from each policy (initial costs minus premium), and also the number of policies sold through reduced demand. Thus, insurers reduce the total investment associated with selling such policies. By raising premiums, insurers also increase returns on these investments. It is likely a general phenomenon that firms raise returns on the remaining investments when they cut investment under tighter financial constraints. This implication is consistent with the common assumption of firms' optimal investment behavior, studies documenting negative relation between firms' cash (flow) and returns on investments (often acquisitions), as well as those documenting negative relationship between stock returns and firms' investments.[5]

Fifth, my results have implications on firms' financing behavior under financial constraints. Insurers can obtain financing by issuing capital-increasing policies, analogous to issuing financing instruments. By lowering premiums, insurers sell more policies, and can attract more capital inflow from policyholders with elastic demand. It is likely a general phenomenon that firms sell financing instruments at a discount when financially constrained.

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and Weiss 2016 examine internal capital transfers among P&C subsidiaries, and Niehaus 2016 between life insurance divisions and the rest of the group.

[4]Some other papers also study firms' real activities beyond investments in the context of internal capital markets, e.g., Khanna and Tice (2001), Campello (2002) and Boutin et al (2013). However, they focus on divisions directly affected by shocks, and find such divisions are less affected if they have access to internal capital markets.

[5]For relation between firms' cash (flow) and returns on investments, see, e.g., Erel et al (2017), Cunha (2014), Richardson (2006), Harford (1999), Lang, Stulz and Walking (1991). For relationship between stock returns and firms' investments, see, e.g., Titman et al. (2004), Anderson and Garcia-Feijoo (2006) and Cooper et al. (2008).

This implication is consistent with studies documenting that firms offer higher returns to financing providers when facing tight financial constraints.[6]

This paper is related to studies on how financial frictions affect life insurance prices, e.g. Koijen and Yogo (2015). They find that during the financial crisis, life insurers lowered markups for annuities and permanent life policies. Consistent with their findings, this paper implies that life insurers lower premiums for permanent policies when insurers become more financially constrained. Koijen and Yogo (2017) find that fees increased for variable annuities since the financial crisis, and argue it is due to the negative effect of the crisis on insurers' capitalization. While they examine the effect of market-wide financing frictions in both of their papers, I study the effect of idiosyncratic shocks to firms' financial constraints. In addition, the financial crisis could have brought changes to all the life insurers' business conditions, while unusual weather events used here are unlikely to only affect certain life insurers' business conditions and are easier to control for. Besides, our models are also different in how financial constraints affect insurance prices.[7]

Another closely-related paper is Koijen and Yogo (2016). They show that insurers can record lower liabilities using shadow insurance. They argue that premiums of 10-year term policies would increase without shadow insurance since selling such a policy would require more capital compared to with shadow insurance. My results on 10-year term policies are consistent with their conclusion. In this paper, adverse financial shocks do not change the amount of capital needed to sell such a policy, but increase the shadow cost of capital.

Sen and Humphry (2016) is also relevant. They find that UK life insurers, who became more constrained under new regulations, reduced underwriting of more capital-intensive policies. Their paper and mine both show that insurers change activities in a way that reduces capital outflow when firms are more constrained. Besides the difference in shocks we use, they focus on underwriting quantities, while I exploit granular pricing data.

[6]See Lim, Schwert and Weisbach (2017), Lim, Minton and Weisbach (2014), and Hertzel and Smith (1993).

[7]In their model, how shadow cost of capital changes prices depends on the relationship between the present value of statutory reserves and actuarial values of policies. By lowering prices, as long as above the present value of reserves, firms will generate gain in statutory capital. In my model, how prices change depends on how selling policies affect insurers' financial strength in the short term.

This paper is also related to Froot and O'Connell (1999) on how capital market imperfections affect catastrophe reinsurance pricing, as well as other papers on P&C pricing (see Harrington, Niehaus and Yu 2013 for a review). The results in this paper on 10-year term policies are consistent with their finding. Different from these studies cited above, this paper shows contrasting effects of financial constraints on product prices, and suggests how financial frictions affect firms' pricing decisions may depend on how products initially affect firms' financial resources.

The remainder of the paper proceeds as follows. Section 2 presents the model. Section 3 describes the data. Section 4 presents empirical results on how affiliated P&C losses affect life insurance premiums. Section 5 presents results on how P&C losses affect internal capital transfers within the insurance group. Section 6 concludes this paper.

2 Model

The model features an insurance group with a life and a P&C division. Capital can flow freely between the two.[8] Since I mainly study the behavior of the life insurer, I do not model the P&C insurer's operations. There are three periods. The life insurer sells the same kind of policies in Periods 1 and 2. Each life policy is in effect for two periods.

I assume the P&C insurer incurs unusual losses before Period 1. Following that, the life insurer makes capital transfers to the P&C affiliate, $k^{LF \to PC}$. Transfers can go from the P&C to the life division, in which case $k^{LF \to PC}$ will be negative. The life insurer also chooses the premium (following Koijen and Yogo, 2016 and 2017) for life policies sold in Period 1, P_1^{LF}, to maximize group value, J_0:

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

π is profits with subscripts denoting periods. The profit functions are in Appendix A. PC

[8]The model does not consider the headquarters. In practice, headquarters can take actions to offset subsidiaries' financial constraints. If headquarters can relax those constraints, empirically life insurers are less likely to change their pricing strategies. In reality, capital going out of an insurance subsidiary is limited by regulation. Adding such limitations will not change the theoretical predictions.

stands for the P&C, and LF for the life division. β is the discount factor.

I define statutory capital as assets minus liabilities, both recorded using statutory accounting rules. Liabilities include reserves for future policy claims. By law, capital must meet a minimum requirement based on the risks of insurers' assets and liabilities. I simplify this constraint and require that capital exceeds a positive lower bound for each division:

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

K stands for capital, and τ the positive lower bound.[9] At the end of Period 3, insurers have no more liabilities, and, thus, face no more capital requirement. Positive capital at the end of Period 2 ensures that the insurers can pay off Period-3 claims in expectation.

Combining Equation (1) and the capital constraints, the optimization problem becomes the following Lagrangian:

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

where $\lambda_1^{PC},\ \lambda_1^{LF},\ \lambda_2^{PC}$ and λ_2^{LF} are Lagrange multipliers.[10]

In the beginning of Period 1, after the life insurer's transfer to the P&C affiliate, insurers' capital positions are

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

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

where K_e^{LF} and K_e^{PC} are the capital endowments of the life and P&C insurer, respectively. The remaining evolution of capital is in Appendix A.

Besides the regulatory requirements, capital is important for insurers for another reason:

[9] This constraint assumes that the group has infinite dis-utility from having the regulators control the operation of a division in the event of not meeting regulatory requirements. 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.

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

customers prefer better-capitalized insurers.[11] Thus, I model the demand for insurance as a function of both premium and the insurer's lagged capital, $Q_t^i\left(P_t^i,\ K_{t-1}^i\right)$, and assume $\frac{\partial Q_t^i}{\partial K_{t-1}^i} > 0$, where i is either LF or PC. I also assume $\frac{\partial Q_t^i}{\partial K_{t-1}^i}$ decreases in K_{t-1}^i, i.e., when capital is lower, the boost in demand through additional capital is larger. This assumption is consistent with Froot (2008)'s argument that "lower amounts in internal capital reduce an insurer's value increasingly rapidly when capital is low", by citing empirical findings in Sommer (1996), Grace, Klein, and Kleindorfer (2004) and Epermanis and Harrington (2006).

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

$$\begin{aligned}&\frac{\partial \pi_1^{LF}}{\partial K_0^{LF}} + \beta R\frac{\partial \pi_2^{LF}}{\partial K_1^{LF}} + \beta^2 R\frac{\partial \pi_3^{LF}}{\partial K_1^{LF}} + \lambda_1^{LF}R + \lambda_2^{LF}R\frac{\partial K_2^{LF}}{\partial K_1^{LF}}\\ =&\frac{\partial \pi_1^{PC}}{\partial K_0^{PC}} + \beta R\frac{\partial \pi_2^{PC}}{\partial K_1^{PC}} + \beta^2 R\frac{\partial \pi_3^{PC}}{\partial K_1^{PC}} + \lambda_1^{PC}R + \lambda_2^{PC}R\frac{\partial K_2^{PC}}{\partial K_1^{PC}}.\end{aligned} \tag{5}$$

Let i be either LF or PC. Higher K_0^i and K_1^i can increase future profits of insurer i, through boosting future demand. The sum of $\frac{\partial \pi_1^i}{\partial K_0^i}$, $\beta R\frac{\partial \pi_2^i}{\partial K_1^i}$, and $\beta^2 R\frac{\partial \pi_3^i}{\partial K_1^i}$ is the marginal contribution of insurer i's capital to the group value, through contributing to insurer i's profits. $\lambda_1^i R$ and $\lambda_2^i\frac{\partial K_2^i}{\partial K_1^i}$ are the shadow value of i's capital in relaxing i's capital requirement constraints. The sum of these six terms is the total shadow value of capital at the beginning of Period 1. From Equation (5), capital will flow between the two subsidiaries until the shadow value of capital equalizes between the two.

When the P&C insurer suffers losses, the shadow value of capital in relaxing P&C division's capital constraint increases (λ_t^{PC}'s are higher). In addition, the shadow value of capital in boosting future P&C profits is also higher, since $\frac{\partial Q_t^{PC}}{\partial K_{t-1}^{PC}}$ is higher when K_{t-1}^{PC} is lower.[12] Thus, the total shadow value of capital at the P&C division increases, which triggers the life division to transfer capital to the P&C division.

[11] Although retail customers shopping for property insurance generally care little about P&C insurers' financial strength ratings, commercial P&C customers prefer insurers with better ratings (Harrington and Niehaus, 2003).

[12] In addition, the profitability of P&C insurance, which is capital-intensive, can be high. The reason can be related to the phenomenon often referred to as P&C insurance hard market (see Harrington, Niehaus and Yu 2013 for a review). After large losses to certain product lines in certain geographic regions, P&C premiums in those lines and regions rise dramatically, before declining again. Many papers argue that the rise in price is due to financial constraints of P&C insurers resulting in limited supply of insurance.

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

$$-\left(\frac{\partial \pi_1^{LF}}{\partial P_1^{LF}}+\beta\frac{\partial \pi_{2(1)}^{LF}}{\partial P_1^{LF}}\right)=\lambda\frac{\partial K_1^{LF}}{\partial P_1^{LF}}. \tag{6}$$

$\pi_{2(1)}^{LF}$ stands for the life division's profit in Period 2 associated with policies sold in Period 1. $\lambda=\beta\frac{\partial \pi_{2(2)}^{LF}}{\partial K_1^{LF}}+\beta^2\frac{\partial \pi_3^{LF}}{\partial K_1^{LF}}+\lambda_1^{LF}+\lambda_2^{LF}\frac{\partial K_2^{LF}}{\partial K_1^{LF}}$, where $\pi_{2(2)}^{LF}$ stands for life division's profit in Period 2 associated with policies sold in Period 2. We can interpret λ as the shadow cost of capital at the end of Period 1, the amount of profit associated with policies sold in Period 1 that the life insurer sacrifices to gain one unit of capital, by changing prices. The additional unit of capital contributes to firm value through profits from policies sold in Period 2, and through keeping the life insurer away from regulatory capital lower bound. Following P&C losses, life division transfers capital to the P&C division. Thus, λ increases. Across groups, λ increases more for groups that are ex ante more financially constrained, since the capital constraints are more binding for these groups and $\frac{\partial Q_t^{LF}}{\partial K_{t-1}^{LF}}$ is higher when K_{t-1}^{LF} is lower.

Combining Equations (A1), (A2), (A3) in Appendix A and (6), the optimal life insurance premium in Period 1, P_1^{*LF}, is a function of λ, see Equation (A4). P_1^{*LF} changes with the shadow cost of capital, λ, as follows.

$$\frac{\partial P_1^{*LF}}{\partial \lambda}=(1-\frac{1}{\epsilon^{LF}})^{-1}(1+\beta s_1+\lambda)^{-2}s_1\beta\left\{[C+B(1-s_1)+s_1V^R]-[B(1-s_2)-\frac{1}{\beta}V^R]\right\}, \tag{7}$$

assuming $\epsilon^{LF}=-\frac{\partial log Q^{LF}}{\partial log P^{LF}}$, the demand elasticity, does not change in P_1^{LF}. C is variable issuing costs, including costs to obtain health information of potential policyholders and agent commissions etc. s_1 and s_2 are policyholders' survival rates in Period 1 and 2, respectively. B is the death benefits per policy. V^R is the statutory reserve per policy, recorded as liability.

Since life insurance products are highly comparable across insurers and more than 200 life insurers on average in each state offer common life policies, demand should be elastic ($\epsilon^{LF}>1$). (Koijen and Yogo 2015 and 2016 assume that demand elasticity is higher than one for both product types in my sample.) 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 (7). $[C+B(1-s_1)+s_1V^R]$ is the capital cost for each policy in Period 1, containing issuing costs (C), death benefit

payout ($B(1-s_1)$), and reserves ($s_1 V^R$). $[B(1-s_2) - \frac{1}{\beta} V^R]$ is the capital cost for each active policy in Period 2, containing the death benefit payout ($B(1-s_2)$), and capital released from liabilities ($\frac{1}{\beta} V^R$). Hence, the term in the curly brackets in Equation (7) is the difference between Period-1 and -2 capital costs.

How life insurance premiums change with shadow cost of capital depends on the difference between Period-1 and -2 capital costs, based on Equation (7). When capital cost in Period 1 is lower than that in Period 2, one can prove that the optimal premium is strictly higher than the capital cost in Period 1. By issuing such capital-increasing policies, the life insurer experiences capital gain initially and capital reduction later. Equation (7) predicts that premiums should fall with shadow cost of capital for these policies. Intuitively, the insurer lowers prices to sell more policies and, with elastic demand, 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.[13] This case is analogous to products with initial capital costs higher than premiums. I call them capital-decreasing policies. Issuing these policies can be seen as investments, with a net capital outflow initially, and inflow in later years. Equation (7) predicts that premiums will rise with shadow cost of capital, for these policies. Increasing the premium raises the marginal return of capital, with lower initial investment (initial capital costs minus premium), and higher future payoff (premium minus capital costs in the remaining years). Since demand decreases with price, the life insurer will sell fewer policies, effectively reducing the investment quantity.

2.1 Testable Predictions of the Model

To summarize, the model generates four main predictions. First, following affiliated P&C losses, life insurers should lower premiums, for policies that initially bring capital inflow (the capital-increasing policies). Second, life insurers should raise premiums for policies that

[13] 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-1 (thus, also Period-2) capital cost is not realistic, since practically, selling a policy usually does not bring in gain to statutory capital each period (i.e. requiring no capital as input), due to competition.

initially cause capital outflow (the capital-decreasing policies). Third, life insurers in more financially constrained groups will change premiums more. Fourth, life insurers will increase transfers to P&C affiliates with P&C losses.

3 Data

3.1 Financial Data

Financial data on insurance companies are from the National Association of Insurance Commissioner (NAIC) and A.M. Best, a major insurer rating agency. Most of the financial variables used are available from 1995 to 2013, with those at the quarterly level limited to 2001 to 2013, and those from A.M. Best limited to 2003 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 both t and $t+1$. All financial variables are winsorized at the 1% and 99% levels. Ratings are from A.M. Best, which reflect insurers' ability to meet 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 209 life insurers with life insurance prices. The life insurers in my pricing sample have a total market share of 64% in terms of number of new term life policies issued. The smaller circle represents the 96 life insurers in 49 groups with P&C divisions. The change of the sample size over time is presented in Table 1.

In Table 2, Panel A reports statistics on the financial data of the life insurers. Panel B provides summary statistics for these individual P&C companies. Panel C summarizes financial data aggregated at the group level of the P&C companies affiliated with the life insurers in my pricing sample.

3.1.1 P&C Losses Measures

3.1.1.A Reported P&C Losses

To construct *P&C Loss*, I aggregate P&C insurers at the group level, with the sum of net underwriting gain scaled by the sum of lagged total assets of all P&C firms in a group. If net underwriting gain is negative, *P&C Loss* is the absolute value of net underwriting gain. If net underwriting gain is positive, I set *P&C Loss* as zero. *P&C Loss* takes into account reinsurance-related payments and present value of estimated unpaid losses (see Table B1 for details). I assign zero to *P&C Loss* for life insurers unaffiliated with P&C insurers.

3.1.1.B Instrumental Variable for P&C Losses with Weather Data

To study the effect of financial constraints on pricing, I can estimate correlations between life insurance premiums and P&C affiliates' losses. However, some unobservable factors might affect both life insurance premiums and P&C losses. Therefore, I use the IV (instrumental variable) method by instrumenting losses using P&C firms' exposure to weather events.

Data on damages due to weather events are from SHELDUS (Spatial Hazard Events and Losses Database for the United States). SHELDUS' main data source is National Centers for Environmental Information. I include all the event types covered in the dataset, including hurricanes, wildfires, tornadoes, etc.[14] Hurricanes account for the largest share of damages, 32%. The database includes every natural hazard event that caused injury, death or property/farm damages since 1960 in US. The data offer estimated monetary damages.

I use weather-related damages to properties 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 (from SHELDUS) at the state-quarter level, naming the aggregated variable $Weather\ Damage_{s,q}$, s denotes the state and q the quarter. I then compute rolling historical averages using data on state s, prior to quarter q, adjusting for inflation. Since weather damages have seasonalities, I construct historical

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

average for quarter q using historical data from the same quarter (first, second, third or fourth). I then subtract the state-quarter historical average (adjusted for inflation) from $Weather\ Damage_{s,q}$, to obtain $Unusual\ Weather\ Damage_{s,q}$.[15] 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 q, as 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:

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

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

$$P\&C\ Weather\ Exposure_{i,q} = \sum_s \left(Unusual\ Weather\ Damage_{s,q} \cdot Lag\ Mkt\ Share_{i,s,q}\right),$$

approximates company i's share of all the weather damages in quarter q, and is my instrument for reported $P\&C\ Loss$. I aggregate $P\&C\ Weather\ Exposure_{i,q}$ at the group level, scaled by the sum of assets at the end of the year before the previous year, to obtain $P\&C\ Weather\ Exposure$ at the group-quarter level.

The instrument can likely satisfy the relevance restriction, since severe weather events can cause significant losses to P&C insurers. Let us turn to the exclusion restriction. Because $Lag\ Mkt\ Share$ is an endogenous choice, it could be correlated with factors (name them X) that also affect life insurance pricing decision. However, the correlation between $P\&C\ Weather\ Exposure$ and X will be zero, if assuming $Unusual\ Weather\ Damage$ is uncorrelated with $Lag\ Mkt\ Share$ or X (Assumption 1), and has an expectation of zero (Assumption 2).[16] Assumption 1 can be justified if unusual variations (deviation from historical

[15] This demean process has a caveat. If the insurer expects the same level of the severity of weather events as the historical mean, the expected monetary damages will be higher than the historical mean, if there are more houses than the historical mean.

[16] $Cov(P\&C\ Weather\ Exposure_{i,s,q},\ X) = E\{[\sum_s (Unusual\ Weather\ Damage_{s,q} \cdot Lag\ Mkt\ Share_{i,s,q}) \cdot X\} - E[\sum_s (Unusual\ Weather\ Damage_{s,q} \cdot Lag\ Mkt\ Share_{i,s,q})] \cdot E(X)\} = \sum_s E(Unusual\ Weather\ Damage_{s,q} \cdot Lag\ Mkt\ Share_{i,s,q} \cdot X) - \{\sum_s [E(Unusual\ Weather\ Damage_{s,q} \cdot$

means) of the severity of weather events are hard to predict. P&C firms with large footprint in the Gulf Coast know they are exposed to higher average risks of hurricanes. However, if insurers do not know next quarter's deviation of weather damages from historical means, their lagged P&C market share or other decisions (like X) should not be correlated with the deviation. Dessaint and Matray (2016) argue that hurricanes are highly unpredictable, citing a number of studies. To the extent that deviations of weather damages from historical means are hard to predict, they are unlikely correlated with insurers' behavior. Assumption 2 that $Unusual\ Weather\ Damage$ has an expectation of zero can be justified if insurers use historical means to forecast future weather damages.

3.2 Life Insurance Price Data

Data on life insurance prices come from *CompuLife*, which sells price quoting software to insurance agents. The data contain monthly 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 policies with fixed premium. The two kinds of policies have very different short-term impact on insurers' statutory capital as discussed below.[17]

The first kind of policies I study is permanent life policies, for which the data are collected by Koijen and Yogo (2015) from *CompuLife*.[18] They are universal life policies without a savings' component (often called universal life with no-lapse guarantee). The policy is in effect as long as the insured is alive (until the age of 120) and fixed premium is paid each period. The insurer pays out death benefit to the beneficiary upon the death of the insured. This subsample of pricing data covers products with a death benefit of $250,000,

$Lag\ Mkt\ Share_{i,s,q})]\} \cdot E(X) = \sum_s [E(Unusual\ Weather\ Damage_{s,q}) \cdot E(Lag\ Mkt\ Share_{i,s,q} \cdot X)] - \{\sum_s [E(Unusual\ Weather\ Damage_{s,q}) \cdot E(Lag\ Mkt\ Share_{i,s,q})]\} \cdot E(X) = 0$. The second to last equality depends on Assumption 1, and the last on Assumption 2.

[17] Insurers do not need to offer cash surrender value for either of the two kinds of policies, which helps with the comparison between the two policies (see Section 9 of Standard Nonforfeiture Law for Life Insurance, 2014).

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

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 here (e.g., for a 40-year old male in regular health with a death benefit of $250,000), so there are 12 product types. This subsample contains monthly price data for these products between January 2005 and July 2011. There are 27,976 policy premium quotes in this sample.

The second kind of policies I use is the 10-year term life policy. I programmed an automation process to extract these policies' 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 in my sample have two different sizes of death benefits, $250,000 and $500,000. They are for male aged between 30 and 80 (every ten years in between), in three health categories (preferred plus, preferred and regular), all non-smoking. Each combination of these product characteristics is defined as a product type in this paper, so there are 36 product types. My sample contains monthly price data for each of these product types between March 1999 and December 2013. There are 366,078 policy premium quotes in this sample. Since the quarterly P&C losses used in the main regressions are available to me only from 2001, I use the 298,567 policy quotes from 2002 in my main regressions. Table 3 offers statistics of premiums as a percentage of the average premium for the same product type in the same year. Table B2 lists all the policy types in my sample, as well as their mean and median premiums.

4 Empirical Results: Life Insurance Prices

The model predicts that for policies that initially increase capital, insurers will lower premiums, while for policies that initially reduce capital, insurers will raise premiums. A candidate for the capital-increasing policies is the permanent life policies in my sample. Panel A in 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 $103 in the first policy year, and a total of $1,420 in the first two years combined. By lowering premiums, life insurers sell more policies, and can attract more capital inflow, as the shadow cost of capital increases.[19]

A candidate for the capital-decreasing policy is the 10-year term life policy. Panel B in Table 4 presents an example showing how such a policy causes a 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 $534, and a net outflow of $558 in the first two years combined. By increasing premiums, insurers reduce capital outflow in the short term.

Table B2 shows how each of the 48 different products impacts life insurers' balance sheet in the first policy year. 10 of the 12 different permanent life policies have a positive impact on life insurers' capital in the first policy year, and all 12 do combining the first two years. 23 of the 36 10-year term policies have a negative impact on capital in the first year, 28 do combining the first two years.

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, which Koijen and Yogo (2015) argue was due to an increase in the shadow cost of capital. Also during the financial crisis, premiums of the 10-year term policies increased, which practitioners claim was also due to the rising cost of capital.[20]

Figure 2 offers an overview of the relationship between life insurance premiums and affiliated P&C losses. The figure only includes life insurers with P&C affiliates. I match life insurance premiums with affiliated *P&C Loss* aggregated over the previous four quarters. I

[19] How selling such a policy exactly affects the RBC ratio of the insurer is complicated and depends on the risks of the insurers' assets and liabilities. The first year's required capital for such policies is zero (adding zero to the denominator of the RBC ratio) (see Stone and Steenman, 2009). If insurers want to increase the RBC ratio, they can invest the increased assets from selling these policies are invested in cash or treasury securities (adding zero to the denominator), insurers' RBC ratio will increase in the first year with higher numerator and unchanged denominator.

[20] "ReliaStar and other ING subsidiaries are raising term-life insurance rates an average of 5% this year, Mr. Britton [CEO of ING's US insurance division] 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.'" "Insurers Raise the Premiums on Term Life", Wall Street Journal, June 9, 2009, http://www.wsj.com/articles/SB124450333064895949.

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 Loss*, by subtracting the group averages and month averages. I then sort the demeaned *P&C Loss* into quintiles. In Figure 2, the horizontal axis presents the *P&C Loss* quintiles, "1" is the smallest, and "5" the largest. The dashed line plots the average demeaned premiums of each *P&C Loss* quintile for the permanent policies, and the solid line for the 10-year term policies. The figure suggests that permanent life premiums fall and 10-year term premiums rise, as affiliated P&C losses increases, consistent with the model predictions.

4.1 Permanent Life Policies Prices

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

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

The dependent variable is the monthly life insurance premium for product type p, offered by life insurer i in group g, in month m within quarter q, year y, as a percentage of the mean premium for product type p in year y. Product types are defined by a combination of two characteristics, age and gender of the policyholders. (Again, the permanent policies in the sample have the same health category and face value.) Among the control variables, the dummy variable for whether the life insurer was rated as A++ or A+ is based on the latest rating information at the end of quarter $q-5$. Other controls are from the end of year $y-2$. The firm-product type fixed effects, $FE_{p,i}$, control for time-invariant differences across firms for each product type. For example, for a certain product type, company A may always set the price higher than other firms. The month-product fixed effects, $FE_{p,m}$, control for trend over time of each product type. In a certain month, the average price for a certain product type could be higher than other months. Since the variation of *P&C Loss* 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 Loss* as the independent variable. Column (2) includes additional controls, which affect the elasticity of demand of life insurance, as in Koijen and Yogo (2015). The coefficient on *P&C Loss* is negative in both columns, and statistically significant in Column (1), suggesting that premiums of permanent life insurance fall with affiliated P&C losses. In untabulated results, I also repeat the analyses in Columns (1)-(2) by constructing *P&C Loss* with data from annual statements of year $y-1$. Coefficients on annual *P&C Loss* are also negative and statistically significant.

Columns (3)-(4) provide results using the IV method. Column (3) reports the first-stage result, where *P&C Loss* is the dependent variable. The coefficient on the instrumental variable, *P&C Weather Exposure*, is positive and statistically significant, suggesting that weather damages in P&C insurers' market areas affect losses the insurers suffer. Column (4) reports the second-stage result. The coefficient on the instrumented *P&C Loss* is negative and statistically significant. These results suggest that adverse shocks to the financial condition of the insurance group cause premiums to fall for permanent life policies.[21]

Panel B of Table 5 presents robustness checks, reporting second-stage results with the IV method. Koijen and Yogo (2015) document that markups for permanent policies decreased drastically from November 2008 to February 2009. One may be concerned that the patterns documented here are driven by insurance groups that suffered P&C losses during the financial crisis. To address this concern, Column (1) excludes the period from July 2008 to December 2009. Column (2) only includes policies for new customers between 30 and 50 years old, whose motives for buying life insurance policies may be different from older customers. Column (3) uses only one type of policies, those for a 40-year-old male, in the regular health category, with death benefits of $250K. Column (4) only includes life insurers

[21] 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 characteristics, the error terms cannot be safely 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 Panel A Table C1 in Appendix B. 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 Cragg-Donald Wald F-statistic is 124.27, much higher than the Stock-Yogo 10% threshold of 16.38, suggesting that the instrument is sufficiently strong.

with P&C affiliates. Column (5) replaces the dependent variable with premiums in dollars, and Column (6) with the natural log of premiums. In untabulated first-stage results, the coefficients on *P&C Weather Exposure* are all positive and statistically significant. In the second stage shown in Panel B, the coefficients on *P&C Loss* are all negative and statistically significant, implying that the premiums fall with weather-related P&C losses.

According to Column (4) in Panel A, a one standard deviation increase in *P&C Loss*, 2.8% of lagged assets or $53.5 million (based on median assets), is associated with an average price decrease by 1.8% of the mean price, which is 15.0% of the standard deviation of the dependent variable (12.0%). According to Column (5) in Panel B, with price in dollars as the dependent variable, a one standard deviation increase in *P&C Loss* is associated with an average price decrease by $118.7, which is 15.8% of the average product type-month standard deviation ($750.6). The results in Table 5 are consistent with the prediction that, for capital-increasing life policies, premiums decrease with P&C affiliates' losses. These results support the idea that when the shadow cost of capital increases, premiums fall if the products initially bring capital inflow. With elastic demand, lower premiums can attract more capital inflow.

If the changes in premiums are due to worse financial constraints, premiums should change in the opposite direction when financial constraints relax. In Panel A of Table C2 in Appendix, I redo Panel A, replacing *P&C Loss* with two measures capturing positive performance of the P&C subsidiaries. One measure is *P&C Gain*, which is underwriting gain of all P&C subsidiaries scaled by the sum of their lagged assets. Another measure is $P\&C\ Gain \geq 0$, which is *P&C Gain* bounded below at zero. The results suggest that when P&C subsidiaries' operating performance is better, life subsidiaries increase premiums for permanent life policies. These results imply that the relaxing and tightening of financial constraints have opposite effects on permanent policies' premiums.

4.2 10-Year Term Policies Prices

The model predicts that, for policies that reduce capital in the short term, premiums will rise with P&C losses. When P&C losses are larger, the shadow cost of capital is higher.

Intuitively, by raising the premium, life insurers will sell fewer such policies and reduce the capital outflow. Life insurers also lower the capital expenditure (initial costs minus premium) and increase the payoff (premium minus costs in later years), thus, increase returns on these investments. I identify the 10-year term policies as capital-decreasing policies. To test the prediction on 10-year term premiums, 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)-(2) present OLS results. The coefficients on *P&C Loss* are positive and significant in both columns. These results suggest that insurers charge higher premiums for 10-year term policies, if P&C affiliates' losses are larger. In untabulated results, I also repeat the analyses in Columns (1)-(2) by constructing *P&C Loss* with data from annual statements of year $y-1$. Coefficients on annual *P&C Loss* are also negative and statistically significant.

Columns (3)-(4) report results using the IV method. Column (3) reports the first-stage result. The coefficient on the instrumental variable, *P&C Weather Exposure*, is positive and statistically significant. Column (4) presents the second-stage result. The coefficient on the instrumented *P&C Loss* is positive and statistically significant, suggesting that adverse shocks to the insurance group's financial condition cause price increases for these life policies.[22]

Panel B of Table 6 presents robustness checks. Column (1) excludes the financial crisis. Column (2) only includes policies for new customers between 30 and 50 years old. Column (3) uses only one type of policies, those for a 40-year-old male, in the regular health category, with death benefits of $250K. Column (4) only includes life insurers with P&C affiliates. One may be concerned that premiums changing differently for permanent and 10-year term policies is because the two sets of life insurers are different. Column (5) only uses life insurers that have permanent life policy prices in my sample, which is a subset of

[22]Following the previous footnote, to obtain the Cragg-Donald Wald F-statistic, 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 C1 in Appendix B. The type of policy used is the 10-year term life policy for a 40-year-old male, in regular health category, with $250K of death benefits. The Cragg-Donald Wald F-statistic is 69.68, much higher than the Stock-Yogo 10% threshold of 16.38, suggesting that the instrument is sufficiently strong.

the insurers with 10-year policy prices in my sample. I also restrict the sample period to that of the permanent policies', between January 2005 and July 2011. Column (6) replaces the dependent variable with premiums in dollars, and Column (7) with the natural log of premiums. In untabulated first-stage results, the coefficients on *P&C Weather Exposure* are all positive and statistically significant. In the second stage, as shown in Panel B, the coefficients on *P&C Loss* are all positive and statistically significant, suggesting premiums rise with weather-related P&C losses.

According to Column (4) in Panel A, a one standard deviation increase in *P&C Loss*, 2.8% of lagged assets or $53.5 million, is associated with an average price increase by 6.4% of the mean price, which is 30.2% of the standard deviation of the dependent variable (21.2%). According to Column (6) in Panel B, with price in dollars as the dependent variable, a one standard deviation increase in *P&C Loss*, is associated with an average price increase by $118.0, which is 13.2% of the average product type-month standard deviation ($894.5). The results in Table 6 are consistent with the prediction that, for capital-decreasing life policies, premiums increase with P&C affiliates' losses. These results support the idea that when the shadow cost of capital increases, premiums rise if the products initially cause capital outflow. Higher premiums can decrease the number of policies sold and decrease the capital outflow from each policy, thus lower capital outflow caused by selling such policies.

Do premiums change in the opposite direction when financial constraints relax? In Panel B of Table C2 in Appendix, I redo Panel A, replacing *P&C Loss* with *P&C Gain* and $P\&C\ Gain \geq 0$. The results suggest that when P&C subsidiaries' operating performance is better, life subsidiaries lower 10-year term premiums. Intuitively, with lower prices, insurers sell more of such investment-like policies, and investment per policy (initial capital costs minus premiums) also increases. We can see this as insurers making more investment when they have more capital. These results imply that the relaxing and tightening of financial constraints have opposite effects on these policies' premiums.

4.3 Change in 10-Year Term Life Prices 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. Intuitively, if the group has ample financial slack, it can mitigate the adverse shock of P&C losses without changing business activities of the life insurance divisions. Therefore, affiliated P&C losses should have a larger impact on life insurance premiums for more constrained than less constrained groups.

I estimate the equation below in Panel A of Table 7,

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

I use five different proxies for the group's prior level of financial constraints. In Columns (1)-(2), *Constrained* equals one if the group-level risk-based capital ratio (RBC ratio) two years prior is lower than the median in that year, zero otherwise.[23] Regulators will intervene when RBC ratio is below a minimum requirement. In Columns (3)-(4), *Constrained* equals one if the average rating (transformed into ordinal numbers) of P&C and life insurers two years prior is worse than the median in that year, zero otherwise. In Columns (5)-(6), *Constrained* equals one if the group's leverage two years prior exceeds or equals the median in that year, zero otherwise. Since life insurers in general have higher RBC and leverage ratio, as well as better rating than P&C insurers, I exclude life insurers without P&C affiliates in Columns (1)-(6) and the calculation of the breakpoints. In Columns (7)-(8), *Constrained* equals one if the life insurer belongs to a group where no subsidiary or holding company was publicly traded in year $y-2$, zero otherwise. Holding company can be either the ultimate owner or a direct parent of an insurance division. If a group is public, presumably it can more easily raise capital to mitigate a negative shock. In Columns (9)-(10), *Constrained* equals one if, in year $y-2$, any non-insurance subsidiary[24] or holding company does not have a long-term

[23] The ratio is defined here as the sum of total adjusted capital, divided by the sum of authorized control level capital, both summing over all the insurers in the group.

[24] One caveat is that I do not observe financial information on the non-insurance subsidiaries within the groups. The first two measures of group-level financial constraints use only information of the insurance

issuer credit rating of investment grade from S&P, zero otherwise. If an affiliated or parent firm can more easily access the public debt market, it can issue debt and inject capital to the insurance division, and relieve the division's financial constraints.[25]

In Panel A of Table 7, I show results testing this prediction with 10-year term life policies, because the number of life insurers affiliated with P&C insurers is 96 for the 10-year term policy sample, and only 35 for the permanent life policy sample. Odd-numbered columns report OLS results, and even-numbered columns report second-stage results using the IV method. Nine of the ten coefficients on $P\&C\ Loss \cdot Constrained$ are positive and six are also statistically significant, suggesting that affiliated P&C losses have a larger impact on life insurance premiums for more constrained than less constrained groups. For example, in Column (1), the impact of $P\&C\ Loss$ on the life insurance premiums for the more constrained groups is 4.8 times as large as that for the less constrained groups. For more constrained groups, a one standard deviation of $P\&C\ Loss$ is associated with an average price increase of 1.8% of the product type-year average price, which is 8.6% of the standard deviation.

Table C3 in Appendix shows the results using permanent life insurance policies. Seven of the ten coefficients on $P\&C\ Loss \cdot Constrained$ are positive and three are also statistically significant, suggesting that prices of permanent policies decrease more for groups that are more constrained as the model predicts. The results support that the life insurance price changes associated with P&C losses are due to tightening financial constraints.

Panel A of Table 7 suggests that 10-year term life insurance prices increase more strongly with P&C losses in more constrained groups than in less constrained ones. Which measures of constraints among the five matter more? In Panel B, I answer this question by including all the five measures of constraints in one regression. In the OLS result in Column (1), among the

subsidiaries, while the third and fourth measures also consider whether the holding company is public or S&P rated. Two reasons make the caveat a lesser concern. First, if a group is truly financially more constrained, presumably, at least the aggregate leverage of the insurance subsidiaries (the first measure of financial constraints) might be higher. Second, the lack of full information of the group-level financial condition introduces noise that should bias against finding statistically significant results.

[25] One caveat is that I do not observe financial information about the non-insurance subsidiaries within the groups for the first three measures of group-level financial constraints. Two reasons make this caveat a lesser concern. First, if a group is truly financially more constrained, the insurance subsidiaries might appear more financially constrained using the first three measures. Second, the lack of full information of the group-level financial condition introduces noise that should bias against finding statistically significant results.

five interaction terms, only those between *P&C Loss* and *Low RBC Ratio*, as well as between *P&C Loss* and *Low Avg Rating* have statistically significant coefficients. In the IV result in Column (2), only the interaction between *P&C Loss* and *Low RBC Ratio* has a significant coefficient. The significant coefficients on the interaction terms are all positive, suggesting that when insurers are ex ante more constrained, they change life insurance premiums more in response to the P&C losses. The results imply that RBC ratios and insurer ratings are the most relevant measures of insurers' financial constraints. Both regulators and the rating agency rely heavily on insurers' statutory capital.[26] Therefore, this paper suggests that statutory capital is an important form of financial resource for the insurance industry likely due to two main reasons: regulatory capital requirements and customers' preference for better-rated insurers.

4.4 Alternative Explanations

4.4.1 Life Insurers' Financial Strength and Life Insurance Demand

I find that life insurers reduce prices for the permanent life policies following losses to the P&C affiliates. One potential alternative explanation is that when life insurers transfer capital to P&C affiliates, the financial strength of the life insurers weakens. Since potential policyholders prefer financially stronger life insurers, prices of the permanent policies decline, consistent with Titman (1984). Table C4 tests whether life insurers' ratings become worse following losses to the P&C affiliates, using different measures of rating and different specifications. The results suggest that life insurers' ratings do not suffer following P&C losses. Additional evidence against this explanation is that 10-year term policy prices increase with affiliated P&C losses, and prices increase more for more financially constrained groups.

[26]The rating agency, A.M. Best, uses primarily insurers' statutory filing for rating, see A.M. Best (2009). Its rating guideline mentions "capital" more than 80 times, compared to "liquidity" 26 and "profit" 18, see A.M. Best (2009).

4.4.2 Weather Events and Life Insurance Demand

One concern is that when P&C losses are large after weather events in certain regions, the demand for life insurance may change in these regions. If life insurers operate in the same regions as their P&C affiliates, premium decrease of the permanent policies could be due to lower demand for permanent policies, while premium increase of 10-year policies could be due to higher demand for these policies. However, I find that premiums of 10-year policies increase more for more financially constrained groups. It is unlikely that demand increase more for these insurers. Regardless, in Table C5 I repeat Panel A in Tables 5-6, controlling for life insurers' own exposure to weather events using life insurers' lagged market share in each state. Life insurers' own exposure to weather events should reflect the change in demand for their products due to weather events. Results suggest that the effects of affiliated P&C losses on life policy prices do not change qualitatively when controlling for life insurers' exposure to weather events, and thus are unlikely due to weather-induced demand changes.

4.4.3 Liquidity vs. Capital

By selling the permanent policies, insurers initially increase statutory capital. At the same time, they also gain liquidity, since premiums are higher than the sum of commissions and expenses. By selling 10-year term policies, insurers initially decrease capital, and decrease liquidity since premiums are lower than the sum of commissions and expenses. Do life insurers change prices to gain liquidity? If this were true, groups with lower ex ante liquidity should change prices more following P&C losses, relative to groups with higher liquidity.

Column (1) in Table C6 repeats the OLS analysis in Panel A of Table 7, and *Constrained* is a dummy variable for lower ex ante group level asset liquidity. The positive and statistically significant coefficient on *P&C Loss·Low Liquidity* suggests, if the group has lower ex ante liquidity, life insurers increase the 10-year term life premiums more following affiliated P&C losses. In Column (2), including interaction terms between *P&C Loss* and other measures of constraints, the coefficient on *P&C Loss·Low Group Liquidity* is no longer statistically significant. However, the coefficients on *P&C Loss·Low RBC* and

P&C Loss·Worse Avg Rating are positive and statistically significant. The results suggest that liquidity is a less relevant measure of financial constraints compared to RBC ratio and insurer ratings, and insurers change prices most likely to increase the financial strength perceived by regulators and rating agencies.[27]

4.5 Additional Results

4.5.1 Duration of the Effect of P&C Losses on Life Insurance Premiums

How long does the effect of affiliated P&C losses on life insurance prices last? Table C7 studies this question by examining how affiliated P&C losses in each of the preceding eight quarters affect life insurance premiums. Table C7 suggests that the effect of affiliated P&C losses in quarter q on permanent policy prices concentrates in the fourth quarter after q, and that on 10-year term policy prices concentrates in the following four and the sixth quarters.

4.5.2 Change in Capital due to Price Change

As life insurers change policy prices, how much change in capital does the price change lead to? Due to lack of detailed data, I offer calculations based on different assumptions in Appendix D. At the mean of the estimates, a one standard deviation increase of P&C losses, $53.5 million, corresponds to $1.2 million (in the first year) or $2.7 million (in the first two years) increase in net capital flow from new policies due to price change. Since a group with P&C divisions has on average 3.7 life insurers, the aggregate change in capital at the group level is $4.4 million in the first year or $10.0 million in the first two years.

4.5.3 Change in Life Policy Prices and Death Benefits

The model generates an additional prediction concerning how the size of the death benefits affects how life insurance prices respond to P&C losses. If two products differ only in the

[27] There can be other alternative explanations. For example, the adverse selection problem may be more severe with the 10-year term life policies than the permanent policies. Insurers might be more averse to such adverse selection when they are financially more constrained. Thus, they change prices to sell more permanent policies and fewer 10-year term policies.

size of the death benefit, and otherwise are the same (health category, age, maturity, etc.), the actuarial value and statutory reserve vary roughly proportionally to the size of the death benefit, while underwriting expenses change less with the death benefit. Therefore, issuing an investment-like policy becomes less capital intensive as the size of the death benefit increases, and the effect of P&C losses on prices increases with the size of the death benefit in a concave manner. With the same logic, for the capital–increasing policies, the magnitude of the effect of P&C losses on prices increases with the death benefit in a convex manner. However, the sample for the capital–increasing policies (permanent life policies) only contains products with the same death benefit. Thus, I only test the prediction on 10-year term policies. Appendix E.1 derives the model prediction, and shows empirical results consistent with the prediction.

4.5.4 Change in Life Policy Prices for 20-Year Term Policies

Results so far suggest that, in response to affiliated P&C losses, life insurers raise prices for 10-year term policies, and lower prices for permanent life policies. I argue that the difference in price changes is due to the difference in the short-term impact on insurers' capital when selling these policies. The different short-term capital impact is mostly due to the different fixed annual premium of these products, which is related to the different policy durations.

For policies with durations longer than 10 years and shorter than permanent, insurers should increase prices by less than the 10-year term policies, or decrease the price by less than the permanent policies. I test this prediction using 20-year term policies. These policies are some of the most common. Appendix E.2 presents the results, which suggest that, for 20-year term policies, life insurers increase the premiums following affiliated P&C losses, but by 61.8% less than that for 10-year term policies. The difference between the two kinds of term policies is statistically significant at the 1% level.

5 Empirical Results: Transfers from Life to P&C Divisions

The model predicts that 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 transfers received from the rest of the group in Schedule Y of its statutory filing. A negative number means net outflow to the parent and affiliates. The transfer variables in Schedule Y include seven different items, e.g., capital contributions received, which refers to reallocation of assets.[28] The data do not offer detailed transfers between two specific entities, but the net amount an insurer receives from the rest of the group. Thus, it is impossible to identify direct transfers from life to P&C divisions. However, even if direct transfers can be identified, they do not capture the full extent of transfers since transfers can also be indirect. Life insurers may first transfer capital to the parent firm or another division, which then passes the transfer to P&C divisions. To study transfers 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 reported net inflow to obtain the net outflow of the life insurers.

First, I examine net total transfer. However, following losses, P&C insurers may receive reinsurance reimbursement according to inter-division reinsurance agreements. In addition, some other components of the transfer might also 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. Capital contributions are less likely to be automatically correlated with P&C losses, and are also among the most frequently reported forms of transfers.[29] Therefore, in addition to total net transfer, I also examine net capital

[28]The other six items are: shareholder dividends received through ownership by the parent or affiliates, 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. I follow Niehaus (2016) to clean the Schedule Y data.

[29]Shareholder dividends are also frequently reported. However, when insurers pay shareholder dividends, if there are shareholders outside of the group, they will also receive the dividends, which makes this form of

contribution. Since insurers file Schedule Y annually, regressions in this section are at the firm-year level. The main independent variable, *P&C Loss*, and its instrumental variable are constructed at the annual level, instead of aggregating over every four consecutive quarters as in regressions on life insurance pricing.

5.1 Transfers from Life Insurers to the Rest of the Group

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

$$Net\ Transfer\ from\ Life_{i,y} = \beta \cdot P\&C\ Loss_{g,y-1} + \gamma \cdot Cntrls_{y-2} + FE_i + FE_y + u_{i,y}.$$

where i indexes the individual life insurer, g the group, and y the year. The control variables are chosen based on Niehaus (2016). (In Table C8, I redo the main tests on life insurance pricing including all the controls used here.)

Columns (1)-(4) in Table 8 present OLS results. The dependent variable is net total transfer in Columns (1)-(2), and net capital contribution in Columns (3)-(4), both scaled by accounting equity (defined here as assets minus liabilities) from year $t-2$. The coefficient on *P&C Loss* is positive and statistically significant in all columns, suggesting, when the P&C divisions suffer larger losses, life divisions transfer more to the rest of the group.

Columns (5)-(7) show results using the IV method. In the first stage in Column (5), the instrument, *P&C Weather Exposure*, is statistically significantly and positively related to the reported losses. Second-stage results are in Columns (6)-(7). The coefficient on *P&C Loss* is positive in both (6) and (7), and statistically significant in (6). The results suggest that the increased P&C losses cause total net transfers out of life divisions to increase.

Based on Column (4), a one standard deviation of *P&C Loss*, 2.8% of lagged assets, is associated with an increase of 1.7 percentage points in the capital contribution (as a percentage of lagged accounting equity) by the life insurers. This magnitude is significant, given the median is 0.0% and standard deviation 10.5%. Using the median size of the P&C

transfer less attractive. Insurers did not report detailed stock ownership information until 2010. Thus, I do not know the ownership structure before 2010.

insurers, a one standard deviation increase in *P&C Loss*, $53.5 million increase in P&C losses is associated with $6.2 million increase in capital contribution from a life insurer with median-sized equity to the rest of its group. The magnitude is 1.6 times as large in Column (7) with the IV method.[30]

If the increase in life divisions' transfers to the rest of the group is due to negative shocks to the P&C divisions, life divisions might decrease such transfers when P&C divisions have positive operating performance. In Panel A of Table C9 in Appendix, I redo Table 8, replacing *P&C Loss* with two measures capturing positive performance of the P&C subsidiaries, *P&C Gain* and *P&C Gain* ≥ 0. The results suggest that when P&C divisions' operating performance is better, life divisions transfer less to the rest of the group, supporting that such transfers respond to P&C divisions' operating performance.

5.2 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 from life insurers end up. This section presents results suggesting that P&C insurers receive more transfers from the rest of the group following larger losses, supporting 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.

$$Net\ Trnsfr\ to\ P\&C_{i,y} = \beta_1 \cdot P\&C\ Loss_{i,y-1} + \gamma \cdot Cntrl_{i,y-2} + FE_i + FE_y + u_{i,y},$$

where i indexes the individual P&C insurer, g the group, and y the year. *P&C Loss* is at individual P&C firm level, instead of aggregating over all the P&C firms in each group.

Columns (1)-(4) in Table 9 present OLS results. The dependent variable is net total transfer in Columns (1)-(2), and net capital contribution in Columns (3)-(4), both scaled by accounting equity from year $t-2$. The coefficient on *P&C Loss* is positive in all four columns and statistically significant in three, implying when the P&C divisions suffer larger

[30]Based on Column (4), $53.5 million increase in P&C losses is associated with $13.6 million increase in net total transfers. However, the P&C losses are net of reinsurance payments, while the total transfer could include reinsurance payments directly or indirectly paid to P&C divisions.

losses, they receive larger transfers from the rest of the group.

Columns (5)-(7) show results using the IV method. In the first stage shown in Column (5), the instrument, *P&C Weather Exposure*, is again statistically significantly and positively related to the reported losses. In the second-stage results shown in Columns (6)-(7), the coefficients on *P&C Loss* are positive and statistically significant in both columns. The results suggest that P&C divisions receive more transfers as a result of increased P&C losses.

Based on Column (4), a one standard deviation increase in *P&C Loss* (7.3% of assets, at the individual P&C firm level) is associated with a 3.7 percentage points increase in the capital contribution (in percentage of lagged accounting equity). This magnitude is substantial, considering that the median net transfer is 0.0% and standard deviation 0.5%. Using the median size of the P&C insurers, a one standard deviation increase in *P&C Loss*, $12.4 million, is associated with an increase of $2.6 million in capital contribution received. The magnitude is 2.7 times as large in Column (7) with the IV method.

If the increase in transfers from the rest of the group to the P&C divisions is due to negative shocks to the P&C divisions, such transfers should decrease when P&C divisions have positive operating performance. In Panel B of Table C9 in Appendix, I redo Table 9, replacing *P&C Loss* with two measures capturing positive performance of the P&C subsidiaries, *P&C Gain* and *P&C Gain* ≥ 0. The results suggest that when P&C divisions' operating performance is better, the rest of the group transfers less to the P&C divisions, supporting that such transfers respond to P&C divisions' operating performance.

To summarize the findings on internal capital transfers, following larger P&C losses, life insurers make larger transfers to the rest of the group (Table 8), and P&C insurers receive larger transfers (Table 9). These results suggest that capital flows from life insurers to the P&C divisions that suffered losses, to relax the financial constraints of the latter. The results also support that P&C losses can tighten the financial constraints of the life affiliates through internal capital markets. These results on internal capital transfers offer further evidence that the change in life insurance premiums is a result of life insurers' tightened financial constraints due to P&C affiliates' losses.

6 Conclusion

When financially constrained firms suffer adverse cash flow shocks, the tightened financial constraints will affect firms' behavior. However, the effect is hard to measure 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 losses. P&C losses can be due to weather events like hurricanes. Such exogenous shocks can increase its shadow cost of capital for the life insurer, but do not change the economics of their business more than other life insurers. In addition, certain life policies are highly comparable, enabling me to identify the effects 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. Insurers face minimum capital requirements.

The empirical findings are consistent with the predictions of the model. First, for permanent life policies, which initially increase insurers' capital, premiums decline with affiliated P&C losses. Intuitively, by lowering premiums, life insurers can sell more policies and attract more capital inflow with elastic demand 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. Intuitively, by increasing premiums, life insurers will sell fewer such policies and reduce the capital outflow. Life insurers also lower the capital expenditure (initial costs minus premium) and increase the payoff (premium minus costs in later years), thus, increase returns on these investments. 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. This finding indicates 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 more than they affect other life insurers.

This study has five main implications. Other implications of this paper can potentially be generalized across industries. First, the short-term impact of products on firms' financial resources can affect how firms change product prices when more constrained. Second, statutory capital is important for insurers, likely due to both regulatory requirements and consumers' preference for better capitalized insurers. Insurers change prices to improve capitalization when constrained. Third, when adverse financial shocks affect some divisions, the unaffected divisions may change their real activities to help mitigate financial constraints in the affected divisions. Fourth, when financial constraints tighten, firms not only reduce total investment, but may also raise returns on the remaining investments. Fifth, with financing frictions, firms badly in need of capital might sell financing instruments at a discount.

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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.

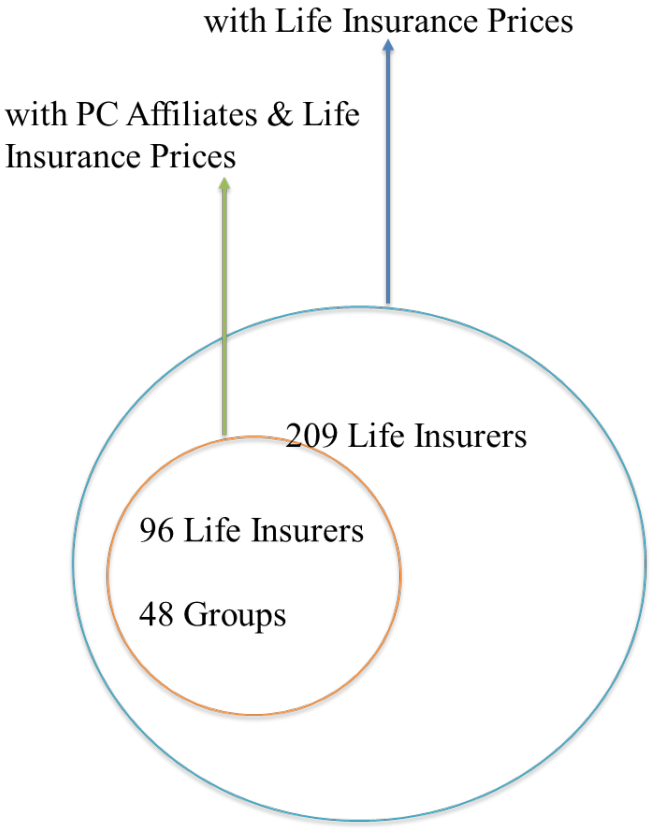


Figure 2: Life Insurance Premiums and Affiliated P&C Losses

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 affiliated P&C losses into quintiles. 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 vertical axis on the left-hand-side), and the solid for the 10-year life term policies (corresponding to the vertical axis on the right-hand-side).

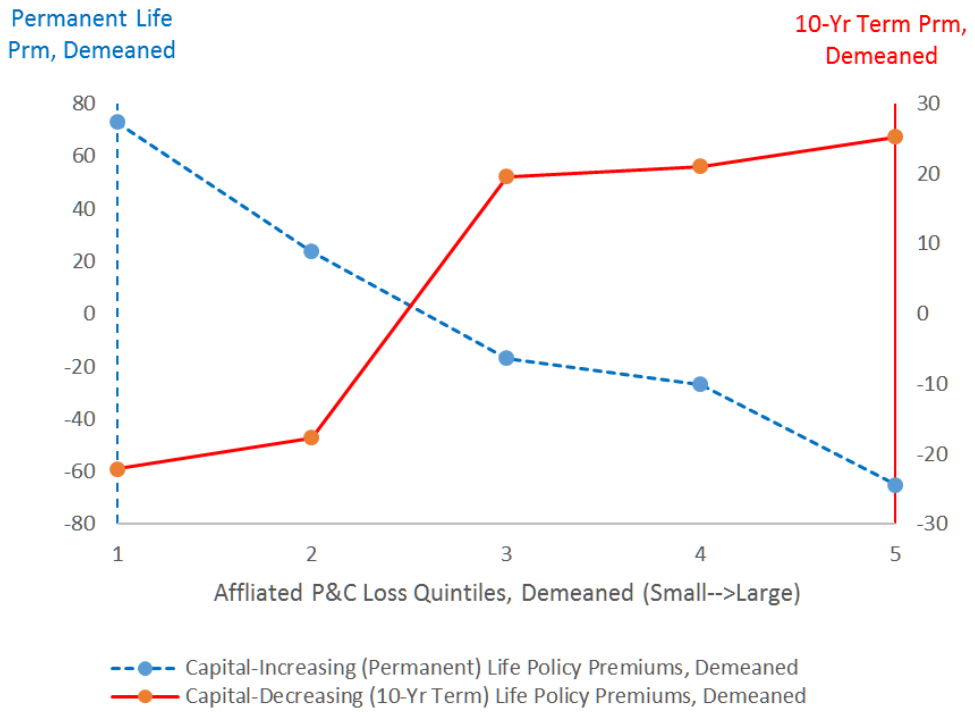


Table 1: Number of Insurance Companies

This table presents the number of insurers and groups in the sample. Column (1) shows the 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	112	27	38	341
2000	117	32	47	323
2001	119	29	49	286
2002	96	23	37	242
2003	99	23	40	234
2004	114	25	46	230
2005	100	22	36	228
2006	97	18	30	234
2007	100	21	33	232
2008	99	20	32	228
2009	89	14	22	231
2010	81	12	21	229
2011	87	16	26	211
2012	75	15	25	212
2013	70	16	23	185
Total	209	48	96	464

Table 2: Summary Statistics of Financial Data of Insurance Companies

Table 2 presents summary statistics of the financial data of the insurers. See Table B1 for variable definitions. Panel A is on life insurers. Columns (1)-(3) in Panel A report the statistics on the financial data of the life insurers, for which I have data on their life insurance premiums. Columns (4)-(6) 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. 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: Individual Life Insurers

	Mean	Std Dev	25th Pctl	Median	75th Pctl
Assets ($ Billion)	13.28	22.58	0.87	3.21	13.01
Leverage (%)	85.58	14.85	83.87	91.14	94.04
Dummy for Life Rating = A++, A+	0.60	0.49	0.00	1.00	1.00
Asset Grth (%)	9.39	28.66	0.68	5.28	11.40
Operating Return on Equity (%)	5.79	18.02	1.40	7.05	13.20
Capital Adequacy Ratio Relative to Guidelines	76.96	139.43	4.00	41.00	98.00
Current Liquidity	94.09	76.85	64.40	77.50	95.25
Net Total Transfer Paid (% of Equity)	10.25	27.04	-0.04	6.03	22.7
Net Capital Contribution Paid (% of Equity)	-1.78	10.51	0.00	0.00	0.00
RBC Ratio	15.24	65.61	6.00	7.89	10.97
Net Income (% of Assets)	1.04	4.41	0.12	0.72	1.58
Unrealized Capital Gain (% of Assets)	-0.06	2.19	-0.08	0.00	0.14
Accounting Equity ($ Billion)	1.23	2.05	0.06	0.36	1.48

Panel B: Individual P&C Insurers

	Mean	Std Dev	25th Pctl	Median	75th Pctl
Assets ($ Billion)	1.29	4.10	0.05	0.17	0.66
Leverage (%)	58.47	17.96	50.51	62.75	70.83
P&C Losses (% of Lag Assets)	2.64	7.32	0.00	0.43	2.75
P&C Loss (% of Lag Assets, when P&C Loss >0)	4.78	9.31	1.19	2.48	5.38
P&C Weather Exposure (% of Lag Assets, Instrument)	1.89	15.52	-0.04	0.07	0.88
Net Total Transfer Received (% of Equity)	-0.06	0.60	-0.10	0.00	0.00
Net Capital Contribution Received (% of Equity)	0.05	0.50	0.00	0.00	0.00
RBC Ratio	17.70	56.20	5.07	7.62	13.35
Net Income (% of Assets)	3.13	6.05	0.93	3.04	5.29
Unrealized Capital Gain (% of Assets)	-0.13	14.70	-0.06	0.00	0.36
Accounting Equity ($ Billion)	0.55	1.62	0.03	0.07	0.30

Panel C: Aggregated at the Group Level

	Mean	Std Dev	25th Pctl	Median	75th Pctl
P&C Loss (% of Lag Assets)	1.49	2.75	0.00	0.00	2.04
P&C Loss (% of Lag Assets, when > 0)	3.34	3.30	1.08	2.40	4.29
P&C Weather Exposure (% of Lag Asset, Instrument)	0.98	3.21	-0.01	0.25	0.90
P&C Assets ($ Billion)	12.09	23.15	0.25	1.91	11.85
Group Assets ($ Billion)	39.65	65.27	1.33	11.98	50.79
Group Leverage (%)	77.11	35.32	63.03	75.27	83.94
Group RBC Ratio	4.33	3.09	1.87	3.85	5.66
Group Net Income (% of Assets)	1.80	2.89	0.61	1.45	2.88
Grpup Unrealized Capital Gain (% of Assets)	0.08	10.96	-1.55	0.52	3.54
P&C Market Share (State-4 Quarters, %, when > 0)	0.18	0.53	0.01	0.04	0.15

Panel D: Weather Damages

	Mean	Std Dev	25th Pctl	Median	75th Pctl
Weather Damages (State-Quarter, $ Million)	108.05	1528.07	0.28	2.73	14.09
Unusal Weather Damages (State-Quarter, $ Million)	53.93	1525.04	-25.70	-5.21	-0.42

Table 3: Life Policies Premiums in Percentage of Average Premiums

This table describes life policies premiums in percentage of mean premiums for the same product type in the same year in my sample.

Sample Period	# of Quotes	% Affiliated with P&C	% of Average Premium for Product Type-Year				
			Mean	Std Dev	25th Pctl	Median	75th Pctl
Panel A: Permanent Life Policy							
Jan. 2005 - Jul. 2011	27,976	50.06	100.00	11.97	91.48	97.97	105.60
Panel B: 10-Year Term Life Policy							
Mar. 1999 - Dec. 2013	366,078	38.12	100.00	21.15	85.05	96.21	111.44
Jan. 2002 - Dec. 2013	298,567	37.83	100.00	21.23	84.76	95.84	111.64

Table 4: How New Policies Change Insurers' Capital Over Time -- Examples

This table presents numeric examples for how accounting equity 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, non-smoking male in regular health category, seeking $250,000 death benefit. Commissions are assumed to be 50% of the premium.[31] Assumptions on other expenses are based on Tables 8 and 9 in Segel (2002).[32] Mortality tables used are 2001 Commissioner's Standard Ordinary (CSO) ANB S&U tables for reserve calculation, and 2001 Valuation Basic Table (VBT) for actuarial value calculation.

Panel A: Permanent Life Policy[33]

	Capital Inflow	Capital Outflow				
			Issuing (Maintenance) Costs			
Year	Premium	Reserve	Commission	Other Expenses	Actuarial Value	Net Change in Capital
1	2103	217	1052	604	128	103
2	2103	565	0	44	178	1317
3	2103	1004	0	44	220	835
4	2103	2287	0	44	258	-485
5	2103	4279	0	44	308	-2527
...	...	...	...	...	...	...

[31] "Insurance Fees, Revealed", Wall Street Journal, 03/30/2012: http://www.wsj.com/articles/SB10001424052702304177104577305930202770336. Assuming a commission rate of between 10% and 100% generates the same implications out of these examples.

[32] I take the average between the estimates of branch and non-branch firms in Segel (2002). The permanent policies are universal life policies, for which the maintenance costs (in this table, other expenses after first year) are assumed to be higher in Segel (2002), because of many potential customer actions w.r.t. the savings component. However, the permanent life policies studied here do not have a savings component. Thus, I use his estimates of maintenance costs for term life policies to the both the 10-year and the permanent life policies. Using his estimates for universal life policies will not change the implications of this table.

[33] Reserve for the permanent policy is based on Roberts (2013). The reserve numbers are based on AG 38 3C with 160% COI, adjusting for the face amount, see Roberts (2013) for more details. I am grateful to Craig Roberts for providing more details and the numbers. The policy in Roberts (2013) is for a male at age 45 instead of 40. Reserves for issue age of slightly 45 are higher than 40, biasing against creating positive initial capital inflow. Reserves can vary based on assumptions used. However, insurers have incentives to record lower reserves permitted by law and use reinsurance (especially captive reinsurance) to achieve lower reserves and thus higher initial statutory gain.

Panel B: 10-Year Term Life Policy[34]

	Capital Inflow	Capital Outflow				
			Issuing (Maintenance) Costs			
Year	Premium	Reserve	Commission	Other Expenses	Actuarial Value	Net Change in Capital
1	394	0	197	604	128	-534
2	394	197	0	44	178	-24
3	394	360	0	44	220	-230
4	394	494	0	44	258	-401
5	394	599	0	44	308	-556
...	...	...	...	...	...	...

[34]Reserve for the 10-year term policy is calculated using software provided by Lombardi (2006), with 4.6% as the discount rate and NLP as the reserve method. Standard Valuation Law specifies how the discount rate is calculated, which is based on historical Moody's composite yield on seasoned corporate bonds. The methods for calculating the discount rate are different for the two kinds of policies. The average discount rate for the 10-year term policies is 4.6% between 2002 and 2013. Using a range of disccount rates does not change the pattern of the net change in capital brought by policies. Using FPT or CRVM as reserve methods generates similar pattern in net change in capital. With lower reserve calculations (zero for second year), the policy still generates initial capital outflows.

Table 5: Capital-Increasing (Permanent) Life Policy Premiums and P&C Losses

This table presents permanent life insurance premiums' relationship with P&C losses in Panels A-B, and with P&C gains in Panel C.

Panel A: Premiums and P&C Losses

Panel A presents permanent life insurance premiums' relationship with P&C losses. The dependent variable is monthly life insurance premiums by company and product, as a percentage of the mean premium for the same product type in the same year. T-statistics are reported in parentheses in Columns (1)-(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 is the product type, i the life insurer, m the month in quarter q, year y. Standard errors are corrected for clustering at the group-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels. See Table B1 for variable definitions.

	OLS		IV	
Dependent Var: (Firm-Month-Product Level)	Premium, % of Avg(q)		1st Stage: P&C Loss (q-4 to q-1)	2nd Stage: Premium, % of Avg(q)
	(1)	(2)	(3)	(4)
1st Stage: P&C Weather Exposure (q-4 to q-1)			0.55***	
			(6.88)	
P&C Loss (q-4 to q-1)	-0.16**	-0.11		-0.61**
	(-2.01)	(-1.25)		(-2.56)
Dummy for Life Rating = A++, A+ (q-5)		4.58***	-0.74**	2.63**
		(2.84)	(-2.20)	(2.07)
Log(Life Assets) (y-2)		-3.04***	-0.44**	-3.47***
		(-3.54)	(-2.00)	(-3.78)
Life Asset Grth (y-2)		-0.01	0.01**	-0.00
		(-0.54)	(2.52)	(-0.17)
Life Operating Return on Equity (y-2)		-0.02**	0.00	-0.02**
		(-1.97)	(0.28)	(-2.24)
Life Leverage (y-2)		-0.33**	-0.00	-0.44***
		(-2.20)	(-0.16)	(-3.71)
Life Capital Adequacy Ratio Relative to Guidelines (y-2)		-0.01	-0.00	-0.01
		(-0.40)	(-1.16)	(-0.74)
Life Current Liquidity (y-2)		0.01	-0.01***	-0.04***
		(0.97)	(-3.51)	(-2.83)
Firm-Prdct FE	Yes	Yes	Yes	Yes
Mnth-Prdct FE	Yes	Yes	Yes	Yes
N	27976	26660	26660	26660

Panel B: Robustness Tests

Panel B presents robustness checks of Panel A, reporting second-stage results with the IV method. The first-stage coefficients on *P&C Weather Exposure* are all positive and statistically significant. Columns (1)-(4) uses premium as a percentage of the product type-year mean price as the dependent variable. Column (5) uses the dollar value of premiums and Column (6) uses the natural log of premiums as the dependent variable. Column (1) excludes the period from Jul. 2008 to Dec. 2009. Column (2) only includes policies for those between 30 and 50 years old. Column (3) uses only one type of policies, those for a 40-year-old male, in the regular health category, with death benefits of $250K. Column (4) 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. See Table B1 for variable definitions. Z-statistics are reported in parentheses. Standard errors are corrected for clustering of observations at the group/quarter level.

Dependent Var:	Premium, % of Avg (q)				Premium ($) (q)	Log of Premium($)(q)
	Exclude Crisis	Age 30-50	40, 250K, Regular	Affiliated w/ P&C		
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Loss(q-4 to q-1)	-0.71***	-0.57**	-0.64**	-0.58***	-42.36***	-0.01**
	(-2.59)	(-2.19)	(-2.07)	(-3.10)	(-2.90)	(-2.56)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes
Mnth-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes
N	20442	13453	2238	13132	26660	26660

Table 6: Capital-Decreasing (10-Yr Term) Life Policy Premiums and P&C Losses

This table presents 10-year term life insurance premiums' relationship with P&C losses in Panels A-B, and with P&C gains in Panel C.

Panel A: Premiums and P&C Losses

In Panel A, the dependent variable is monthly life insurance premiums by company and product. T-statistics are reported in parentheses in Columns (1)-(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 is the product type, i the life insurer, m the month in quarter q, year y. Standard errors are corrected for clustering at the group-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels. See Table B1 for variable definitions.

	OLS		IV	
Dependent Var: (Firm-Month-Product Level)	Premium, % of Avg(q)		1st Stage: P&C Loss (q-4 to q-1)	2nd Stage: Premium, % of Avg(q)
	(1)	(2)	(3)	(4)
1st Stage: P&C Weather Exposure (q-4 to q-1)			0.23***	
			(2.78)	
P&C Loss (q-4 to q-1)	0.28***	0.48***		2.27**
	(2.70)	(2.72)		(2.28)
Dummy for Life Rating = A++, A+ (q-5)		3.35***	0.15*	1.86***
		(5.77)	(1.66)	(3.59)
Log(Life Assets) (y-2)		0.02	-0.50***	0.9984
		(0.04)	(-3.64)	(1.39)
Life Asset Grth (y-2)		-0.01	-0.00	-0.01
		(-1.18)	(-0.72)	(-0.84)
Life Operating Return on Equity (y-2)		-0.04***	0.01***	-0.06***
		(-4.26)	(4.43)	(-4.51)
Life Leverage (y-2)		-0.17***	0.03***	-0.23***
		(-3.35)	(3.17)	(-5.05)
Life Capital Adequacy Ratio Relative to Guidelines (y-2)		0.01***	-0.00	0.01***
		(4.01)	(-0.56)	(3.25)
Life Current Liquidity (y-2)		0.01**	0.002*	-0.00
		(2.07)	(1.80)	(-0.33)
Firm-Prdct FE	Yes	Yes	Yes	Yes
Mnth-Prdct FE	Yes	Yes	Yes	Yes
N	298567	206365	206365	206365

Panel B: Robustness Tests

Panel B presents robustness checks, reporting second-stage results with the IV method. The first-stage coefficients on *P&C Weather Exposure* are all positive and statistically significant. Columns (1)-(4) uses premium as a percentage of the product type-year mean price as the dependent variable. Column (5) uses the dollar value of premiums and Column (6) uses the natural log of premiums as the dependent variable. Column (1) excludes the period from Jul. 2008 to Dec. 2009. Column (2) only includes policies for those between 30 and 50 years old. Column (3) uses only one type of policies, those for a 40-year-old male, in the regular health category, with death benefits of $250K. Column (4) only includes life insurers with P&C affiliates. Column (5) only includes life insurers, for which I also have permanent life policies prices and restrict the sample period to between January 2005 and July 2011. Additional controls include all controls in Panel A. See Table B1 for variable definitions. Z-statistics are reported in parentheses. Standard errors are corrected for clustering of observations at the group-quarter level.

Dependent Var:	Premiu, % of Avg (q)					Premium ($) (q)	Log of Premium($)(q)
	Exclude Crisis	Age 30-50	40, 250K, Regular	Affiliated w/ P&C	With Perm Policies		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
P&C Loss(q-4 to q-1)	2.22** (2.12)	2.41** (2.17)	3.72** (2.29)	3.16* (1.68)	2.30** (2.30)	63.56** (2.26)	0.02** (2.19)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mnth-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	172038	120446	7386	73622	52968	206365	206365

Table 7: Capital-Decreasing (10-Yr Term) Life Policy Premiums, P&C Losses, and Financial Constraint

This table presents results on how group-level proxies for financial constraints affect the relationship between 10-year term life insurance premiums and P&C losses. *Constrained* equals one if group-level risk-based capital ratio two years prior is lower than the median in that year in (1)-(2); if the life insurer belongs to a group whose average rating among all subsidiaries in year $y-2$ is worse than the median in year $y-2$ in (3)-(4); if the group leverage in year $y-2$ the median of that year in (5)-(6); if the life insurer is in a group where no subsidiary or holding company was publicly traded in year$y-2$ in in (7)-(8); if in year$y-2$ any non-insurance subsidiary or holding company does not have a long-term issuer credit rating of investment grade from S&P in Columns (9)-(10), and zero otherwise. In Columns (1)-(6), only life insurers with P&C affiliates are included, so that the group leverage and RBC ratio are comparable across groups. Controls include those in Panel A Table 5 and *Constrained*. Odd-numbered columns report OLS results with t-statistics in parentheses, even-numbered columns report second-state results using the IV method with z-statistics in parentheses, in Panel A. Panel B reports OLS results with t-statistics in parentheses. Standard errors are corrected for clustering of observations at the group-quarter level. See Table B1 for variable definitions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A

Dependent Var:	% of Avg Premium (q)									
	Constrained= Low RBC Ratio(y-2)		Constrained= Worse Avg Rating(y-2)		Constrained= High Grp Lev(y-2)		Constrained= Private(y-2)		Constrained= Not S&P Invest Grade(y-2)	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
P&C Loss(q-4 to q-1)	0.50**	1.42	1.16***	-0.55	0.30	4.51**	0.67**	5.12**	1.14***	6.93
*Constrained	(2.39)	(1.61)	(4.86)	(-0.17)	(1.00)	(1.98)	(2.08)	(2.44)	(4.19)	(1.07)
P&C Loss(q-4 to q-1)	0.13	1.10	-0.36**	5.07	0.25	1.12	-0.17	-2.20	-0.24*	0.17
	(0.72)	(1.27)	(-2.15)	(1.07)	(1.15)	(0.67)	(-0.62)	(-1.24)	(-1.72)	(0.41)
Constrained	1.64**	-1.66	-2.77***	0.84	-0.39	-7.16	17.90***	2.80	-1.38	-4.34
	(2.14)	(-0.80)	(-3.73)	(0.15)	(-0.32)	(-1.59)	(7.91)	(1.22)	(-1.29)	(-1.18)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	69293	69293	72623	72623	69293	69293	206365	206365	206365	206365

Panel B

Dependent Var:	% of Avg Premium (q)	
	OLS	IV
	(1)	(2)
P&C Loss(q-4 to q-1)*Low RBC Ratio(y-2)	0.68***	3.47***
	(3.31)	(3.17)
P&C Loss(q-4 to q-1)*Worse Avg Rating(y-2)	1.27***	-0.77
	(4.56)	(-0.36)
P&C Loss(q-4 to q-1)*High Grp Lev(y-2)	-0.04	0.70
	(-0.16)	(0.46)
P&C Loss(q-4 to q-1)*Private(y-2)	0.20	6.05
	(0.51)	(1.31)
P&C Loss(q-4 to q-1)*Not S&P Invest Grade(y-2)	0.26	-3.38
	(0.93)	(-1.51)
P&C Loss(q-4 to q-1)	-1.21***	-6.00
	(-3.03)	(-1.29)
Low RBC Ratio(y-2)	0.80	-2.36*
	(0.98)	(-1.82)
Worse Avg Rating(y-2)	-2.90***	0.95
	(-3.32)	(0.48)
High Grp Lev(y-2)	0.62	-2.37*
	(0.48)	(-1.65)
Private(y-2)	25.97***	-10.82
	(7.19)	(-0.84)
Not S&P Invest Grade(y-2)	3.64**	-0.41
	(2.55)	(-0.45)
Controls	Yes	Yes
Firm-Prdct FE	Yes	Yes
Mnth-Prdct FE	Yes	Yes
N	69293	69293

Table 8: Transfers from Life Divisions to the Rest of the Group and P&C Losses

This table presents results on the relationship between net transfers from life insurers and affiliated P&C losses. Columns (1)-(4) use OLS, with t-statistics in parentheses. (5)-(7) use IV. In (5) is the first stage with t-statistics in parentheses. (5)-(6) are second stage with z-statistics in parentheses. Standard errors are corrected for clustering of observations at the group level. See Table B1 for variable definitions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

$Net\ Trnsfr\ frm\ Life_{i,y} = \beta \cdot P\&C\ Loss_{g,y-1} + \gamma \cdot Cntrl_{y-2} + FE_i + FE_y + u_{i,y}$, where i indexes the individual life insurer, g group, and y year.

	OLS				IV		
Dependent Var:					1st Stage	2nd Stage	
(Transfers Out from Life)	Total Transfer(y)		Capital Con -tribution(y)		P&C Loss(y-1)	Total Transfer(y)	Capital Con -tribution(y)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st Stage: P&C Weather Exposure(y-1)					0.10**		
					(2.01)		
P&C Loss(y-1)	1.21**	1.35**	0.48**	0.60***		9.37***	0.96
	(2.54)	(2.44)	(2.29)	(2.99)		(3.02)	(1.16)
log Life Assets(y-2)		3.95		3.48***	-0.21	4.81	2.80***
		(1.45)		(2.72)	(-0.88)	(1.63)	(3.83)
Life Leverage(y-2)		-0.19		-0.04	-0.01	-0.26	-0.04
		(-1.54)		(-0.73)	(-0.55)	(-1.36)	(-0.85)
Life RBC(y-2)		-0.01		-0.01	-0.00	-0.05	0.00
		(-0.15)		(-0.45)	(-0.52)	(-1.05)	(0.06)
Life Net Income(y-2)		0.04		0.14*	-0.05**	0.20	0.15**
		(0.19)		(1.75)	(-2.12)	(0.62)	(2.04)
Life Unrealized		1.42		-0.62*	0.00	1.03	-0.67*
Capital Gain(y-2)		(1.25)		(-1.72)	(0.07)	(0.87)	(-1.91)
log Group Assets(y-2)		-2.10		-0.65	-0.14	2.87	-1.02
		(-0.63)		(-0.65)	(-0.86)	(0.87)	(-1.19)
Group Leverage(y-2)		0.00		0.00	0.00	0.00	0.00
		(0.51)		(1.05)	(0.41)	(0.75)	(0.97)
Group RBC(y-2)		-0.74		0.06	0.08	-1.99	-0.25
		(-0.49)		(0.16)	(0.85)	(-1.16)	(-0.64)
Group Net		0.13		-0.04	-0.05	1.26	-0.04
Income(y-2)		(0.20)		(-0.26)	(-0.60)	(1.15)	(-0.21)
Group Unrealized		0.13		0.06	-0.03***	0.36	0.06
Capital Gain(y-2)		(0.59)		(0.84)	(-3.14)	(1.52)	(0.82)
Firm FE, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1022	937	1022	937	937	937	937

Table 9: Transfers from the Rest of the Group to P&C Divisions and P&C Losses

This table presents results on the relationship between net transfers received by P&C divisions and their losses. Columns (1)-(4) use OLS, with t-statistics in parentheses. (5)-(7) use IV. In (5) is the first stage with t-statistics in parentheses. (5)-(6) are second stage with z-statistics in parentheses. Standard errors are corrected for clustering of observations at the group level. See Table B1 for variable definitions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

$Net\ Trnsfr\ to\ P\&C_{i,y} = \beta \cdot P\&C\ Loss_{i,y-1} + \gamma \cdot Cntrl_{y-2} + FE_i + FE_y + u_{i,y}$, where i indexes the individual life insurer, g group, and y year.

	OLS				IV		
Dependent Var:					1st Stage	2nd Stage	
(Transfers	Total		Capital Con		P&C	Total	Capital Con
Received by P&C)	Transfer(y)		-tribution(y)		Loss(y-1)	Transfer(y)	-tribution(y)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st Stage: P&C					0.03***		
Weather Exposure(y-1)					(6.50)		
P&C Loss(y-1)	0.76	0.94**	0.53***	0.51***		2.72**	1.36***
	(1.51)	(2.16)	(3.57)	(3.11)		(2.08)	(3.43)
log P&C Assets(y-2)		-11.87***		-6.14***	-0.05	-9.15***	-6.03***
		(-2.85)		(-3.51)	(-0.26)	(-3.24)	(-5.18)
P&C Leverage(y-2)		-0.15		0.12**	-0.01	-0.04	0.12***
		(-0.91)		(2.12)	(-0.77)	(-0.29)	(3.19)
P&C RBC(y-2)		-0.14*		-0.02	0.00	-0.09*	-0.03
		(-1.91)		(-0.53)	(0.65)	(-1.65)	(-0.95)
P&C Net Income(y-2)		0.11		0.06	-0.19***	0.53	0.24**
		(0.31)		(0.66)	(-6.18)	(1.27)	(2.22)
P&C Unrealized		0.36		0.01	-0.07	0.49	0.07
Capital Gain(y-2)		(0.69)		(0.06)	(-1.44)	(1.02)	(0.39)
log Group Assets(y-2)		2.01		2.08	-0.05	1.56	1.29*
		(0.62)		(1.22)	(-0.35)	(0.85)	(1.69)
Group Leverage(t-2)		-0.22		-0.17	-0.00	-0.16	-0.11
		(-0.76)		(-1.51)	(-0.03)	(-0.77)	(-1.43)
Group RBC(t-2)		-1.35		0.10	0.05	-1.11	0.28
		(-0.95)		(0.18)	(0.72)	(-1.04)	(0.69)
Group Net		-1.11		-0.30	0.12**	-1.17*	-0.43*
Income(t-2)		(-1.51)		(-1.09)	(2.07)	(-1.66)	(-1.73)
Group Unrealized		-1.28*		-0.61*	-0.18***	-0.86	-0.46
Capital Gain(t-2)		(-1.67)		(-1.70)	(-3.17)	(-1.23)	(-1.43)
Firm FE, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3092	2741	3092	2741	2741	2741	2741

APPENDIX

Appendix A Model Details

In Period 1, the life insurer sells $Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right)$ policies at the premium P_1^{LF}. The life insurer incurs variable issuing costs, C, including costs to obtain health data of potential policyholders, hourly underwriters' wages, etc. Policyholders' survival rate in Period 1 is s_1. The insurer pays out death benefits, B per policy, if the policyholder dies. The life insurer's Period-1 profits are

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

At the end of Period 1, the life insurer records reserve, V^R per policy, for the $s_1 \cdot Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right)$ surviving policies. It is recorded as liability and reduces capital. Regulations specify the computation of the reserve. At the end of Period 1, the life insurer's capital is the value of capital from the beginning of Period 1, plus the change from selling insurance,

$$K_1^{LF} = RK_0^{LF} + \pi_1^{LF} - V^R s_1 \cdot Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right), \tag{A.2}$$

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, $B\left(1 - s_2\right) s_1 \cdot Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right)$, where s_2 is the policyholders' survival rate of the second period. The profits in Period 2 from policies sold in Period 1 are $\left[P_1^{LF} - B\left(1 - s_2\right)\right] s_1 \cdot Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right)$.[35] 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

$$\pi_2^{LF} = \left[P_1^{LF} - B\left(1 - s_2\right)\right] s_1 \cdot Q^{LF}\left(P_1^{LF},\ K_0^{LF}\right) + \left\{P_2^{LF} - \left[C + B\left(1 - s_1\right)\right]\right\} \cdot Q^{LF}\left(P_2^{LF},\ K_1^{LF}\right). \tag{A.3}$$

[35] In practice, insurers also incur maintenance costs through servicing customers after the first year. Such costs are usually low relative to premiums and do not change model predictions, and are thus omitted here.

Combining Equations (A1), (A2), (A3) and (6), the optimal life insurance premium is

$$P_1^{*LF} = (1 - \frac{1}{\epsilon^{LF}})^{-1}(1 + \beta s_1 + \lambda)^{-1}\left\{(1+\lambda)[C + B(1-s_1)] + \beta B s_1(1-s_2) + \lambda s_1 V^R\right\}, \quad \text{(A.4)}$$

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

Appendix B Data

Table B1: Variable Definitions

Variable	Definition
P&C Loss (Reported)	Set to zero if net underwriting gain is positive. Equal to the negative of net underwriting gain, scaled by lagged assets, if net underwriting gain is negative. Net underwriting gain is available on Statement of Income in the statutory filings, Line 8 Column 1 in 2014 filing. 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. Life insurers unaffiliated with P&C insurers, when included in regressions, are assigned P&C Losses equal to zero. Losses incurred = losses paid less salvage from direct business and reinsurance assumed - reinsurance recovered + net losses unpaid current year - net losses unpaid prior year.
P&C Weather Exposure	Instrument variable for P&C Loss. See Section 3.1.1.B for the construction of the variable.
P&C Gain	Underwriting income scaled by assets, both aggregated among all the P&C affiliates within a group
P&C Gain $\geq$0	Equals *P&C Gain* if *P&C Gain* is positive, and equals zero otherwise.
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	The sum of liabilities of all the P&C companies within the group, divided by sum of assets all the P&C companies within the group (%). Liabilities of a P&C company divided by its assets (%) in Table 9.
P&C Market Share	P&C insurer i's lagged market share in state s, quarter q, as 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
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 (%).
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.
Asset Grth	The admitted assets of the life insurer in year (t - 1) minus that in year (t - 2), scaled by the latter, in percentage.
Operating Return on Equity	A.M. Best's measure of After-tax insurance earnings in relation to the mean of the company's current and prior year policyholders' and shareholders' surplus base.
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, which measures the proportion of liabilities (excluding AVR, conditional reserves and separate account liabilities) covered by cash and unaffiliated holdings, excluding mortgages and real estate.
Net Income	Net income scaled by assets.
Unrealized Capital Gain	Unrealized capital gain scaled by assets.
Accounting Equity	Total assets minus total liabilities.
RBC	Risk-based capital ratio, which is total adjusted capital, divided by authorized control level capital.
Grp RBC	Risk-based capital ratio at the group level, defined as 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.
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.

Table B2: Life Policies' 1st Year Net Impact on Capital

This table presents how capital is affected by selling life policies. The calculation for net change in capital is as described in Table 4. For permanent policies other than for 10-year-old male, I adjust the reserve value of a male at age 45 by ratios implied by first two non-zero values of reserves calculated with software provided by Lombardi (2006) for universal life using CRVM. The reserve values for 10-year term policies are all proxied using those for the regular health category for the corresponding age. Assuming a commission rate of between 10% and 100% generates the same implications.

Panel A: Permanent Life Policies

Death Benefits ($000)	Health Category	Age	Gender	Mean Premium	Median Premium	Net Change in Capital (Using Mean Premium)	
						1st Year	1st&2nd Year
250	Regular	30	Female	1163	1135	-152	697
250	Regular	40	Female	1705	1673	32	1229
250	Regular	50	Female	2633	2547	265	1930
250	Regular	60	Female	4301	4143	789	3405
250	Regular	70	Female	7570	7276	1553	5919
250	Regular	80	Female	15502	15075	2403	9795
250	Regular	30	Male	1398	1373	-78	923
250	Regular	40	Male	2103	2039	103	1419
250	Regular	50	Male	3250	3133	457	2536
250	Regular	60	Male	5463	5314	1115	4491
250	Regular	70	Male	9914	9601	2240	7799
250	Regular	80	Male	19721	19359	3804	13920

Panel B: 10-Year Term Life Policies

Death Benefits ($000)	Health Category	Age	Gender	Mean Premium	Median Premium	Net Change in Capital (Using Mean Premium)	
						1st Year	1st&2nd Year
250	Pref+	30	Male	166	163	-556	-578
500	Pref+	30	Male	253	245	-547	-626
250	Pref	30	Male	199	198	-554	-560
500	Pref	30	Male	317	310	-545	-595
250	Regular	30	Male	278	270	-547	-522
500	Regular	30	Male	473	460	-532	-521
250	Pref+	40	Male	213	208	-552	-655
500	Pref+	40	Male	339	320	-544	-792
250	Pref	40	Male	263	258	-550	-633
500	Pref	40	Male	439	418	-539	-747
250	Regular	40	Male	394	370	-534	-558
500	Regular	40	Male	691	645	-513	-614
250	Pref+	50	Male	420	401	-511	-776
500	Pref+	50	Male	737	705	-470	-1059
250	Pref	50	Male	532	516	-500	-695
500	Pref	50	Male	956	915	-451	-906
250	Regular	50	Male	818	769	-467	-526
500	Regular	50	Male	1507	1440	-395	-599
250	Pref+	60	Male	974	938	-341	-1030
500	Pref+	60	Male	1813	1735	-147	-1615
250	Pref	60	Male	1219	1178	-309	-886
500	Pref	60	Male	2288	2195	-90	-1349
250	Regular	60	Male	1865	1744	-199	-450
500	Regular	60	Male	3519	3345	101	-567
250	Pref+	70	Male	2902	2760	280	-1205
500	Pref+	70	Male	5544	5219	1033	-2154
250	Pref	70	Male	3645	3458	426	-886
500	Pref	70	Male	6990	6625	1306	-1575
250	Regular	70	Male	5294	5120	714	298
500	Regular	70	Male	10221	9880	1847	693
250	Pref+	80	Male	10419	9804	2761	585
500	Pref+	80	Male	20261	19188	5837	951
250	Pref	80	Male	12219	11305	2924	838
500	Pref	80	Male	23816	21880	6140	1389
250	Regular	80	Male	16896	16345	3524	3984
500	Regular	80	Male	32884	32270	7198	7255

Appendix C Supporting Evidence

Table C1: Life Policy Premiums and P&C Losses, Group/Quarter Averages

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 in Columns (1)-(2) and 10-year term in (3)-(4), both for a 40-year-old male, in regular health category, with $250K of death benefits. Columns (1) and (3) show first-stage results, Columns (2) and (4) second-stage results. 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 Panel A of Table 5. See Table B1 for variable definitions. T-statistics are reported in parentheses in Columns (1), and z-statistics are reported in parentheses in Columns (2). ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Capital-Increasing (Permanent)		**Capital-Decreasing (10-Year)**	
	1st Stage	2nd Stage	1st Stage	2nd Stage
Dependent Var:	P&C Loss (q-4 to q-1)	Grp-Qtr Avg of % of Avg Premium	P&C Loss (q-4 to q-1)	Grp-Qtr Avg of % of Avg Premium
	(1)	(2)	(3)	(4)
1st Stage: P&C Weather Exposure(q-4 to q-1)	0.53***		0.12***	
	(10.06)		(8.35)	
P&C Loss(t-4 to t-1)		-0.37		-0.10
		(-1.10)		(-0.11)
Other Controls	Yes	Yes	Yes	Yes
Group FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
N	474	474	1825	1825
Craig-Donald Wald F statistic	124.27		69.68	

Table C2: Life Policy Premiums and P&C Losses, Group/Quarter Averages

This table presents results on the relationship life insurance premiums and affiliated P&C underwriting gains. The dependent variable is monthly life insurance premiums by company and product, as a percentage of the mean premium for the same product type in the same year. Panel A uses permanent life insurance premiums, B uses 10-year term life premiums. *P&C Gain* is the underwriting income scaled by assets, both aggregated among all the P&C affiliates within a group. *P&C Gain* ≥ 0 equals *P&C Gain* if *P&C Gain* is positive, and equals zero otherwise. In each panel, Columns (1) and (2) show OLS results, Columns (3) and (5) IV first-stage results, and (4) and (6) IV second-stage results. T-statistics are reported in parentheses in Columns (1)-(2), (4) and (6), and z-statistics in Columns (3) and (5). Additional controls include all controls in Panel A of Table 5. See Table B1 for variable definitions. Standard errors are corrected for clustering at the group-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Capital-Increasing (Permanent) Life Policy Premiums and P&C Gains

	OLS		IV			
Dependent Var: (Firm-Month-Prdct)	% of Avg Premium (q)		1st Stage: P&C Gain (q-4 to q-1)	2nd Stage: Premium, % of Avg(q)	1st Stage: P&C Gain≥0 (q-4 to q-1)	2nd Stage: Premium, % of Avg(q)
	(1)	(2)	(3)	(4)	(5)	(6)
1st Stage:P&C Weather Exposure (q-4 to q-1)			-0.60***		-0.13***	
			(-5.80)		(-2.85)	
P&C Gain (q-4 to q-1)	-0.02			0.56**		
	(-0.21)			(2.46)		
P&C Gain≥0 (q-4 to q-1)		-0.16				2.63**
		(-0.74)				(2.11)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes
Mnth-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes
N	26660	26660	26660	26660	26660	26660

Panel B: Capital-Decreasing (10-Year) Life Policy Premiums and P&C Gains

	OLS		IV			
Dependent Var: (Firm-Month-Prdct)	% of Avg Premium (q)		1st Stage: P&C Gain (q-4 to q-1)	2nd Stage: Premium, % of Avg(q)	1st Stage: P&C Gain≥0 (q-4 to q-1)	2nd Stage: Premium, % of Avg(q)
	(1)	(2)	(3)	(4)	(5)	(6)
1st Stage:P&C Weather Exposure (q-4 to q-1)			-0.21*		-0.04	
			(-1.73)		(-1.07)	
P&C Gain (q-4 to q-1)	-0.42***			-2.43*		
	(-3.61)			(-1.74)		
P&C Gain≥0 (q-4 to q-1)		-0.44**				-12.17
		(-2.44)				(-1.01)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes
Mnth-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes
N	206365	206365	206365	206365	206365	206365

Table C3: Capital-Increasing (Permanent) Life Policy Premiums, P&C Losses, and Financial Constraint

This table presents results on how group-level proxies for financial constraints affect the relationship between permanent life insurance premiums and P&C losses. *Constrained* equals one if group-level risk-based capital ratio two years prior is lower than the median in that year in (1)-(2); if the life insurer belongs to a group whose average rating among all subsidiaries in year $y-2$ is worse than the median in year $y-2$ in (3)-(4); if the group leverage in year $y-2$ the median of that year in (5)-(6); if the life insurer is in a group where no subsidiary or holding company was publicly traded in year$y-2$ in in (7)-(8); if in year$y-2$ any non-insurance subsidiary or holding company does not have a long-term issuer credit rating of investment grade from S&P in Columns (9)-(10), and zero otherwise. In Columns (1)-(6), only life insurers with P&C affiliates are included, so that the group leverage and RBC ratio are comparable across groups. Controls include those in Panel A Table 6 and *Constrained*. Odd-numbered columns report OLS results with t-statistics in parentheses. Even-numbered columns report second-state results using the IV method with z-statistics in parentheses. Standard errors are corrected for clustering of observations at the group-quarter level. See Table B1 for variable definitions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent Var:	% of Avg Premium (q)									
	Constrained= Low RBC Ratio(y-2)		Constrained= Worse Avg Rating(y-2)		Constrained= High Grp Lev(y-2)		Constrained= Private(y-2)		Constrained= Not S&P Invest Grade(y-2)	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
P&C Loss(q-4 to q-1)	-0.42**	0.45	-0.02	-0.53	-0.89**	-1.13	-1.00***	-3.26*	0.62***	0.41
*Constrained	(-2.32)	(0.81)	(-0.10)	(-1.36)	(-2.55)	(-0.82)	(-2.76)	(-1.82)	(3.42)	(0.62)
P&C Loss(q-4 to q-1)	0.33**	-0.65	-0.04	0.12	0.82**	0.76	0.84**	2.69	-0.60***	-0.79
	(2.26)	(-0.75)	(-0.18)	(0.23)	(2.41)	(0.53)	(2.39)	(1.48)	(-4.01)	(-1.27)
Constrained	-1.02	-2.55**	-0.85	1.16	3.46***	5.57***	-1.71	2.98	3.00***	4.51***
	(-1.38)	(-2.57)	(-0.92)	(1.11)	(2.78)	(2.99)	(-0.96)	(1.30)	(2.79)	(4.58)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	11372	11372	11804	11804	11372	11372	26660	26660	26660	26660

Table C4: 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. See Table B1 for variable definitions. Standard errors are corrected for clustering of observations at the group/quarter level. Z-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Multinomial Logit		OLS			
Dependent Var:	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

Table C5: Life Policy Premiums and Life Insurers' Exposure to Weather Events

This table presents 10-year term life insurance premiums' relationship with P&C losses, controlling for life insurers' own exposure to weather events. The dependent variable is monthly life insurance premiums by company and product. Analogous to the instrumental variable, $Life\ Weather\ Exposure_{i,q} = \sum_s (Unusual\ Weather\ Damage_{s,q} \cdot Lag\ Mkt\ Share_{i,s,q-4})$, where $Lag\ Mkt\ Share_{i,s,q-4}$ is computed using the number of new policies written by each life insurer in each state s in the year before quarter $q-4$. The unit of $Life\ Weather\ Exposure$ is in billions of dollars.Additional controls include all controls in Panel A of Table 5. T-statistics are reported in parentheses in Columns (1)-(3), and z-statistics are reported in parentheses in Column (4). Standard errors are corrected for clustering at the group-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels. See Table B1 for variable definitions.

Panel A: Permanent Life Policies

	OLS		IV	
Dependent Var: (Firm-Month-Product Level)	Premium, % of Avg(q)		1st Stage: P&C Loss (q-4 to q-1)	2nd Stage: Premium, % of Avg(q)
	(1)	(2)	(3)	(4)
1st Stage: P&C Weather Exposure (q-4 to q-1)			0.49***	
			(5.19)	
P&C Loss (q-4 to q-1)	0.00	0.02		-0.85**
	(0.01)	(0.19)		(-2.27)
Life Weather Exposure (q-4 to q-1)	0.00	-0.00	-0.00	-0.00
	(0.07)	(-0.33)	(-0.76)	(-0.35)
Controls		Yes	Yes	Yes
Firm-Prdct FE	Yes	Yes	Yes	Yes
Mnth-Prdct FE	Yes	Yes	Yes	Yes
N	18787	17840	17840	17840

Panel B: 10-Year Term Life Policies

Dependent Var: (Firm-Month-Product Level)	OLS		IV	
	Premium, % of Avg(q)		1st Stage: P&C Loss (q-4 to q-1)	2nd Stage: Premium, % of Avg(q)
	(1)	(2)	(3)	(4)
1st Stage: P&C Weather Exposure (q-4 to q-1)			0.22***	
			(2.64)	
P&C Loss (q-4 to q-1)	0.35***	0.46***		2.47**
	(3.28)	(2.59)		(2.26)
Life Weather Exposure (q-4 to q-1)	-0.57	-1.554*	0.21	-2.89***
	(-0.65)	(-1.79)	(0.89)	(-2.58)
Controls		Yes	Yes	Yes
Firm-Prdct FE	Yes	Yes	Yes	Yes
Mnth-Prdct FE	Yes	Yes	Yes	Yes
N	284160	197601	197601	197601

Table C6: Capital-Decreasing (10-Yr Term) Life Policy Premiums, P&C Losses, and Liquidity

This table presents results on how group-level proxies for liquidity affect the relationship between 10-year term life insurance premiums and P&C losses. The dummy variable *Low Liquidity*$(y-2)$ is one if the sum of cash and treasury security scaled by assets in year $t-2$ is below the median of that year. Controls include all the control variables in Panel A of Table 5. This table reports OLS results with t-statistics in parentheses. Standard errors are corrected for clustering of observations at the group-quarter level. See Table B1 for variable definitions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent Var:	% of Avg Premium (q)	
	(1)	(2)
P&C Loss(q-4 to q-1)*Low Liquidity(y-2)	0.88***	0.28
	(3.14)	(0.90)
P&C Loss(q-4 to q-1)*Low RBC Ratio(y-2)		0.63***
		(2.88)
P&C Loss(q-4 to q-1)*Worse Avg Rating(y-2)		1.21***
		(4.35)
P&C Loss(q-4 to q-1)*High Grp Lev(y-2)		-0.06
		(-0.21)
P&C Loss(q-4 to q-1)*Private(y-2)		-0.53
		(-1.21)
P&C Loss(q-4 to q-1)*Not S&P Invest Grade(y-2)		0.19
		(0.72)
P&C Loss(q-4 to q-1)	-0.06	-0.58
	(-0.32)	(-1.19)
Low Liquidity(y-2)	-0.55	-0.57
	(-0.57)	(-0.55)
Low RBC Ratio(y-2)		0.87
		(1.13)
Worse Avg Rating(y-2)		-2.69***
		(-3.07)
High Grp Lev(y-2)		0.73
		(0.57)
Private(y-2)		26.83***
		(7.17)
Not S&P Invest Grade(y-2)		4.10**
		(2.55)
Controls	Yes	Yes
Firm-Prdct FE	Yes	Yes
Mnth-Prdct FE	Yes	Yes
N	74218	69052

Table C7: Life Insurance Prices and P&C Losses over Preceding Eight Quarters

This table presents the relationship between life insurance premiums and P&C losses over the preceding eight quarters. Columns (1)-(2) use permanent policies, while (3)-(4) use the 10-year term policies. Additional controls include all controls in Panel A of Table 5. Standard errors are corrected for clustering at the group-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels. See Table B1 for variable definitions.

	OLS			
	Permanent Policies		10-Year Term Policies	
Dependent Var: (Firm-Month-Product)	% of Avg Premium (q)	Premium, $ (q)	% of Avg Premium (q)	Premium, $ (q)
	(1)	(2)	(3)	(4)
P&C Loss (q-1)	-0.08	-12.95	0.79**	36.91***
	(-0.35)	(-0.30)	(2.14)	(3.57)
P&C Loss (q-2)	-0.14	-27.10	0.44	23.27**
	(-0.61)	(-0.67)	(1.16)	(2.27)
P&C Loss (q-3)	-0.20	-41.57	0.58	22.57**
	(-0.78)	(-0.93)	(1.63)	(2.39)
P&C Loss (q-4)	-0.44*	-85.06**	0.53	20.16*
	(-1.78)	(-2.10)	(1.55)	(1.90)
P&C Loss (q-5)	-0.13	-43.84	0.48	11.33
	(-0.39)	(-0.76)	(1.54)	(1.17)
P&C Loss (q-6)	-0.10	-36.93	0.76**	19.83**
	(-0.33)	(-0.71)	(2.22)	(2.02)
P&C Loss (q-7)	-0.34	-75.61	0.58	13.64
	(-1.14)	(-1.53)	(1.63)	(1.39)
P&C Loss (q-8)	-0.35	-74.33*	0.49	11.21
	(-1.40)	(-1.81)	(1.38)	(1.06)
Controls	Yes	Yes	Yes	Yes
Firm-Prdct FE	Yes	Yes	Yes	Yes
Mnth-Prdct FE	Yes	Yes	Yes	Yes
N	67534	67534	206369	206369

Table C8: Life Policy Premiums and P&C Losses, Additional Controls

This table presents life insurance premiums' relationship with P&C losses, with additional control variables. Panel A uses permanent policies, and B 10-year term. The dependent variable is monthly life insurance premiums by company and product, as a percentage of the mean premium for the same product type in the same year. T-statistics are reported in parentheses in Columns (1)-(2), and z-statistics are reported in parentheses in Column (3). Standard errors are corrected for clustering at the group-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels. See Table B1 for variable definitions.

Panel A: Permanent Life Premiums

	OLS	IV	
Dependent Var: (Firm-Month-Product Level)	Premium, % of Avg(q)	1st Stage: P&C Loss(q-4 to q-1)	2nd Stage: Premium, % of Avg(q)
	(1)	(2)	(3)
1st Stage: P&C Weather Exposure (q-4 to q-1)		0.44***	
		(4.62)	
P&C Loss (q-4 to q-1)	0.05		-0.42*
	(0.36)		(-1.80)
Dummy for Life Rating = A++, A+ (q-5)	0.53	-0.91*	-2.48*
	(0.40)	(-1.67)	(-1.90)
Log(Life Assets) (y-2)	1.78*	-1.42**	2.96**
	(1.81)	(-2.14)	(2.12)
Life Asset Grth (y-2)	-0.01	0.01*	-0.01
	(-0.78)	(1.83)	(-0.43)
Life Operating Return on Equity (y-2)	-0.00	0.00	0.01
	(-0.36)	(0.99)	(0.42)
Life Leverage (y-2)	0.87***	-0.02	-0.05
	(4.89)	(-0.19)	(-0.34)
Life Current Liquidity (y-2)	-0.04***	-0.01	-0.03***
	(-2.96)	(-1.41)	(-2.65)
Life RBC (y-2)	0.62***	0.07	-0.29*
	(3.13)	(0.79)	(-1.75)
Life Net Income (y-2)	0.28*	0.13	-0.09
	(1.72)	(1.44)	(-0.42)
Life Unrealized Capital Gain (y-2)	0.15	0.18	0.65**
	(0.72)	(1.51)	(2.47)
Log(Group Assets) (y-2)	-5.85**	1.18	-5.24**
	(-2.30)	(1.50)	(-2.39)
Group Leverage (y-2)	-0.39***	-0.13	-0.46**
	(-2.72)	(-1.35)	(-2.20)
Group RBC (y-2)	-3.34***	0.08	-0.18
	(-3.31)	(1.15)	(-1.04)
Group Net Income (y-2)	-1.19***	0.05	-0.21
	(-2.93)	(0.30)	(-0.59)
Group Unrealized Capital Gain(t-2)	-0.02	-0.14***	-0.16***
	(-0.51)	(-3.17)	(-2.82)
Firm-Prdct FE, Mnth-Prdct FE	Yes	Yes	Yes
N	11763	11763	11763

Panel B: 10-Year Term Life Premiums

	OLS	IV	
Dependent Var: (Firm-Month-Product Level)	Premium, % of Avg(q)	1st Stage: P&C Loss(q-4 to q-1)	2nd Stage: Premium, % of Avg(q)
	(1)	(2)	(3)
1st Stage: P&C Weather Exposure (q-4 to q-1)		0.19*	
		(1.87)	
P&C Loss (q-4 to q-1)	0.63***		3.19*
	(3.76)		(1.72)
Dummy for Life Rating = A++, A+ (q-5)	3.43***	-0.50	3.85***
	(3.76)	(-1.59)	(3.00)
Log(Life Assets) (y-2)	2.07**	0.07	0.26
	(2.35)	(0.31)	(0.27)
Life Asset Grth (y-2)	-0.02	0.00	-0.01
	(-1.17)	(0.78)	(-0.74)
Life Operating Return on Equity (y-2)	-0.08***	0.00	-0.08***
	(-4.43)	(0.97)	(-3.83)
Life Leverage (y-2)	-0.04	0.06**	-0.30**
	(-0.32)	(2.50)	(-2.10)
Life Current Liquidity (y-2)	0.04**	0.01	0.02
	(2.27)	(1.46)	(1.06)
Life RBC (y-2)	0.09	-0.00	0.01
	(1.05)	(-0.02)	(0.12)
Life Net Income (y-2)	0.19	0.12*	-0.06
	(1.14)	(1.79)	(-0.16)
Life Unrealized Capital Gain (y-2)	-0.92***	0.04	-0.76
	(-3.11)	(0.38)	(-1.64)
Log(Group Assets) (y-2)	3.11***	0.51*	0.60
	(2.77)	(1.71)	(0.40)
Group Leverage (y-2)	-0.28**	-0.06**	-0.01
	(-2.31)	(-2.02)	(-0.04)
Group RBC (y-2)	0.97***	-0.06	0.46
	(3.37)	(-0.80)	(1.39)
Group Net Income (y-2)	-0.75***	-0.10	-0.25
	(-3.25)	(-1.16)	(-0.59)
Group Unrealized Capital Gain(t-2)	0.14**	-0.08***	0.37**
	(2.37)	(-2.83)	(1.98)
Firm-Prdct FE, Mnth-Prdct FE	Yes	Yes	Yes
N	78465	78465	78465

Table C9: Internal Capital Transfers and P&C Gains

In each panel, Columns (1)-(2) use OLS, with t-statistics in parentheses. (3)-(6) use IV. In (3) and (5) are the first stage with t-statistics in parentheses. (4) and (6) are second stage with z-statistics in parentheses.

Panel A: Transfers from Life Divisions to the Rest of the Group and P&C Gains

This table presents results on the relationship between net transfers from life insurers and affiliated P&C underwriting gains. Controls include those in Table 8. Standard errors are corrected for clustering of observations at the group level. See Table B1 for variable definitions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

$Net\ Trnsfr\ frm\ Life_{i,y} = \beta \cdot P\&C\ Gain_{g,y-1} + \gamma \cdot Cntrl_{y-2} + FE_i + FE_y + u_{i,y}$, where i indexes the individual life insurer, g group, and y year.

	OLS		IV			
Dependent Var: (Transfers Out from Life)	Total Transfer(y)		1st Stage: P&C Gain (y-1)	2nd Stage: Total Transfer(y)	1st Stage: P&C Gain≥0 (y-1)	2nd Stage: Total Transfer(y)
	(1)	(2)	(3)	(4)	(5)	(6)
1st Stage:P&C Weather Exposure (y-1)			-0.21		-0.13*	
			(-1.54)		(-1.65)	
P&C Gain (y-1)	-1.00***			-4.00***		
	(-3.27)			(-3.78)		
P&C Gain≥0 (y-1)		-1.26***				-7.71***
		(-2.64)				(-3.50)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	937	937	937	937	937	937

Panel B: Transfers from the Rest of the Group to P&C Divisions and P&C Gains

This table presents results on the relationship between between net transfers received by P&C divisions and their underwriting gains. Columns (1)-(2) use OLS, with t-statistics in parentheses. (3)-(6) use IV. In (3) and (5) are the first stage with t-statistics in parentheses. (4) and (6) are second stage with z-statistics in parentheses. Controls include those in Table 9. Standard errors are corrected for clustering of observations at the group level. See Table B1 for variable definitions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

$Net\ Trnsfr\ to\ P\&C_{i,y} = \beta \cdot P\&C\ Gain_{i,y-1} + \gamma \cdot Cntrl_{y-2} + FE_i + FE_y + u_{i,y}$, where i indexes the individual life insurer, g group, and y year.

	OLS		IV			
Dependent Var: (Transfers Received by P&C)	Total Transfer(y)		1st Stage: P&C Gain (y-1)	2nd Stage: Total Transfer(y)	1st Stage: P&C Gain≥0 (y-1)	2nd Stage: Total Transfer(y)
	(1)	(2)	(3)	(4)	(5)	(6)
1st Stage:P&C Weather Exposure (y-1)			-0.04***		-0.01***	
			(-7.62)		(-3.54)	
P&C Gain (y-1)	-0.89***			-2.13**		
	(-3.54)			(-2.01)		
P&C Gain≥0 (y-1)		-1.40***				-11.34*
		(-3.74)				(-1.74)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	2741	2741	2741	2741	2741	2741

Appendix D Capital Change due to Price Change

Life insurers report the number of new term policies issued, but not the number of universal life policies issued. Therefore, the calculation of capital change due to price change here is based on term policies. Life insurers in my sample on average sell around 15,138 new term life insurance policies each year. The data does not offer a detailed breakdown of the number of policies sold across different types of life policies. Assume that a firm sells only 10-year term policies, evenly distributed among the types of policies in my sample. Column (4) in Panel A of Table 6 suggests that one standard deviation of P&C losses, leads to a 6.4% change of life insurance premium. This premium change will lead to a 14.1% change in number of policies sold, or 2,131 fewer new policies sold, based on Koijien and Yogo (2016)'s demand elasticity estimate of 2.2. Using the median 1st-year capital impact of the 10-year policies in my sample ($-395), the 2,131 fewer new policies lead to a reduction of capital outflow by $841,915. In addition, the price increase for the 13,007 (15,138-2,131) new policies sold leads to a reduction of $767,388 (13,007*$118.0/2) of capital outflow, where $118.0 is based on Column (6) in Panel B (dividing by two assuming commission is 50%). In total, the price change causes a reduction of $1,609,303 capital outflow in the first year.

Using the median capital impact in the first two years of the 10-year policies in my sample ($-672), the 2,131 fewer new policies lead to a reduction of capital outflow by $1,432,321. In addition, the price increase for the 13,007 new policies sold leads to a reduction of $2,302,163 (13,007*$118.0*1.5) of capital outflow, where $118.0 is based on Column (6) in Panel B (dividing by two assuming commission is 50%). In total, the price change causes a reduction of $3,734,484 capital outflow in the first year.

Assume that a firm sells only 10-year term policies, evenly distributed among the types of policies in my sample for those aged between 30 and 50 (likely the more common buyers of 10-year term policies). Column (4) in Panel B suggests that one standard deviation of P&C losses, leads to a 3.7% change of life insurance premium. This premium change will lead to a 8.14% change in number of policies sold, or 1,232 fewer new policies sold. Using the median 1st-year capital impact of these 10-year policies in my sample ($-547), the 1,232 fewer new policies lead to a reduction of capital

outflow by $674,031. In addition, the price increase for the 13,906 (15,138-1,232) new policies sold leads to a reduction of $133,696. (13,906*3.7%*$519.7/2) of capital outflow, where $519.7 is the average mean premium of these 10-year term policies. In total, the price change causes a reduction of $807,727 outflow.

Using the median capital impact in the first two years of the 10-year policies in my sample ($-651), the 2,131 fewer new policies lead to a reduction of capital outflow by $1,387,561. In addition, the price increase for the 13,007 new policies sold leads to a reduction of $375,153 (13,906*3.7%*$519.7*1.5) of capital outflow. In total, the price change causes a reduction of $1,762,714 capital outflow in the first year.

Appendix E Additional Model Predictions and Tests

E.1 Change in Life Policy Prices and Death Benefits

According to Equation (7) in the model, when the difference between capital costs in Period 1 and Period 2, of a product is greater, the price change is greater. Without exact measurement of the term in the curly brackets, $\left\{[C + B(1 - s_1) + s_1 V^R] - [B(1 - s_2) - \frac{1}{\beta} V^R]\right\}$, it is hard to directly test this prediction. However, the following identification can be explored empirically. I examine life insurance policies with different amounts of death benefit. If products are only different in the size of death benefit, and otherwise the same, in terms of health category, age etc., the variable underwriting expenses, C, will be similar, for the same health category, the medical exams ordered will be the same, and the work needed from the underwriter will be similar too, not affected by the death benefit size of the policies. When increasing the face value of a product by a certain percentage, the death benefit, B, and reserve value , V^R, of the product increase by the same percentage. s_1 and s_2 do not change with the size of death benefit. Because of similar variable underwriting expenses, C, the difference between capital costs in Period 1 and Period 2, $\left\{[C + B(1 - s_1) + s_1 V^R] - [B(1 - s_2) - \frac{1}{\beta} V^R]\right\}$, increases by a smaller percentage than the increase in the death benefit. Assuming the two products have the same elasticity of demand,

Equation (7) indicates that when increasing the face value, the effect of losses on the price increases by less. For example, the effect of losses on the price of a product with a death benefit of $500,000 should be less than twice that of a product with a death benefit of $250,000. Intuitively, the same underwriting expenses are spread over a larger investment, when increasing the death benefit. In other words, the capital costs increase in death benefit in a concave way, or at a decreasing rate. Therefore, when increasing the death benefit, issuing a policy becomes less capital intense for each dollar of death benefit. The need to raise the price, hence, declines with death benefit. Therefore, the effect of P&C losses on prices increases with the size of the death benefit in a concave manner.

To test this prediction, I use the 10-year term life policies, for which I have policies with death benefit of both $250,000 and $500,000. I redo the test in Table 6 and add an interaction term between P&C losses and a dummy variable, $D(High\ Face)$, that equals one if the face value of the policy is $500,000, zero if $250,000:

Table E1: Capital-Decreasing (10-Yr Term) Life Policy Premiums, Death Benefits and P&C Losses

The dependent variable is life insurance prices of 10-year term life policies. The dummy variable, D(High Face), equals one if the face value of the policy is $500,000, zero if $250,000. I use OLS. Controls include all control variables in Panel A of Table 5. Standard errors are corrected for clustering at the group-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels. See Table B1 for variable definitions.

Dependent Var: (Firm-Month-Product Level)	Premium ($)	
	(1)	(2)
P&C Loss (q-4 to q-1)*D(High Face)	3.92*	7.70***
	(1.84)	(2.72)
P&C Loss (q-4 to q-1)	9.21***	16.48***
	(4.36)	(3.87)
Controls		Yes
Firm-Prdct FE, Mnth-Prdct FE	Yes	Yes
N	298567	206365

E.2 Change in Life Policy Prices for 20-Year Term Policies

In this section, I estimate how life insurers change premiums for 20-year term policies following affiliated P&C losses. Columns (1)-(2) only include 20-year term policies. The coefficient on *P&C Loss* is positive and statistically significant in each column, suggesting that life insurers increase prices of these policies. The coefficients, 2.99 and 6.99 are smaller than those for 10-year term policies, 11.14 and 20.46, in Columns (1)-(2) Panel A Table 6.

In Columns (3)-(4), I test whether the difference between the two kinds of policies are statistically significant. I include both of these two kinds of policies, and add an interaction term, $P\&C\ Loss \cdot D(20-Year)$, where $D(20-Year)$ is a dummy variable indicating 20-year term policies. The coefficient on this interaction term is negative and statistically significant, implying that, compared to 10-year term policies, life insurers increase prices of the 20-year term policies by less, consistent with my prediction.

Table E2: 20-Yr Term Life Policy Premiums and P&C Losses

The dependent variable is life insurance prices of 10-year term life policies in Columns (1)-(2), 20-year term life policies in Columns (3)-(4), and both 20- and 10-year term policies in (5)-(6). The dummy variable, D(20-Year), equals one if the face value of the policy is 20-year policy, zero if 10-year. I use OLS. Controls include all control variables in Panel A of Table 5. Standard errors are corrected for clustering at the group-quarter level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels. See Table B1 for variable definitions.

Dependent Var:	Premium ($) (Firm-Month-Product Level)					
	Only 10-Year Policies		Only 20-Year Policies		20-Year & 10-Year Policies	
	(1)	(2)	(3)	(4)	(5)	(6)
P&C Loss (q-4 to q-1) *D(20-Year)					-8.15***	-12.18***
					(-4.16)	(-3.75)
P&C Loss (q-4 to q-1)	11.14***	20.46***	2.99**	6.99***	11.14***	19.71***
	(4.16)	(4.38)	(2.34)	(3.26)	(4.16)	(4.27)
Controls		Yes		Yes		Yes
Firm-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes
Mnth-Prdct FE	Yes	Yes	Yes	Yes	Yes	Yes
N	298567	206365	263930	192424	562497	398789