Reinsurance Demand and Liquidity Creation*

Denise Desjardins and Georges Dionne
HEC Montreal

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Introduction

This paper analyzes the relation between insurers' liquidity creation and reinsurance demand. The empirical measure of liquidity creation was developed for banks by Berger and Bouwman (2009), who distinguished two important bank activities: liquidity creation and risk transformation. Insurers also actively transform risk, but the extent of their engagement in liquidity creation is less clear. Because liquidity creation is a risky activity, it may affect the demand for reinsurance.

Early theoretical contributions on liquidity creation (Bryant, 1980 and Diamond and Dybvig, 1983) propose that banks enhance economic growth by creating liquidity on the balance sheet. Liquidity creation means banks finance relatively illiquid assets with relatively liquid liabilities. Holmstrom and Tirole (1998) and Kashyap, Rajan, and Stein (2002) suggest that banks also create liquidity off the balance sheet through loan commitments and similar claims to liquid funds. Berger and Bouwman (2009) affirm that large banks created most of the liquidity in the United States over the 1993-2003 period. These banks were responsible for 81% of industry liquidity creation, yet comprised only 2% of the sample observations. Bank liquidity creation is shown to be positively correlated with bank value.

Berger and Bouwman (2009) also find that the relationship between liquidity creation and capital is positive for large banks and negative for small banks. For small banks, higher capital ratios shift funds from deposits to bank capital. Given that deposits are liquid and bank equity is illiquid, there is a reduction in overall liquidity creation when the capital ratio is higher. Large banks use liabilities that are less liquid than deposits to create liquidity, suggesting that an increase in capital may lead to a drop in other liabilities rather than in deposits. Thus, capital is more likely to crowd out deposits for small banks than for large banks.

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Liquidity creation exposes financial institutions to risk. Because large banks are typically more exposed to capital regulation, they keep more capital as part of their overall risk management. Large banks are also subject to greater market discipline from uninsured providers of funds, so capital has a greater effect on both the cost and the availability of uninsured financing. Finally, some large banks may see new opportunities to offer large loan commitments or engage in off-balance sheet activities. Because these activities are risky, large banks may boost equity capital when engaging in these risky activities that are less available to small banks.

Choi *et al*. (2013) are the first to measure liquidity creation in the US Property and Liability insurance industry (P/L insurance industry). They use Berger and Bouwman's (2009) approach to liquidity creation and find that insurers destroy liquidity rather than create it. It seems that insurers' liabilities are less liquid, and their assets are more liquid. Moreover, the regulators ask insurers to keep a significant amount of reserves in assets that are easy to liquidate. Larger insurers seem to account for more than 55% of liquidity de-creation, yet they represent only 3% of the insurance industry. One explanation for the difference between banks and insurers is the ratio of equity to assets. In Choi *et al*.'s (2013) data, this ratio is equal to 45%, compared with about 10% in Berger and Bouwman's (2009) study.

For a financial intermediary, creating liquidity involves, for example, transforming liquid liabilities with low returns into illiquid assets with higher returns to compensate for the risk taken. An insurer with a high level of liquidity creation will hold more illiquid assets and will be considered as more risky by the regulator and possibly the policyholders. If a more risky insurer receives more claims than expected, it may have to sell illiquid assets quickly at a lower price to pay the corresponding claims. There is thus a trade-off between getting higher returns on risky investments and being able to compensate clients at a low cost when unexpected claims happen. However, unexpected claims can be protected by reinsurance, which introduces a second trade-off between reinsurance and liquidity creation. This trade-off can be more important for smaller insurers that have fewer diversification opportunities.

The goal of this study is to analyze how liquidity creation affects demand for reinsurance. Do insurers that take more risk in creating liquidity buy more reinsurance to cover this risk? Our period of data is much longer than that of Choi *et al*. (2013). Their period ranges from 1998 to 2007 while ours spans 1993 to 2014, which gives us better coverage of the recent financial crisis period.

Liquidity creation: the basic framework

The methodology of Berger and Bouwman (2009) and Choi *et al*. (2013) is divided into three steps. First they categorize assets, liabilities and surplus into liquid, semi-liquid and illiquid items. This classification is based on cost and time to meet contractual obligations. A bank will create one dollar of liquidity by transforming one dollar of liquid liabilities into one dollar of illiquid assets, or will create one dollar of liquidity de-creation by transforming one dollar of liquid assets into one dollar of illiquid liability or equity. Transforming one dollar of liquid (illiquid) assets into one dollar of liquid (illiquid) liabilities (or the converse) is considered neutral with respect to liquidity creation. Shorter maturities are also considered more liquid in the literature. However, Berger and Bouwman (2009) prefer to distinguish categories of assets and liabilities as opposed to their corresponding maturities.

Further, they assign weights to the different assets, liabilities, equity, and off-balance sheet positions according to their degree of relative liquidity creation. The weights are based on liquidity creation theory. Finally they add up the different relative measures to obtain an index of liquidity creation for a particular bank in a given period.

Extending the same methodology to insurance, we apply positive weights to both illiquid assets and liquid liabilities. These weights are presented in Table 1 for an insurer's balance sheet. Accordingly, when one dollar of tax (liquid liability) is used to finance one dollar of real estate (illiquid asset), liquidity is created. With the same reasoning, we give negative weights to liquid assets, illiquid liabilities, and equity, so that when illiquid liabilities or equity is used to finance liquid assets (such as loss reserves within one year), liquidity is destroyed.

Let us consider in detail two examples of transformation proposed by Berger and Bouwman (2009), applied to insurance. Based on the above rules, as shown in Table 1, we can assign a weight of ½ to both illiquid assets and liquid liabilities, and a weight of -½ to both liquid assets and illiquid liabilities. Thus, when one dollar of liquid liabilities (such as unearned premiums) is used to finance one dollar of illiquid assets (such as real estate), liquidity creation equals $½ \times \$1 + ½ \times \$1 = \$1$. In this case, maximum liquidity ($1) is created. Intuitively, the weight of ½ applies to both illiquid assets and liquid liabilities, because the amount of liquidity created is only determined by 1/2 of the source of the funds, but both entries are needed to create liquidity. Similarly, when one dollar of illiquid liabilities or equity is used to finance one dollar of liquid assets (such as treasury securities), liquidity creation equals $-½ \times \$1 - ½ \times \$1 = -\$1$; maximum liquidity is thus destroyed.

Berger and Bouwman (2009) also discuss why they prefer the cat fat measure of liquidity creation. First, they argue that category (cat) measures are superior to maturity (mat) measures primarily because what matters to liquidity creation on the asset side is the ease, cost, and time for bank to sell their bonds in order to obtain more liquid funds. Second, they argue that including the off-balance sheet activities (fat) measures is more important than non-including (nonfat) them because off-balance sheet activities provide liquidity in similar ways to on-balance sheet items.

Table 1: Liquidity classification

Step 1: We classify all items in assets, liabilities and surplus as liquid or illiquid.
Step 2: Assign weights to the activities
Step 3: Combine insurance activities as classified in step 1 and as weighted in step 2 to construct the liquidity creation (LC) measure

LC = + ½ × illiquid assets – ½ × liquid assets
+ ½ × liquid liabilities – ½ × illiquid liabilities
– ½ × surplus

Assets

Illiquid assets (weight = ½)	Liquid assets (weight = – ½)
Mortgage loan	Cash, cash equivalents and short-term investments
Real estate	Investments in stock and bonds
Other invested assets	
Uncollected premiums and agents' balances	
Electronic data processing equipment and software	
Furniture and equipment	

Liabilities plus surplus

Liquid liabilities (weight = ½)	Illiquid liabilities plus surplus (weight = – ½)
Loss reserves within one year (Net losses and expenses unpaid)	Loss reserves with more than one year
Reinsurance payable on paid losses and loss adjustment expenses	Funds held by company under reinsurance treaties
Other expenses	Provision for reinsurance
Taxes, licenses and fees	Amounts withheld or retained by company on others' behalf
Current federal and foreign income taxes	Draft outstanding

Net deferred tax liability	Liability for amounts held under uninsured accident and health plans
Unearned premiums	Surplus
Dividends declared unpaid	

Data

We use the National Association of Insurance Commissioners' (NAIC) annual financial statement data for U.S. property-liability insurance companies. We focus on demand for reinsurance and liquidity creation in the U.S. property-liability insurance industry over the 1993-2014 period.

Several data exclusion criteria are applied. We first remove general insurers that report non-positive total admissible assets and premiums. We exclude insurers reporting a value outside of the 0 and 1 range for the ratio of reinsurance demand. The observations are winsorized at the 1 and 99 percent levels to remove the potential effects of outliers.

All explanatory variables are one-year lagged to the dependent variables. In order to estimate one-way fixed-effect regressions, firms with only one observation are also removed from the sample.

The resulting sample consists of 34,376 firm-year observations from 2,792 insurers. We then have an unbalanced data panel to allow a comprehensive evaluation of the U.S. property-liability insurance industry. The sample includes insurers that entered or left the market during the study period.

Dependent variable

We use *Reins* to measure an insurer's demand for reinsurance. It is defined as (affiliated reinsurance ceded + non-affiliated reinsurance ceded) / (direct business written plus reinsurance assumed).

Endogenous variables

Chang, Jeng and Tzeng (2013) and Shiu (2011) suggest that insurers' liquidity creation may represent an endogenous influence on demand for reinsurance. An insurer's liquidity creation may influence its demand for reinsurance, and the reverse causality from reinsurance purchase to liquidity creation may also exist. One of our objectives is to analyze the true causality relationship.

We treat liquidity creation as an endogenous variable in the reinsurance demand equation. To measure liquidity creation precisely, we use the definition discussed above, developed by Berger and Bouwman (2009), and we use the ratio of liquidity creation to total admitted assets.

An insurer with a high level of liquidity creation for the economy is considered more risky for policyholders because it holds more illiquid assets or has a large amount of liquid liabilities.

Control variables

Table 2 summarizes the definitions and construction of the following control variables:

Firm size

The natural logarithm of admitted assets is used as a proxy of firm size.

Several studies predict that insurer size has a negative impact on demand for reinsurance. In effect, small insurers may need more protection because it is more difficult for them to self-insure efficiently (Mayers and Smith, 1990; Hoyt and Khang, 2000; Garven and Lamm-Tennant, 2003; Weiss and Chung, 2005; Cole and McCullough, 2006).

Insurance leverage ratio

As a proxy for the insurance leverage ratio, we consider the direct business written to surplus.

Garven and Lamm-Tennant (2003) and Cole and McCullough (2006) predict a positive relationship between the insurance leverage ratio and demand for reinsurance. A positive relationship between the insurance leverage ratio and demand for reinsurance would suggest that firms that write more business relative to surplus would have a greater need for reinsurance because they have a higher probability of insolvency, and thus higher expected bankruptcy costs (Carson and Hyot, 1995; and Shiu, 2011).

Line of business, geographic and business mix diversification

Following Mayers and Smith (1990), Kim, Mayers and Smith (1996), Garven and Lamm-Tennant (2003) and Cole and McCullough (2006), we use the line of business Herfindahl index as a proxy for line of business concentration, the geographic Herfindahl index as a proxy for geographic concentration, and the business mix Herfindahl index to reflect the degree of diversification of the four major branches of a property-liability insurance company, namely short- and long-term personal insurance and short- and long-term commercial insurance.

A higher value of the Herfindahl index indicates a more specialized (less diversified) company. The highest level of diversification (i.e. lower value) would indicate that the insurer's operation is well spread over various lines of business or states or business branches, while the lowest level of diversification (i.e. higher score) indicates that the insurer's operation is fully devoted to a single line of business or a state or business branch.

Line of business concentration is defined as the sum of the squares of the ratio of the dollar amount of direct business written in a particular line of insurance to the dollar amount of direct business across all 26 lines of insurance (Mayers & Smith, 1990).

Geographical concentration is defined as the sum of the squares of the ratio of the dollar amount of direct business in state *j* to the total amount of direct business across all states.

Business mix concentration is defined as the sum of the squares of the ratio of the dollar amount of direct business of a particular branch of a property-liability insurance company to the total amount of direct business.

The degrees of business concentration, geographic concentration and business mix concentration may influence the insurer's reinsurance decision.

Insurers with higher concentration (less diversification) in a given line of business, or in a given geographic area, may have higher incentives to purchase more reinsurance. In contrast, the economic benefits of specialization can reduce the demand for reinsurance (Chang, Jeng and Tzeng 2013; Cole and McCullough 2006; Mayers and Smith 1990; Shiu 2011; Wang *et al*. 2008).

Mayers and Smith (1990) examine the effects of the composition of a firm's portfolio of activities on demand for reinsurance. They observe that an increased concentration of activities increases the volatility of cash flows and the risk of bankruptcy. Reinsurance could be a solution to the risk of insolvency arising from this source. Moreover, Shortridge *et al*. (2004) state that *reinsurers have more experience with a wide range of low probability events; therefore, they can provide valuable information on rating different lines of business. Thus, as insurers become less concentrated across lines of insurance, reinsurance services become more valuable.*

We predict a negative relationship between the degree of specialization and the demand for reinsurance.

Regulatory pressure

The firm's net premium-to-surplus ratio measures the adequacy of the policyholders' surplus cushion, net of the premiums ceded to reinsurers' effects. The higher the ratio, the more risk the insurer bears in relation to the policyholders' surplus. The usual range for the ratio includes

results up to 300 percent (NAIC, Insurance Regulatory Information System (IRIS) Ratios Manual, Edition 2014).

We use a dummy variable equal to 1 if the firm's net premium-to-surplus ratio is greater than 300 percent. It is equal to zero otherwise.

Liabilities to liquid asset ratio

A firm's adjusted liability-to-liquid asset ratio is a measure of the insurer's ability to meet short-term obligations. Analysis has shown that many insurers that became insolvent reported an increasing Adjusted Liabilities to Liquid Assets ratio in their final years. The usual range for the ratio includes results below 100 percent (NAIC, Insurance Regulatory Information System (IRIS) Ratios Manual, Edition 2014). We use a dummy variable equal to 1 if the firm's adjusted liability to liquid asset ratio is greater than 100 percent. It is equal to zero otherwise.

Price of reinsurance

Several studies use the economic loss ratio of the reinsurance industry to measure the price of reinsurance (Winter, 1994; Sommer, 1996; and Weiss & Chung, 2004). This ratio is defined as net premiums written to the present value of incurred losses adjusted for underwriting expenses, loss adjustment expenses, and dividend payments. For a detailed discussion on constructing the ratio, see Winter (1994). We predict a negative effect of this price variable on the demand for reinsurance.

Two-year loss development

Potential financial constraints can influence the demand for reinsurance, as suggested by previous contributions (Petroni, 1992; Weiss, 1995; Grace, 1990; Christensen, Hoyt & Paterson, 1999; Gaver & Paterson, 1999; Cole & McCullough, 2006; and Wang *et al*., 2008). Chang (2014) expected a positive relationship between loss reserve and demand for reinsurance because insurers with positive loss development will purchase more reinsurance, whereas insurers will purchase less reinsurance if they have a negative loss development. In addition, Harrington and Danzon (1994) indicate that insurers may hide their underreported claim liability and capital adequacy by using reinsurance.

As Cole and McCullough (2006) recommend, we used the two-year loss development variable to determine if adjustments to loss reserves affect the demand for reinsurance. Two-year loss development is defined as development in estimated losses and loss expenses incurred two years before the current year and prior year, scaled by policyholders' surplus.

New York license

A dummy variable equal to 1 if the insurer is licensed in New York State. It is equal to zero otherwise.

Cost of capital

Similar to Ayuso *et al*. (2004) and Jokipii and Milne (2008), we approximate this cost as the average of return on equity (ROE) over the last five years and predict a negative sign for that variable.

Firm affiliation

Similar to Cole and McCullough (2006), we include a group dummy variable to indicate an affiliated insurer. The variable is equal to 1 if the insurer is affiliated and 0 if it is non-affiliated. Mayers and Smith (1990) hypothesize that insurance companies that are members of groups are expected to reinsure within the group because this activity is profitable among the group and redistributes overall taxes for the group. Powell and Sommer (2007) find a significant effect for this assumption.

Tax exemption

Mayers and Smith (1982, 1990) are the first to introduce the tax argument in favor of insurance demand by corporate firms or reinsurance demand by insurance companies. The presence of carry-forward and carry-back tax rules can create some non-linearities in the tax function and justify risk management. More importantly, losses can affect the marginal tax rate when the tax function is locally convex. If important losses reduce the marginal tax rate in these states of nature, risk management will reduce the expected pre-tax shield by reducing the volatility of ex-ante losses (Graham and Rodgers, 2002, Dionne and Triki, 2013).

We use Powell and Sommer's (2007) estimation for tax-exempt investment income relative to total investment income adjusted to reflect changes in the tax code since 1987. Tax treatment is estimated as follows: bond interest exempt from federal taxes plus 70 percent of dividends on common and preferred stock. We use tax-exempt investment income as a proxy to capture the influence of expected tax liability and/or tax-favored assets. A positive relationship between the tax-exempt factor and the demand for reinsurance is predicted because, as Garven and Lamm-Tennant (2003) assert, insurers can take advantage of reinsurance demand to offset the costs of

huge unexpected losses and improve investment in tax-favored assets. Adams, Hardwick and Zou (2008) and Shiu (2011) do not support the positive influence of tax-exempt factors on demand for reinsurance.

Information Asymmetry

We use the volatility of ROE as a measure of information asymmetry (Cummins & Nini, 2002 and Grubisic & Leadbetter, 2007).

Cummins and Nini (2002) hypothesize that higher risk, as measured by standard deviation of ROE, will be associated with higher capital utilization. Given that surplus is classified as illiquid liabilities, we expect a negative relationship with the liquidity creation ratio.

Furthermore, Cummins and Nini (1992) state that "the principal informational asymmetry for property-liability insurers arises from uncertainty about true value of reserves for the payment of unpaid losses." Petroni (1992) finds that financially troubled insurers are more likely to understate loss reserves.

Scordis and Steiworth (2012) argue that "Reinsurance is purchased when information asymmetry is low rather than in order to reduce information asymmetry. The greater the information asymmetry between the insurer and outsiders, the higher is the effective price imposed by the reinsurer on the ceding insurer." Jean-Baptiste and Santomero (2000) show that eliminating the information asymmetry premium results in a lower effective reinsurance price, and in higher reinsurance purchases. Thus, as Garven and Lamm-Tennant (2002) point out, high use of reinsurance may be indicative of low information asymmetry.

Capital

We measure capitalization as the ratio of policyholder surplus to total admitted assets. Choi *et al*. (2013) state that a negative relation with the liquidity creation ratio supports the *financial fragility-crowding out* hypothesis while a positive coefficient supports the *risk absorption* hypothesis.

Table 2: Variable definitions and construction

Variable Name	Symbol	Variable definition
Insurance leverage ratio	dbs	Direct business written to surplus
Geographic diversification in direct premium written	ghi_w	Herfindahl index defined as $\sum_{l=1}^{58}\left(\frac{PW_l}{TPW}\right)^2$ where PW_l is the value of direct premium written in each state and TPW represent the insurer's total direct premiums written
Regulatory pressure	ratio2_over	Dummy variable equal to 1 if firm's net premium to surplus ratio ≥ 300 percent, 0 otherwise
Liabilities greater than liquid assets	ratio9_over	Dummy variable equal to 1 if firm's adjusted liabilities to liquid assets ratio ≥ 100 percent, 0 otherwise
Line of business diversification in direct premium written	bhi_w_1	Herfindahl index defined as $\sum_{l=1}^{29}\left(\frac{PW_l}{TPW}\right)^2$ where PW_l is the value of direct premiums written in each line of business in the insurers' annual statement and TPW represents the insurer's total direct premiums written
Price of reinsurance	price	$\frac{Net\,premium\,written - \exp - divp}{D \times losses\,incurred}$ where exp = Commissions, expenses paid and aggregate write-ins for deduction; divp = Dividend paid D is the Discount factor used in Winter (1994) to calculate the economic loss ratio. Losses incurred is losses incurred in current year.
2-yr loss development	twoyr	Development in (estimated losses and loss expense incurred 2 years before current year and prior year scaled by policyholder's surplus)×100
New York license	newyork	Dummy variable equal to 1 if firm is licensed in New York State, 0 otherwise
Cost of capital	mean_roe	Average of positive ROE over the last 5 years
Firm size	size	Logarithm of total admitted assets
Firm affiliated with a group	group_dummy	Dummy variable equal to 1 if the insurer is affiliated with a group, 0 otherwise
Business mix	mixline_w	Herfindahl index of short and long tails or personal and commercial lines
Tax-exempt investment income	tax_ex	Bond interest exempt from federal taxes plus 70% of dividends received from common and preferred stock to total investment income
Information asymmetry	std_roe	Standard deviation of the firm's ROE over the last 5 year
Capital	surplus_ratio	Ratio of surplus to total admitted assets

Model

Two-Stage Least Square (2SLS) regressions are performed. We use the following regression models for demand for reinsurance and liquidity creation.

$$\begin{aligned}\text{Liquidity creation ratio}_{i,t} = {} & \beta_1 \times \text{Capital}_{i,t-1} + \beta_2 \times \text{Standard deviation ROE}_{i,t-1} + \\ & \sum \beta \times \text{Control variables}_{i,t-1} + \text{Firm fixed effects} + \varepsilon_{i,t}\end{aligned} \tag{1}$$

and

$$\begin{aligned}\text{Demand for reinsurance}_{i,t} = {} & \alpha_1 \times \text{Predicted liquidity creation ratio}_{i,t} + \\ & \sum \alpha \times \text{Control variables}_{i,t-1} + \text{Firm fixed effects} + \upsilon_{i,t}\end{aligned} \tag{2}$$

In the first step, represented by Eq. (1), the liquidity creation ratio is regressed on the lagged value of capital and the lagged values of other control variables. For now we do not use exogenous instruments in the estimation. This first step leads to the estimation of a predicted liquidity creation ratio. In the second step, represented by Eq. (2), the demand for reinsurance is regressed on the predicted liquidity creation ratio and lagged values of the control variables. The control variables in the demand for reinsurance equation include the Insurance leverage ratio, Geographic diversification, Regulatory pressure, Line of business diversification, Price, 2-yr loss development, Cost of capital, Firm size, Firm affiliation, Business mix and Tax exempt.

The two-step regressions are estimated using firm fixed effects. We also correct standard errors for within-firm correlation and heteroscedasticity using the Huber–White consistent estimator. This approach allows us to account for time-invariant unobservable firm characteristics and explore within-firm differences.

Insurers with more liquidity creation should be more risky and demand more reinsurance. Yet this effect may vary for different activity levels. Therefore, we also performed the quantile regression with firm fixed effects.

We consider the following model for the conditional quantile function (Q) of the response (demand for reinsurance) of insurer *i* in quantile τ_k for the period *t:*

$$\begin{aligned}Q_{reins_{it}} = {} & \alpha_1(\tau_k) \times \text{Predicted liquidity creation ratio}_{i,t} + \\ & \sum \alpha(\tau_k) \text{Control variables}_{i,t-1} + \text{Firm fixed effects} + \upsilon^*_{i,t}\end{aligned} \tag{3}$$

In this formulation, firm fixed effects have a pure location shift effect on the conditional quantiles of demand for reinsurance. The effects of the control variables and the predicted liquidity

creation ratio are permitted to depend upon the quantile, τ_k, of interest, but the firm fixed effects do not. To estimate Equation (3) for several quantiles $\{\tau_1,\ldots,\tau_q\}$ simultaneously, we propose solving,

$$\min \sum_{k=1}^{q}\sum_{i=1}^{n}\sum_{t=1}^{t_i} w_k \rho_{\tau_k}(reins_{i,t} - \alpha_1(\tau_k)\times \text{Predicted liquidity creation ratio}_{i,t} - \sum \alpha(\tau_k)\text{Control variables}_{i,t-1} - \text{ Firm fixed effects}) \quad (4)$$

where $\rho_\tau(u) = u\left(\tau - I(u<0)\right)$, denotes the piecewise linear quantile loss function of Koenker and Bassett (1978). The weights w_k control the relative influence of the q quantiles $\{\tau_1,\ldots,\tau_q\}$, in the estimation of firm fixed effects. The choice of the weights, w_k, and the associated quantiles, τ_k, is somewhat analogous to the choice of discretely weighted L-statistics, as in the study by Mosteller (1946).

Results

Descriptive Statistics

Summary statistics for all variables are shown in Table 3. To capture the variation in demand for reinsurance and liquidity creation by insurer size, we divide the sample of insurers into three classes:

1. Large insurers, whose total admitted assets are greater than $3 billion;
2. Medium insurers, whose total admitted assets are between $1 billion and $3 billion;
3. Small insurers, whose total admitted assets are lower than $1 billion.

Summary statistics for all variables are shown in Tables 3a, 3b and 3c (see Appendix) for large, medium and small insurers. Among the 34,376 insurer-year observations, large insurers consist of 1,329 observations (3.9 percent), medium insurers represent 2,235 observations (6.5 percent) and small insurers account for 30,812 observations (89.6 percent).

We dropped 3,083 observations because, for the econometric analyses, we need at least two observations by firm, and divided the remaining 31,293 firm-year observations into two groups:

1. Insurers with a level of ceded reinsurance equal to 27.5% or less of their gross premiums (lower forty-fifth percentile). They represent 13,951 observations, corresponding to 1,547 insurers; and

2. Insurers whose ceded reinsurance is greater than 27.5% of their gross premiums (higher fifty-fifth percentile). They represent 17,342 observations, which correspond to 1,874 insurers.

Summary statistics for all variables of insurers in the lower forty-fifth percentile and those in the higher fifty-fifth percentile are presented in Tables 3d and 3e respectively (see Appendix).

The mean value of demand for reinsurance is 37.2%, with a 28.1% standard deviation. On average, demand for reinsurance for large insurers is 30.6%, and 37.6% for small insurers. Small insurers use more reinsurance to mitigate risk.

The average ratio of liquidity creation divided by total assets is –0.4295, indicating that insurers generate liquidity de-creation normalized by total admitted assets. The liquidity creation ratio is –0.4346 for small insurers, while for large and medium insurers the ratio is –0.3854 and –0.3886 respectively, indicating that large and medium insurers generate more liquidity normalized by total admitted assets than do small insurers. On average, the liquidity creation ratio is –0.4456 for insurers in the lower forty-fifth percentile of ceded insurance to gross premiums ratio while the average for insurers in the higher fifty-fifth percentile is –0.4196, indicating that insurers whose ceded reinsurance is more than 27.5% higher than their gross premiums generate more liquidity creation normalized by total admitted assets than do insurers whose ceded reinsurance is equal to 27.5% or less of their gross premiums.

The mean value of the insurance leverage ratio is 1.9324, and ranges from 0 to 33. This ratio is, on average, 2.0328 for small insurers, which is nearly three times higher than for large insurers (0.7712). This ratio is 1.1887 for insurers in the lower forty-fifth percentile and twice as high for insurers in the higher fifty-fifth percentile (2.6159). According to Carson and Hoyt (1995), small insurers and insurers in the higher fifty-fifth percentile with higher levels of leverage are more likely to be associated with an increased probability of bankruptcy than are the large firms and insurers in the lower forty-fifth percentile, whose levels of leverage are lower on average.

The capital ratio variable also indicates variations among the different sizes of insurers. The capital for large insurers is 0.3671 and 0.4430 for small insurers. Therefore, small insurers have to maintain a higher level of capital than large insurers do, which affects liquidity creation because the surplus is assigned to illiquid liabilities. The capital ratios are 0.4482 and 0.4251 for insurers in the lower forty-fifth percentile and in the higher fifty-fifth percentile respectively.

Diversification variables by product, geographic area or business mix indicate that larger insurers are, on average, more diversified than medium and small insurers. Medium insurers are

more diversified than small insurers. Insurers in the higher fifty-fifth percentile are, on average, more diversified than those in the lower forty-fifth percentile.

Most of large insurers are affiliated with a group (96.9%), and 60.9% of small insurers are affiliated with a group.

Small insurers bear more risk in relation to policyholders' surplus than large insurers, 3.0% of small insurers have net premiums written to policyholders' surplus greater than 300%, compared with 1.5% for large insurers (regulatory pressure). The proportions are 3.46% for insurers in the lower forty-fifth percentile and 2.05% for insurers in the higher fifty-fifth percentile.

For large insurers, 33.2% had a liabilities to liquid assets ratio greater than 100%, versus only 8.5% for small insurers and 17.7% for medium insurers. For insurers in the higher fifty-fifth percentile, 13.57% had a liabilities to liquid assets ratio higher than 100 percent, compared with only 5.62% for insurers in the lower forty-fifth percentile. Insurers whose liabilities exceed their liquid assets should focus on the adequacy of reserves.

The mean for the two-year loss development ratio is equal to 0.5619% and is –3.1064% for large insurers and small insurers respectively. On average, large firms had positive loss development (reserves were deficient), meaning that they are more likely to demand more reinsurance to mitigate potential financial constraints. The mean for the two-year loss development ratio is –5.4330%, and is –1.0285% for insurers in the lower forty-fifth percentile and in the fifty-fifth percentile respectively.

The usual range for the two-year loss development ratio includes results below 20%. Among the 34,376 observations, 7.35% have results greater than 20%, and 10.23% have results greater than 20% among large firms. Among insurers in the higher fifty-fifth percentile, 7.9% have results greater than 20% and 16.5% have results greater than 20% for large firms in the upper fifty-fifth percentile. Among insurers in the lower forty-fifth percentile, 6.7% have results greater than 20%, and 4.5% have results greater than 20% for the large firms in the lower forty-fifth percentile.

Only 27.7% of small insurers held a New-York State license, compared with 81.2% for large insurers. Only 23.07% of the insurers in the lower forty-fifth percentile had a New-York State license, compared with 40.12% for insurers in the higher fifty-fifth percentile.

Table 3: Summary statistics

This table provides summary statistics for the 2,792 firms for the period 1993-2014. Variables are defined in Table 2.

Variables	Obs	Mean	Median	Std	Min	Max
Demand for reinsurance	34,376	0.3723	0.3205	0.2809	0.0000	0.9992
Liquidity creation ratio	34,376	-0.4295	-0.4143	0.2070	-1.2663	0.6950
Insurance leverage ratio	34,376	1.9324	1.2409	2.7908	0.0000	33.0000
Geographic diversification	34,376	0.5860	0.5943	0.3851	0.0303	1.0000
Regulatory pressure	34,376	0.0282	0.0000	0.1655	0.0000	1.0000
Liabilities greater than liquid assets	34,376	0.1007	0.0000	0.3009	0.0000	1.0000
Line of business diversification	34,376	0.5520	0.5000	0.2865	0.1012	1.0000
Price	34,376	1.4349	1.2020	1.2822	0.0000	12.0000
2-yr loss development	34,376	-2.9148	-2.2351	19.1562	-73.7500	80.6200
New York license	34,376	0.3217	0.0000	0.4671	0.0000	1.0000
Cost of capital	34,376	0.0858	0.0828	0.1299	-0.4648	0.5280
Firm size	34,376	18.1026	18.0298	1.9930	11.1812	25.7466
Firm affiliation	34,376	0.6459	1.0000	0.4783	0.0000	1.0000
Business mix	34,376	0.6719	0.6023	0.2473	0.2505	1.0000
Tax exempt	34,376	0.2513	0.1855	0.2445	0.0000	1.0000
Information asymmetry	34,376	0.1179	0.0802	0.1351	0.0020	1.1110
Capital	34,376	0.4344	0.3912	0.1890	0.0000	1.0000

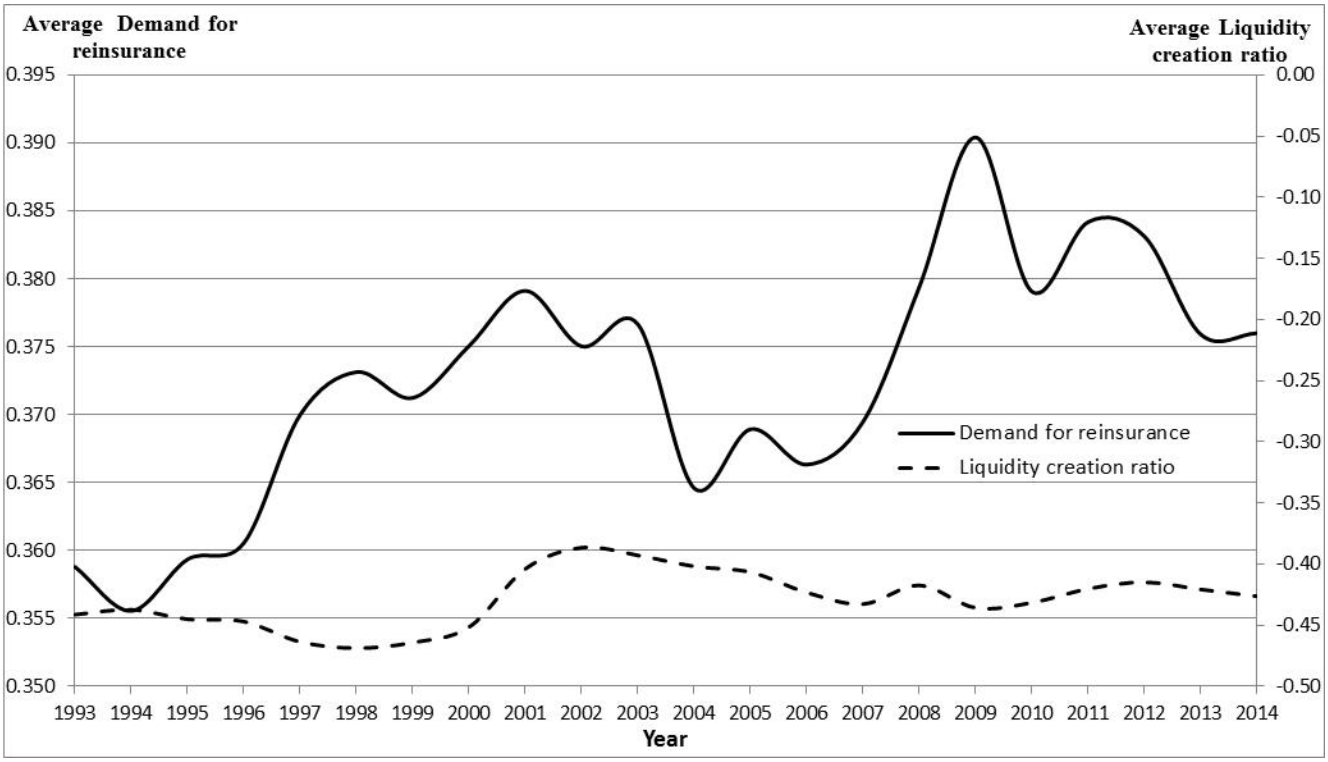
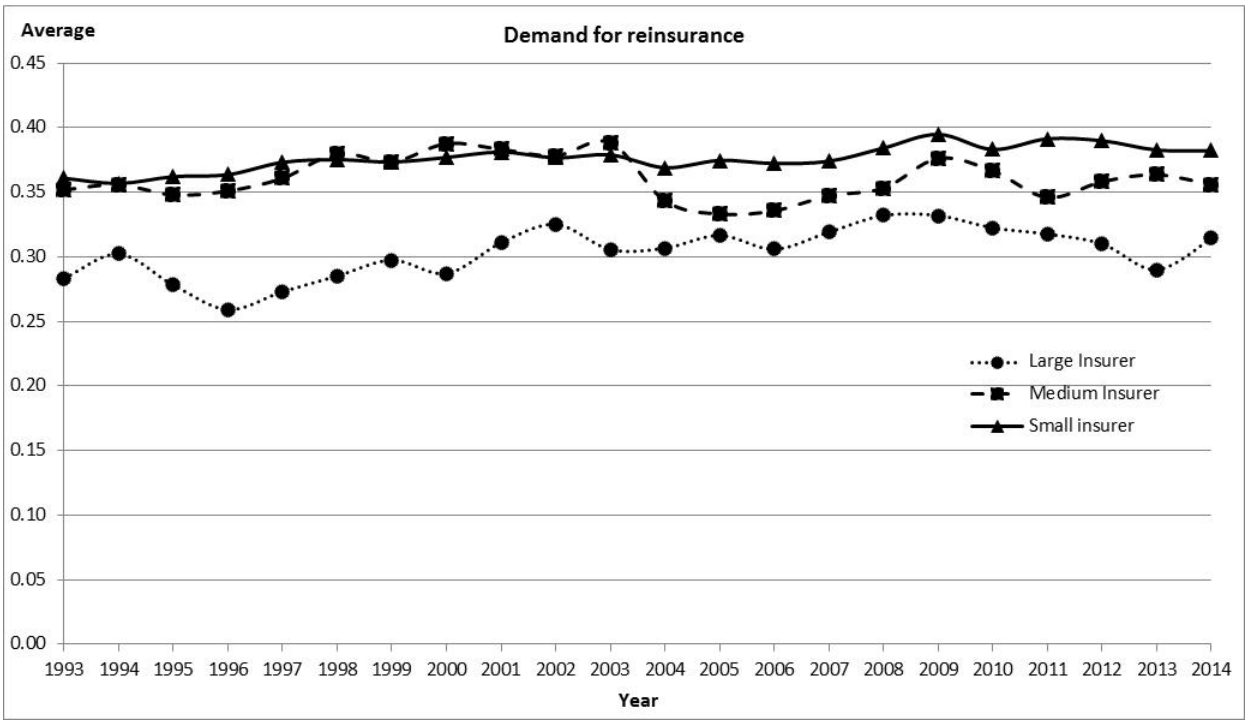


Figure 1

Average Demand for reinsurance and Liquidity creation ratio by year



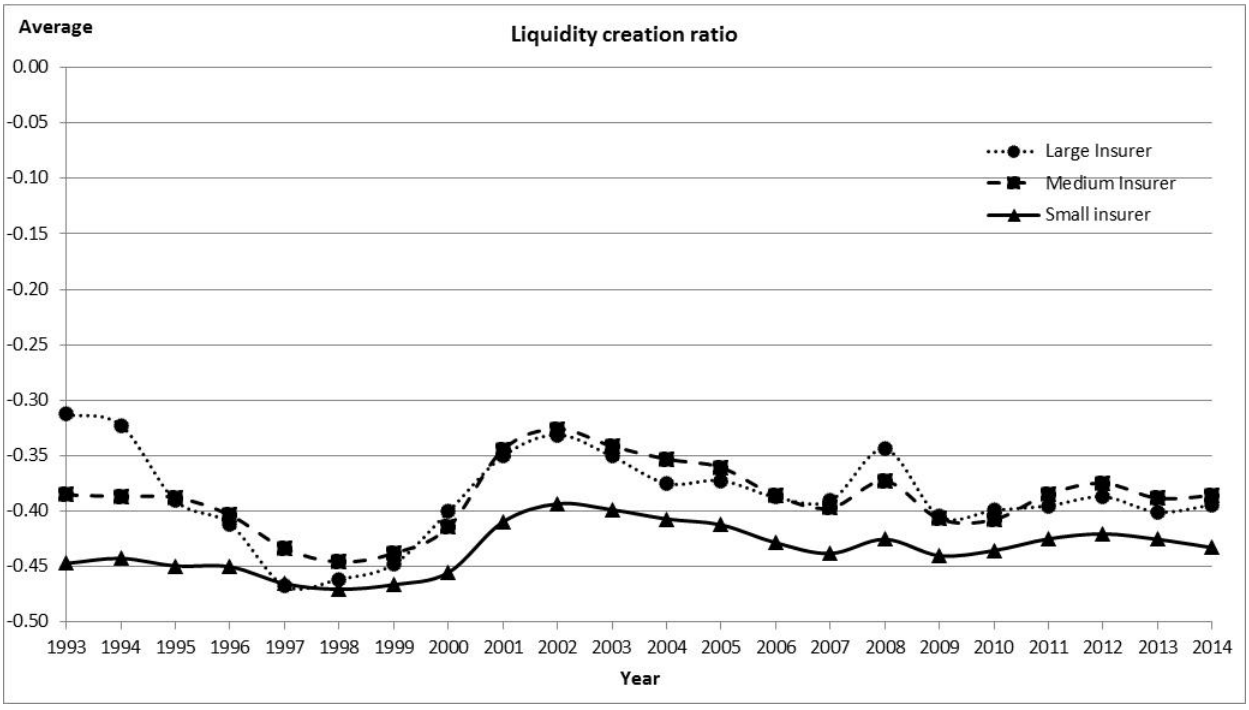
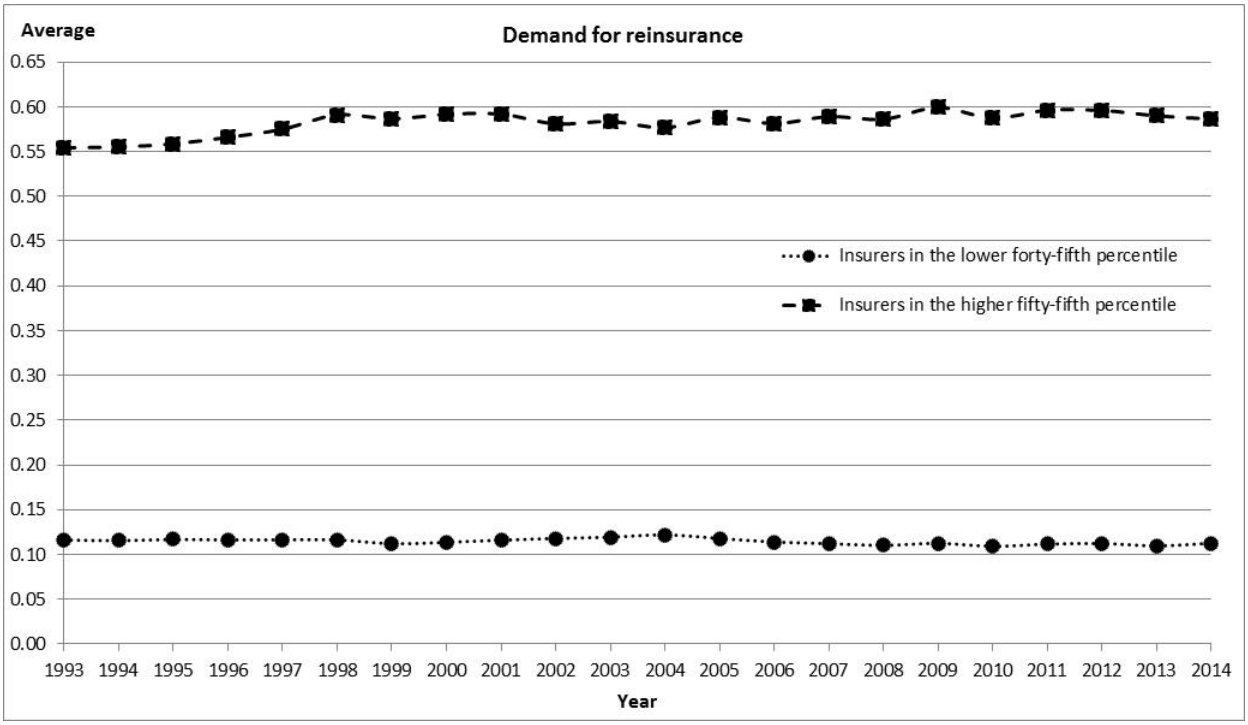


Figure 2

Average Demand for reinsurance (above) and Liquidity creation ratio (below) by year and type of insurer



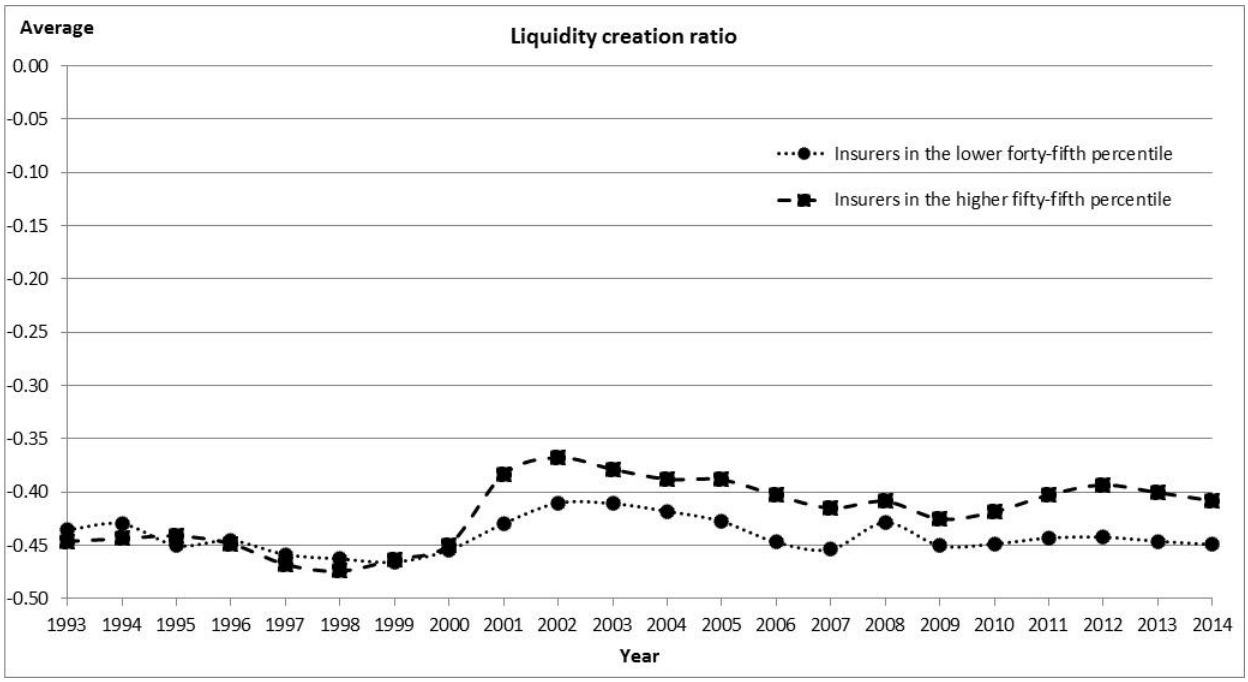


Figure 3

Average Demand for reinsurance (above) and Liquidity creation ratio (below) by year, and for insurers in the lower forty-fifth percentile and the higher fifty-fifth percentile.

Econometric results

Table 4 presents the results from the first and second-stage estimations, and show very important findings. For large, medium and small firms, the results are presented in Tables 4a, 4b and 4c respectively. We also divided the insurers into two groups according to whether they are in the lower forty-fifth percentile or in the upper fifty-fifth percentile depending on the value of their demand for reinsurance: insurers that cede 27.5% or less of gross premiums to reinsurance and insurers that cede more than 27.5% of gross premiums to reinsurance. The results are presented in Tables 4d and 4e respectively (see Appendix).

The results in Table 4 show a highly significant relationship between the predicted liquidity creation ratio and demand for reinsurance. On average, an increase in liquidity creation ratio decreases demand for reinsurance which runs counter to our prediction. In addition, the coefficient is negatively significant for the three types of insurers: large, medium and small. The coefficients are greater for large insurers than for the two other types of insurers, and the coefficient is greater for medium insurers than small insurers. These results indicate that the impact of the liquid creation ratio on reinsurance use is greater for large insurers than for the other two groups, and is greater for medium insurers than for small insurers.

The results in Table 4d show a positively significant relationship between the predicted liquidity creation ratio and demand for reinsurance. Table 4e indicates a negatively significant relationship between the predicted liquidity creation ratio and demand for reinsurance. These results imply that the impact of the liquid creation ratio on reinsurance use has an opposite effect depending on whether the firms fall in the lower forty-fifth percentile or in the higher fifty-fifth percentile, and on reinsurance demand. These contrary results will be investigated in the near future.

The coefficient of the insurance leverage ratio is positively and significantly related to demand for reinsurance, suggesting that firms that write more business relative to surplus have a greater need for reinsurance because they have a higher probability of insolvency. There is no significant relationship between leverage and demand for reinsurance for insurers in the lower forty-fifth percentile. The coefficient estimate is the lowest (0.0167) for insurers in the fifty-fifth percentile and highest for the large insurer group (0.0619).

The relations between the insurance leverage ratio and both demand for reinsurance and the insurance liquidity creation ratio are positively significant, implying that insurers with a higher insurance leverage ratio tend to reinsure to a greater extent and create more liquidity. For large insurers, medium insurers and those in the lower forty-fifth percentile there is no statistical

relationship between insurance leverage and the liquidity creation ratio.

We find a negative relationship between firm size and insurers' reinsurance demand, implying that when the value of firm size decreases, insurers are more likely to purchase reinsurance as a way to manage unexpected losses (Mayers and Smith, 1990). The firm size variable is not significantly related to the liquidity creation ratio. However, among large firms we find a positive relationship between firm size and the liquidity creation ratio, but the relation is not significant for reinsurance use. The same results are observed for medium insurers and those in the higher fifty-fifth percentile. Among insurers in the lower forty-fifth percentile, there is no statistical relationship between firm size and demand for reinsurance, but a negative relationship between firm size and liquidity creation ratios is observed.

Both product and geographic concentration are significantly and negatively related to reinsurance demand. The results indicate that insurers with higher concentration in a given line of business or geographic area may have a lower incentive to purchase more reinsurance in order to diversify the risks associated with concentration (Cole and McCullough, 2006). However, business mix concentration is not significantly related to reinsurance use, nor is it significantly related to the liquidity creation ratio.

Among medium insurers, there is no relationship between product, geographic or business mix concentration and reinsurance use. This relationship is also observed concerning the liquidity creation ratio.

Among large insurers, both product and geographic concentration are significantly and negatively related to reinsurance demand, but only geographic concentration is significantly and negatively related to the liquidity creation ratio. In addition, large insurers with higher business mix concentration (short and long tails or personal and commercial lines) are more likely to purchase reinsurance. There is no statistical relationship between business mix concentration and the liquidity creation ratio.

Among insurers in the higher fifty-fifth percentile, we did not find a significant relationship between business mix concentration and demand for reinsurance or the liquidity creation ratio. However, product and geographic concentration are negatively significantly related to reinsurance demand, but are not significantly related to the liquidity creation ratio.

Among insurers in the lower forty-fifth percentile, both product and geographic concentration are significantly and negatively related to reinsurance demand, and negatively related to the liquidity creation ratio. In addition, the group of insurers with the highest diversification of concentration in their line of business mix are more likely to purchase

reinsurance. There is no statistical relationship between business mix concentration and the liquidity creation ratio.

Tax exempt status is not significantly related to demand for reinsurance, consistent with the study by Garven and Lam Tennant (2003). However, it is negatively significantly related to the liquidity creation ratio. For large insurers, tax-exempt status is significantly and negatively related to demand for reinsurance but not to the liquidity creation ratio. For insurers in the lower forty-fifth percentile and for insurers in the higher fifty-fifth percentile, tax-exempt status is significantly and negatively related to the liquidity creation ratio, but not to reinsurance demand.

The price measured by the inverse of the economic loss ratio is significantly and negatively related to reinsurance demand, and significantly and positively related to the liquidity creation ratio. We obtain the same results for insurers in the lower forty-fifth percentile. However, these results are not significant for large insurers. For medium insurers, the price is significantly and negatively related to demand for reinsurance only. For insurers in the higher fifty-fifth percentile, there is no statistical relationship between price and demand for reinsurance, but this relationship is positive for the liquidity creation ratio.

The firm affiliation variable is significant for demand for reinsurance, indicating that insurers affiliated with a group demand more insurance. This variable is not significantly related to the liquidity creation ratio. For large firms and for insurers in the lower forty-fifth percentile, firm affiliation is not significantly related to demand for reinsurance and is positively related to the liquidity creation ratio. However, for medium insurers firm affiliation is significant, implying that medium insurers affiliated with a group demand more reinsurance and create more liquidity. Insurers in the higher fifty-fifth percentiles affiliated with a group demand more reinsurance but do not create more liquidity.

Regulatory pressure is significantly and negatively related to demand for reinsurance and is negatively related to the liquidity creation ratio. Accordingly, firms whose net premiums to surplus ratio is higher than 300% demand less reinsurance and create less liquidity. We find the same results for the medium insurer group, and those in the higher fifty-fifth percentile. For large insurers, regulatory pressure is not statistically significantly related to the demand for reinsurance, but is negatively related to the liquidity creation ratio. For insurers in the lower forty-fifth percentile there is no statistical relationship between regulatory pressure and both demand for reinsurance and the liquidity creation ratio.

Firms whose liabilities exceed their liquid assets tend to purchase more reinsurance and create more liquidity. We find the same results for large and small insurers, and for those in the

higher fifty-fifth percentile. For insurers in the lower forty-fifth percentile, the relationship is only significant for the liquidity creation ratio but not for demand for reinsurance.

Insurers that had a license in New York State are more likely to purchase reinsurance and they are not significantly related to the liquidity creation ratio. We find the same results among medium insurers, small insurers and those in the higher fifty-fifth percentile. For large insurers, and for those in the lower forty-fifth percentile, we find no relationship with demand for reinsurance or with the liquidity creation ratio.

The two-year loss development variable is not significant: firms that keep low reserves do not tend to purchase higher levels of reinsurance, nor do they create more liquidity. However, for insurers in the lower forty-fifty percentile, the two-year loss development variable is significantly related to the liquidity creation ratio, indicating that firms that keep low reserves tend to create more liquidity, but this variable is not significantly related to reinsurance demand.

Both the information asymmetry and capital variables are significantly and negatively related to the liquidity creation ratio, except for large insurers, for which information asymmetry is not significantly related to the liquidity creation ratio.

Table 4
Demand for reinsurance and Liquidity creation ratio (2SLS)

This table provides the results of the fixed effects regressions. The dependent variable is Demand for reinsurance. The endogenous variable is the Liquidity creation ratio. All the variables are defined in Table 2. Control variables are included in lagged values. Heteroscedasticity-consistent standard errors clustered at the firm level are reported.

	First stage			Second stage		
	Liquidity creation ratio			Demand for reinsurance		
Variables	Coeff	Std error	P-value	Coeff	Std error	P-value
Predicted liquidity creation ratio				-0.3349	0.0395	0.000
Insurance leverage ratio	0.0036	0.0009	0.000	0.0251	0.0022	0.000
Geographic diversification	-0.0274	0.0104	0.009	-0.0870	0.0169	0.000
Regulatory pressure	-0.0214	0.0078	0.006	-0.0715	0.0091	0.000
Liabilities greater than liquid assets	0.0229	0.0044	0.000	0.0529	0.0075	0.000
Line of business diversification	-0.0240	0.0134	0.072	-0.1594	0.0244	0.000
Price	0.0034	0.0008	0.000	-0.0044	0.0012	0.000
2-yr loss development	0.0001	0.0001	0.294	-0.0001	0.0001	0.147
New York license	0.0058	0.0071	0.416	0.0734	0.0129	0.000
Cost of capital	-0.0487	0.0127	0.000	-0.1075	0.0188	0.000
Firm size	0.0022	0.0026	0.395	-0.0091	0.0047	0.052
Firm affiliation	0.0024	0.0067	0.721	0.0625	0.0123	0.000
Business mix	-0.0236	0.0145	0.103	0.0056	0.0269	0.835
Tax exemption	-0.0176	0.0065	0.007	-0.0120	0.0117	0.308
Information asymmetry	-0.0588	0.0129	0.000			
Capital	-0.6180	0.0145	0.000			
Number of observations	34,376			34,376		
Number of firms	2,792			2,792		
R-Square	0.7920			0.7770		
Endogeneity Test (P-value)	0.0000					

Two-stage quantile regression model (2SQR)

Descriptive statistics

We divide the 34,376 insurer-year observations into 10 deciles ordered by reinsurance demand. We then calculate the average insurer's characteristics within each decile as reported in Table 5 and Tables 5a, 5b and 5c (see Appendix) for large, medium and small insurers and Tables 5e and 5d for insurers in the lower forty-fifth percentile and insurers in the higher fifty-fifth percentile.

Table 5 points to several interesting features. Row 1 shows the demand for reinsurance ratio broken down by deciles. The mean demand for reinsurance is 0.3723, compared with a median of 0.3205 (see Table 3). The mean demand for reinsurance in the bottom deciles is only 0.007, and for the fifth deciles it is 0.276, whereas the average for the top deciles is 0.886.

Row 2 shows the predicted liquidity creation ratio. The average is lower among the bottom and top deciles, at –0.502 and –0.469 respectively, than it is for the middle and upper deciles, for which it ranges from –0.419 to –0.397. This suggests that insurers with higher and lower demand for reinsurance are considered less risky to policyholders than those in the middle and upper deciles.

Rows 4 and 7 show geographic and line of business diversification. One can see that values decrease monotonically with an increase in demand for reinsurance. Geographic diversification is 0.738, 0.616 and 0.462 respectively for the bottom, fifth and top deciles, while it is 0.743, 0.530 and 0.511 for line of business diversification. Insurers with higher demand for reinsurance are more diversified.

Row 5 shows the proportion of insurers whose net premium to surplus ratio exceeds 300%. The proportion decreases monotonically with an increase in demand for reinsurance. The percentage of insurers whose net premium to surplus ratio exceeds 300% in the bottom, fifth, and top deciles is 5.6, 2.2, and 1.6 respectively.

Row 6 shows the proportion of insurers whose liabilities exceed their liquid assets. The proportion decreases up to the third deciles and increases monotonically for the higher deciles. The percentage of insurers whose liabilities exceed their liquid assets in the fifth and top deciles is 6.7 and 18.8 respectively.

Row 9 shows two-year loss development. The average value for the bottom deciles is –4.827, compared with –3.592 for the fifth deciles, and 0.074 and 0.719 for the two top deciles. This suggests that insurers with positive loss development tend to purchase more reinsurance,

whereas insurers purchase less if they have negative loss development.

Row 11 shows the cost of capital. For the bottom deciles, the average value is 0.103, while the average value is 0.086 (see Table 3). These averages decrease for the higher deciles, but remain above 0.086 up through the fifth deciles.

Row 13 shows the proportion of affiliated insurers. The proportions in the bottom, fifth, and top deciles are 0.530, 0.527 and 0.878 respectively.

Table 5
Description of each reinsurance demand decile

This table presents the means for each reinsurance demand decile for all variables. Decile 1 is the group of the lowest Reins group, and decile 10 is the highest Reins group.

Variables	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
Reinsurance demand	0.007	0.061	0.127	0.195	0.276	0.373	0.481	0.590	0.726	0.886
Liquidity creation ratio	-0.502	-0.428	-0.425	-0.421	-0.419	-0.417	-0.408	-0.397	-0.410	-0.469
Insurance leverage ratio	1.128	1.231	1.222	1.254	1.312	1.431	1.602	1.956	2.615	5.573
Geographic diversification	0.738	0.639	0.655	0.640	0.616	0.592	0.548	0.502	0.469	0.462
Regulatory pressure	0.056	0.032	0.028	0.029	0.022	0.029	0.029	0.026	0.016	0.016
Liabilities greater than liquid assets	0.073	0.049	0.056	0.069	0.067	0.088	0.118	0.137	0.161	0.188
Line of business diversification	0.743	0.601	0.560	0.553	0.530	0.526	0.511	0.498	0.486	0.511
Price	1.755	1.513	1.472	1.504	1.406	1.441	1.403	1.318	1.262	1.275
2-yr loss development	-4.827	-6.066	-5.454	-4.431	-3.592	-2.294	-1.350	-1.928	0.074	0.719
New York license	0.167	0.225	0.238	0.287	0.313	0.346	0.376	0.376	0.426	0.463
Cost of capital	0.103	0.114	0.094	0.091	0.086	0.080	0.078	0.076	0.069	0.068
Firm size	17.461	18.596	18.148	18.053	18.049	18.069	18.240	18.277	18.212	17.921
Firm affiliation	0.530	0.602	0.502	0.515	0.527	0.612	0.699	0.783	0.812	0.878
Business mix	0.784	0.681	0.670	0.683	0.670	0.664	0.646	0.632	0.637	0.651
Tax exempt	0.269	0.283	0.254	0.250	0.245	0.242	0.248	0.236	0.246	0.240

Econometric results

Chang (2015) studied the determinants of an insurer's demand for reinsurance using a two-stage quantile regression approach (2SQR) to correct for the bias caused by endogenous variables.

To examine the determinants of insurers' demand for reinsurance across various quantiles, we also performed a quantile regression with firm fixed effects.

Table 6 reports estimates for the quantiles $\tau \in \{0.10, 0.25, 0.50, 0.75, 0.90\}$ from 2SQR

and Tables 6a, 6b, 6c, 6d and 6e (see Appendix) for large, medium and small insurers, for insurers in the lower forty-fifth percentile and insurers in the higher fifty-fifth percentile respectively.

The estimated effects of the various control variables, as presented in Tables 6, 6a, 6b, 6c, 6d, 6e, are discussed in more detailed below:

Table 6 indicates that the effect of the predicted liquidity creation ratio differs; it has a strong negative effect on demand for reinsurance at higher quantiles. The median estimate is similar to the 2SLS point estimate (Table 4).

For large firms, there is no statistical effect of the predicted liquidity creation ratio on reinsurance demand, for all quantiles. For medium and small firms, there are significantly negative coefficient estimates in all the quantiles except the lowest one, which is not significant at the 10% level (Medium insurers).

For insurers in the higher fifty-fifth percentile, there are significantly negative coefficient estimates for all quantiles. Conversely, for insurers in the lower forty-fifth percentile, coefficient estimates are significantly positive at the 0.1, 0.25 and 0.50 quantiles, with larger effects found at the median estimate. The relationship is not statistically significant for the 0.75 quantile and is negatively significant at 10% at the 0.90 quantile.

The effect of the insurance leverage ratio is estimated to be significantly positive across all quantiles, with larger effects found at higher quantiles. The coefficient of geographic diversification is not statistically significant for the top quantile. However, the coefficients are significantly negative for the remaining quantiles, meaning that more geographically concentrated insurers purchase less reinsurance. For large firms, the coefficient is significantly negative only for the highest quantiles (0.75 and 0.90). Conversely, for insurers in the lower forty-fifth percentile and for insurers in the higher fifty-fifth percentile, we found that the more geographic concentrated the insurer, the higher the likelihood of its purchasing reinsurance, but only at the highest quantiles.

Regarding line of business diversification, the coefficient is not significant at the top quantile but is negatively significant for the remaining quantiles. These coefficients are the highest for the 0.10 to 0.50 quantiles. We found the same results for large firms, but the coefficient is not significant at the 0.75 and 0.90 quantiles. For medium insurers, the coefficient has a negative effect, but for the lowest quantile only (0.10, 0.25). Regarding insurers in the lower forty-fifth percentile and in the higher forty-fifth percentile, we found converse results: estimated results are significantly negative across all quantiles, with larger effects found at middle quantiles (0.25, 0.50 and 0.75) for insurers in the lower forty-fifth percentile. However, for insurers in the higher fifty-

fifth percentile there is no statistical relationship for the 0.10, 0.25 and 0.50 quantiles. Further, more concentrated insurers are more likely to purchase reinsurance at the 0.75 and 0.90 quantiles.

Regarding the business mix diversification variable, estimations are significantly positive across quantiles, with larger effects found at lower quantiles. We found the same results for large firms, apart from in the upper quantile. For medium firms, there is no statistical effect across the quantiles. For insurers in the higher fifty-fifth percentile, the coefficients are not statistically significant for the bottom quantile, but are positively significant for the 0.75 and 0.90 quantiles, implying that more concentrated business mix insurers are more likely to purchase reinsurance. For insurers in the lower forty-fifth percentile, estimates are significantly positive across all quantiles.

Table 6 shows that the effect of two-year loss development is insignificant at the 10^{th}, 25^{th} and 50^{th} quantiles. Yet starting from the 75^{th} quantile we can see the positive impact of two-year loss development on demand for reinsurance. However, this finding only applies to small firms, because the effect of two-year loss development is insignificant across the quantiles for large and medium firms, insurers in the lower forty-fifth percentile and those in the higher fifty-fifth percentile.

The effect of firm size is positive and significant on demand for reinsurance in the 90^{th} quantile only. The same result is observed for medium insurers. For large insurers, the effect is insignificant across all quantiles, and the effect is positive and significant across all quantiles for insurers in the lower forty-fifth percentile and insurers in the upper fifty-fifth percentile.

Regarding firm affiliation, the results suggest that insurers affiliated with a group purchase significantly more reinsurance than do those that are not affiliated with a group. The effect of being affiliated with a group increases systematically with level of demand for reinsurance, rising from 0.0275 in the 25^{th} quantile to 0.1922 in the 75^{th} quantile. Being affiliated with a group has no significant effect on demand for reinsurance in the 10^{th} quantile. The effect of firm affiliation is insignificant across all quantiles for large and medium firms. However, the converse effect is observed depending on whether the insurer is in the lower forty-fifth percentile or the upper fifty-fifth percentile. Insurers affiliated with a group in the lower forty-fifth percentile are less likely to purchase reinsurance than are insurers unaffiliated with a group, and insurers affiliated with a group in the upper fifty-fifth percentile are more likely to purchase reinsurance than are insurers unaffiliated with a group, across all quantiles.

The price (inverse of the economic loss ratio) does not significantly affect demand for reinsurance in the 10th quantile. The impact of price rises monotonically from the 25th quantile and reaches its highest value (0.0082 in absolute value) in the 75th quantile.

Insurers who had a license in New York State are more likely to purchase reinsurance than are those who do not have this license. The effect increases up to the 50th quantile, and decreases in the two top quantiles. The New York State license effect on demand for reinsurance is insignificant across quantiles for large insurers and for those in the upper fifty-fifth percentile.

Insurers in the lower forty-fifth percentile whose liabilities exceed their liquid assets are less likely to purchase reinsurance from the 10th quantile up to the 50th quantile. However, at the highest quantiles (75 th and 90th quantiles) the effect is insignificant. In contrast, insurers in the upper fifty-fifth percentile whose liabilities exceed their liquid assets are more likely to purchase reinsurance across all quantiles.

Summary

We compare the 2SLS and 2SQR approaches for different types of insurers: large, medium and small firms, along with insurers in the lower forty-fifth percentile and the higher fifty-fifth percentile, and summarize the results from these two approaches in Table 7.

First, we look at the results concerning the liquidity creation equation (1st stage). The variable ratio9_over, which corresponds to insurers whose liabilities exceed their liquid assets, has a significant positive effect, implying that these insurer are more likely to create liquidity than are those whose liquid assets exceed their liabilities, for all the groups: large, medium, and small insurers, those in the lower forty-fifth percentile, insurers who cede 27.5% or less of their gross premiums to reinsurance and those in the upper fifty-fifth percentile, along with insurers who cede more than 27.5% of their gross premium to reinsurance.

The insurance leverage ratio (dbs) and price variables are also positively significant. However, the price is insignificant for large and medium firms, while leverage is significant only for small insurers and those in the upper 55th percentile. Firm size is positively related to liquidity creation for large and medium firms, and for insurers in the upper fifth-fifth percentile only.

Further, the ratio2_over variable, which correspond to insurers whose net premium to surplus ratio exceeds 300%, has a significant negative effect, implying that insurers that are risky relative to policyholders' surplus are less likely to create liquidity, for large insurers, medium insurers, small insurers, and those in the upper fifty-fifth percentile. The cost to capital, tax exempt, product and geographic concentration variables are also negatively significant.

Second, the results regarding demand for reinsurance indicate that the coefficient of the predicted liquidity creation ratio is significantly negative in the 2SLS (2nd stage). Thus, insurers that create more liquidity are less likely to purchase reinsurance. However, the coefficient for insurers in the lower forty-fifth percentile is positively significant, implying that insurers that cede 27.5% or less of gross premiums to reinsurance and that create more liquidity are more likely to purchase reinsurance, especially in the lower quantiles (0.10, 0.25 and 0.50).

Table 7 illustrates that both the 2SLS and 2SQR models propose that the tax-exempt factor is negatively related to insurers' demand for reinsurance when the effect is significant, with the exception of the 0.75 and 0.90 quantiles for medium firms, where the relation with reinsurance demand is positive instead of negative.

The coefficients of insurance leverage (dbs) are significantly related to demand for both 2SLS and 2SQR models. These results are consistent with the hypotheses of bankruptcy cost, agency cost, and risk bearing (Chang and Jeng 2013; Cole and McCullough 2006; Wang *et al*., 2008).

Liu *et al*. (2016) state that '*There are two conflicting arguments relating the effect of business concentration on reinsurance. The first argument is that insurers with more concentrated business do not have diversification benefit. These insurers are riskier and therefore need more reinsurance. An opposite argument is also proposed. Insurers with few lines of business generally have a competitive advantage on their rivals on these lines. These insurers know their business and manage associated risk well. Reinsurance is thus less needed.'* Table 7 illustrates that the second argument seems more applicable to our data: insurers with higher concentration are less likely to need reinsurance. This result is consistent with the empirical findings of Cole and McCullough (2006), and supports the real service hypothesis, which suggests that the more focused the insurer is relative to line of business concentration, the less reinsurance it will demand. The second argument of Liu *et al*. (2016) seems to concern geographic concentration. However, the first argument seem more pertinent to our data concerning business mix concentration, namely that insurers with higher concentration of short or long tails, or personal and commercial lines are risker and therefore need more reinsurance. This result is significant for large insurers and those in the lower forty-fifth percentile.

The price of reinsurance measured by the inverse of the economic loss ratio is negatively related to demand for reinsurance, implying that as the price increases, demand for reinsurance decreases. This result is significant for medium and small insurers only.

The ratio9_over, newyork, group_dummy and mixline variables are also positively significant related to demand for reinsurance. However, business mix concentration (mixline) is significant only for large insurers and for those in the lower forty-fifth percentile, whereas the newyork and group_dummy variables are significant for medium insurers, small insurers and those in the upper fifth-fifth percentile.

Further, the ratio2_over variable, which corresponds to insurers whose net premium to surplus ratio is higher than 300 percent, has a significant negative effect, implying that insurers that are more risky regarding policyholders' surplus are less likely to purchase reinsurance, for medium insurers, small insurers, and those in the upper fifty-fifth percentile. The cost to capital (mean_roe) variable is also negatively significant for medium insurers, small insurers, those in the lower forty-fifth percentile and those in the upper fifty-fifth percentile.

Conclusion

This study analyzed how liquidity creation affects demand for reinsurance, a relationship that had not been studied adequately in the literature. The results we obtained are mixed. Our statistical analysis indicates that predicted liquidity creation has a negative effect on reinsurance demand for most firms. Insurers that create more liquidity are less likely to purchase reinsurance. However, the effect is positive for the insurers in the lower forty-fifth percentile, representing insurers that cede less than 28% of gross premiums to reinsurance. Our next step will be to analyze the two groups of insurers in more detail to better explain this important difference.

Another extension will be to find an exogenous variable (instrument) that can explain liquidity creation activities. Presently, we assume that predicted liquidity creation can explain reinsurance demand but we do not have a causality effect. Technically, to obtain such causality we must find an exogenous variable that explains liquidity creation but not reinsurance demand.

Table 4c Small firms
Real Implications of Liquidity creation ratio (2SLS)

This table provides the results of the fixed effects regressions corresponding to the second step for the real implications of the predicted liquidity creation ratio demand for reinsurance. The dependent variable is the Demand for reinsurance. All the variables are defined in Table 2. Control variables are included in lagged values. Heterosedasticity-consistent standard errors clustered at the firm level are reported.

	First stage			Second stage		
	Liquidity creation ratio			Demand for reinsurance		
Variables	Coeff	Std error	P-value	Coeff	Std error	P-value
Predicted liquidity creation ratio				-0.3346	0.0418	0.000
Insurance leverage ratio	0.0036	0.0009	0.000	0.0248	0.0023	0.000
Geographic diversification	-0.0285	0.0111	0.010	-0.0867	0.0177	0.000
Regulatory pressure	-0.0197	0.0083	0.017	-0.0706	0.0094	0.000
Liabilities greater than liquid assets	0.0204	0.0051	0.000	0.0567	0.0085	0.000
Line of business diversification	-0.0285	0.0146	0.052	-0.1543	0.0264	0.000
Price	0.0037	0.0008	0.000	-0.0042	0.0012	0.001
2-yr loss development	0.0000	0.0001	0.468	-0.0001	0.0001	0.130
New York license	0.0072	0.0076	0.343	0.0724	0.0137	0.000
Cost of capital	-0.0529	0.0138	0.000	-0.1130	0.0204	0.000
Firm size	0.0006	0.0030	0.852	-0.0058	0.0053	0.273
Firm affiliation	0.0019	0.0069	0.789	0.0616	0.0128	0.000
Business mix	-0.0188	0.0157	0.231	-0.0032	0.0295	0.915
Tax exempt	-0.0182	0.0070	0.009	-0.0082	0.0126	0.515
Information asymmetry	-0.0621	0.0142	0.000			
Capital	-0.6231	0.0155	0.000			
Number of observations	30,753			30,753		
Number of firms	2,658			2,658		
R-Square	0.7956			0.7728		
Endogeneity Test (P-value)	0.0000					

Table 5a Large firms
Description of each demand for reinsurance decile

This table presents the means for each demand for reinsurance deciles for all variables. The decile 1 is the group of the lowest Reins group, whereas decile 10 is the highest Reins group.

Variables	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
Demand for reinsurance	0.010	0.033	0.070	0.121	0.203	0.296	0.414	0.504	0.621	0.784
Liquidity creation ratio	-0.444	-0.413	-0.427	-0.428	-0.361	-0.395	-0.373	-0.341	-0.335	-0.337
Insurance leverage ratio	0.695	0.727	0.476	0.460	0.756	0.545	0.726	0.777	0.896	1.658
Geographic diversification	0.309	0.372	0.336	0.202	0.151	0.091	0.086	0.114	0.095	0.079
Regulatory pressure	0.000	0.008	0.000	0.000	0.040	0.000	0.000	0.089	0.008	0.000
Liabilities greater than liquid assets	0.033	0.097	0.105	0.138	0.307	0.363	0.496	0.411	0.605	0.764
Line of business diversification	0.507	0.445	0.396	0.444	0.409	0.311	0.273	0.350	0.284	0.347
Price	1.176	1.210	1.374	2.037	1.632	1.476	1.197	1.472	1.097	1.100
2-yr loss development	-4.758	-9.074	0.271	-1.226	-1.494	1.070	5.362	1.943	10.153	3.376
New York license	0.553	0.710	0.661	0.813	0.855	0.927	0.894	0.855	0.903	0.943
Cost of capital	0.127	0.123	0.118	0.141	0.097	0.140	0.112	0.132	0.085	0.102
Firm size	23.055	22.606	22.750	22.618	22.914	22.955	22.630	22.629	22.832	22.762
Firm affiliation	0.927	0.879	0.984	0.968	0.952	0.992	0.992	1.000	1.000	1.000
Business mix	0.556	0.563	0.506	0.592	0.574	0.587	0.525	0.526	0.536	0.584
Tax exempt	0.372	0.366	0.418	0.435	0.369	0.411	0.374	0.374	0.396	0.328

Table 5b Medium firms
Description of each demand for reinsurance decile

This table presents the means for each demand for reinsurance decile for all variables. Decile 1 is the group of the lowest Reins group, whereas decile 10 is the highest Reins group.

Variables	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
Demand for reinsurance	0.018	0.063	0.124	0.203	0.283	0.378	0.482	0.556	0.673	0.822
Liquidity creation ratio	-0.434	-0.420	-0.382	-0.384	-0.395	-0.373	-0.390	-0.351	-0.375	-0.382
Insurance leverage ratio	0.898	0.904	0.915	0.943	0.906	0.893	1.001	1.477	1.595	2.621
Geographic diversification	0.661	0.458	0.457	0.353	0.372	0.232	0.304	0.173	0.175	0.179
Regulatory pressure	0.010	0.005	0.005	0.020	0.020	0.015	0.015	0.035	0.020	0.000
Liabilities greater than liquid assets	0.085	0.040	0.090	0.101	0.070	0.125	0.251	0.165	0.362	0.477
Line of business diversification	0.535	0.520	0.501	0.451	0.434	0.381	0.375	0.343	0.374	0.378
Price	1.246	1.436	1.496	1.286	1.306	1.273	1.200	1.269	1.217	1.126
2-yr loss development	-7.434	-7.014	-5.210	-5.629	-4.396	-1.090	1.291	-2.321	0.105	3.231
New York license	0.352	0.327	0.470	0.618	0.533	0.770	0.774	0.850	0.844	0.769
Cost of capital	0.116	0.129	0.119	0.132	0.115	0.132	0.098	0.121	0.079	0.083
Firm size	21.259	21.211	21.187	21.156	21.142	21.227	21.168	21.197	21.153	21.205
Firm affiliation	0.899	0.930	0.925	0.940	0.940	0.950	0.960	0.990	0.965	1.000
Business mix	0.609	0.637	0.652	0.601	0.636	0.607	0.572	0.533	0.643	0.570
Tax exempt	0.447	0.425	0.321	0.361	0.317	0.330	0.360	0.323	0.333	0.406

Table 5c Small firms
Description of each demand for reinsurance decile

This table presents the means for each demand for reinsurance decile for all variables. Decile 1 is the group of the lowest Reins group, whereas decile 10 is the highest Reins group.

Variables	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
Demand for reinsurance	0.006	0.063	0.129	0.198	0.278	0.375	0.484	0.597	0.733	0.894
Liquidity creation ratio	-0.509	-0.429	-0.428	-0.426	-0.422	-0.421	-0.413	-0.404	-0.416	-0.476
Insurance leverage ratio	1.166	1.312	1.265	1.298	1.372	1.498	1.699	2.067	2.772	5.880
Geographic diversification	0.762	0.678	0.688	0.675	0.653	0.635	0.597	0.548	0.503	0.478
Regulatory pressure	0.061	0.038	0.029	0.030	0.023	0.031	0.029	0.026	0.016	0.017
Liabilities greater than liquid assets	0.074	0.046	0.049	0.058	0.055	0.072	0.092	0.110	0.127	0.165
Line of business diversification	0.768	0.620	0.567	0.563	0.545	0.543	0.534	0.521	0.501	0.517
Price	1.817	1.533	1.445	1.515	1.411	1.463	1.409	1.322	1.286	1.281
2-yr loss development	-4.637	-6.212	-5.538	-4.607	-3.688	-2.594	-1.998	-2.150	-0.316	0.677
New York license	0.130	0.181	0.198	0.245	0.274	0.295	0.310	0.316	0.383	0.441
Cost of capital	0.100	0.110	0.092	0.088	0.081	0.075	0.072	0.073	0.068	0.066
Firm size	16.918	18.031	17.761	17.672	17.625	17.698	17.731	17.820	17.821	17.702
Firm affiliation	0.486	0.541	0.455	0.469	0.479	0.578	0.661	0.756	0.793	0.876
Business mix	0.807	0.694	0.673	0.693	0.675	0.673	0.658	0.642	0.644	0.653
Tax exempt	0.254	0.259	0.244	0.237	0.233	0.231	0.230	0.225	0.229	0.234

Table 6a Large firms

Demand for reinsurance and Liquidity creation ratio (2SQR)

This table provides the results of the quantile regression with panel data fixed effect on the demand for reinsurance. The dependent variable is Demand for reinsurance. The endogenous variable is the liquidity creation ratio. All the variables are defined in Table 2. Control variables are included in lagged values.

Large firms	2SQR/Quantiles(τ=0.1, 0.25, 0.50, 0.75 and 0.90)														
	0.10			0.25			0.50			0.75			0.9		
	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)
Predicted liquidity creation ratio	-0.0441	0.1121	0.6939	-0.0480	0.1338	0.7196	-0.0802	0.2137	0.7077	-0.1227	0.1968	0.5331	-0.1073	0.1781	0.5471
Insurance leverage ratio	0.0232	0.0229	0.3120	0.0525	0.0308	0.0880	0.0702	0.0273	0.0103	0.0963	0.0278	0.0006	0.0886	0.0251	0.0004
Geographic diversification	0.0233	0.0335	0.4868	0.0080	0.0371	0.8299	-0.0635	0.0637	0.3189	-0.3120	0.0827	0.0002	-0.4017	0.0763	0.0000
Regulatory pressure	0.2287	0.1690	0.1763	0.1901	0.1295	0.1424	0.1362	0.0850	0.1094	-0.0080	0.1069	0.9403	-0.1533	0.1008	0.1286
Liabilities greater than liquid assets	0.0891	0.0378	0.0184	0.1976	0.0534	0.0002	0.2629	0.0798	0.0010	0.2074	0.0605	0.0006	0.1807	0.0364	0.0000
Line of business diversification	-0.2525	0.0675	0.0002	-0.2316	0.0895	0.0098	-0.2755	0.1270	0.0303	-0.1689	0.1718	0.3259	-0.0634	0.1244	0.6106
Price	0.0148	0.0056	0.0089	0.0093	0.0057	0.1029	-0.0022	0.0095	0.8161	-0.0157	0.0120	0.1935	-0.0086	0.0099	0.3864
2-yr loss development	0.0006	0.0005	0.2446	0.0012	0.0007	0.0986	0.0013	0.0009	0.1532	-0.0004	0.0008	0.6419	0.0001	0.0007	0.8809
New York license	0.0260	0.0180	0.1496	0.0312	0.0293	0.2866	0.0508	0.0489	0.2993	0.0937	0.0672	0.1636	0.0376	0.0613	0.5403
Cost of capital	-0.0243	0.0872	0.7806	-0.0800	0.1433	0.5766	0.0825	0.2226	0.7110	-0.0146	0.2867	0.9594	-0.0045	0.2348	0.9848
Firm size	-0.0028	0.0042	0.5105	-0.0073	0.0055	0.1893	-0.0073	0.0073	0.3148	0.0001	0.0089	0.9943	0.0116	0.0090	0.1971
Firm affiliation	-0.0191	0.0391	0.6258	0.0318	0.0669	0.6352	0.0306	0.0997	0.7593	0.0525	0.1011	0.6038	0.0647	0.0975	0.5069
Business mix	0.1648	0.0617	0.0076	0.2769	0.0982	0.0049	0.3755	0.1358	0.0058	0.3297	0.1969	0.0943	0.1678	0.1308	0.1996
Tax exempt	-0.0232	0.0385	0.5470	-0.0060	0.0625	0.9233	0.0702	0.0994	0.4803	0.1075	0.0940	0.2530	0.0426	0.0774	0.5826

Table 6b Medium firms

Demand for reinsurance and Liquidity creation ratio (2SQR)

This table provides the results of the quantile regression with panel data fixed effect on the demand for reinsurance. The dependent variable is Demand for reinsurance. The endogenous variable is the liquidity creation ratio. All the variables are defined in Table 2. Control variables are included in lagged values.

Medium firms	2SQR/Quantiles(τ=0.1, 0.25, 0.50, 0.75 and 0.90)														
	0.10			0.25			0.50			0.75			0.9		
	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)
Predicted liquidity creation ratio	-0.0456	0.1118	0.6838	-0.2647	0.1155	0.0220	-0.3325	0.1945	0.0874	-0.4118	0.1535	0.0074	-0.3461	0.1048	0.0010
Insurance leverage ratio	0.0407	0.0226	0.0716	0.0876	0.0131	0.0000	0.1057	0.0138	0.0000	0.0885	0.0128	0.0000	0.0673	0.0137	0.0000
Geographic diversification	-0.0567	0.0395	0.1514	-0.1209	0.0439	0.0060	-0.1657	0.0720	0.0215	-0.1543	0.0876	0.0784	-0.1950	0.0730	0.0076
Regulatory pressure	-0.1038	0.1609	0.5188	-0.0055	0.1126	0.9610	-0.0565	0.0719	0.4319	-0.0451	0.0518	0.3841	-0.0508	0.0598	0.3956
Liabilities greater than liquid assets	0.0570	0.0422	0.1766	0.1306	0.0483	0.0068	0.1444	0.0460	0.0017	0.2042	0.0398	0.0000	0.1633	0.0254	0.0000
Line of business diversification	-0.1364	0.0701	0.0519	-0.1708	0.0864	0.0481	-0.0859	0.0879	0.3284	-0.0647	0.0969	0.5045	0.0098	0.0894	0.9130
Price	-0.0096	0.0107	0.3697	-0.0241	0.0155	0.1217	-0.0107	0.0144	0.4571	-0.0188	0.0147	0.2033	-0.0112	0.0134	0.4036
2-yr loss development	0.0001	0.0005	0.9262	-0.0001	0.0006	0.8323	0.0001	0.0005	0.8522	0.0001	0.0006	0.8249	0.0002	0.0007	0.8133
New York license	0.0238	0.0216	0.2706	0.0758	0.0321	0.0183	0.1304	0.0533	0.0146	0.1062	0.0600	0.0766	0.0997	0.0476	0.0363
Cost of capital	-0.0328	0.0787	0.6769	-0.0997	0.1004	0.3205	-0.2703	0.1419	0.0569	-0.4203	0.1213	0.0005	-0.5230	0.1354	0.0001
Firm size	0.0007	0.0034	0.8331	-0.0010	0.0043	0.8209	0.0049	0.0078	0.5245	0.0114	0.0070	0.1040	0.0187	0.0047	0.0001
Firm affiliation	0.0120	0.0261	0.6455	0.0376	0.0502	0.4537	0.0070	0.0933	0.9401	-0.0379	0.1151	0.7418	-0.0455	0.0828	0.5829
Business mix	0.1336	0.0850	0.1160	0.1383	0.0899	0.1240	0.0047	0.0881	0.9575	0.0522	0.0968	0.5899	0.0521	0.0795	0.5120
Tax exempt	-0.0701	0.0472	0.1380	-0.0791	0.0572	0.1670	-0.0253	0.0795	0.7504	0.1154	0.0515	0.0252	0.1183	0.0510	0.0205

Table 6c Small firms

Demand for reinsurance and Liquidity creation ratio (2SQR)

This table provides the results of the Quantile regression with panel data fixed effect on the demand for reinsurance. The dependent variable is the Demand for reinsurance. The endogenous variable is the liquidity creation ratio. All the variables are defined in Table 2. Control variables are included in lagged values.

Small firms	2SQR/Quantiles(τ=0.1, 0.25, 0.50, 0.75 and 0.90)														
	0.10			0.25			0.50			0.75			0.9		
	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)
Predicted liquidity creation ratio	-0.0297	0.0152	0.0515	-0.0698	0.0311	0.0247	-0.3092	0.0351	0.0000	-0.5157	0.0310	0.0000	-0.5578	0.0257	0.0000
Insurance leverage ratio	0.0290	0.0011	0.0000	0.0425	0.0059	0.0000	0.0713	0.0049	0.0000	0.0773	0.0041	0.0000	0.0682	0.0041	0.0000
Geographic diversification	-0.0227	0.0089	0.0107	-0.0358	0.0117	0.0023	-0.0608	0.0147	0.0000	-0.0505	0.0132	0.0001	-0.0209	0.0147	0.1551
Regulatory pressure	-0.1544	0.0156	0.0000	-0.2165	0.0189	0.0000	-0.2571	0.0185	0.0000	-0.2257	0.0204	0.0000	-0.1885	0.0272	0.0000
Liabilities greater than liquid assets	0.0121	0.0100	0.2231	0.0615	0.0141	0.0000	0.0680	0.0112	0.0000	0.0753	0.0122	0.0000	0.0777	0.0119	0.0000
Line of business diversification	-0.1852	0.0250	0.0000	-0.2220	0.0234	0.0000	-0.1439	0.0267	0.0000	-0.0760	0.0260	0.0034	-0.0016	0.0251	0.9483
Price	-0.0008	0.0010	0.4344	-0.0038	0.0014	0.0049	-0.0063	0.0033	0.0516	-0.0080	0.0027	0.0025	-0.0071	0.0034	0.0350
2-yr loss development	0.0000	0.0001	0.6280	0.0000	0.0001	0.9703	0.0002	0.0002	0.3068	0.0006	0.0002	0.0014	0.0006	0.0002	0.0024
New York license	0.0415	0.0082	0.0000	0.0725	0.0127	0.0000	0.0694	0.0138	0.0000	0.0429	0.0105	0.0000	0.0216	0.0112	0.0527
Cost of capital	-0.0470	0.0168	0.0050	-0.1045	0.0266	0.0001	-0.1822	0.0287	0.0000	-0.2308	0.0323	0.0000	-0.2764	0.0353	0.0000
Firm size	0.0008	0.0007	0.2766	0.0035	0.0013	0.0084	0.0026	0.0017	0.1261	0.0034	0.0016	0.0294	0.0092	0.0015	0.0000
Firm affiliation	-0.0018	0.0048	0.7151	0.0313	0.0084	0.0002	0.1438	0.0112	0.0000	0.1938	0.0115	0.0000	0.1606	0.0127	0.0000
Business mix	0.1227	0.0250	0.0000	0.1505	0.0286	0.0000	0.0906	0.0330	0.0061	0.0808	0.0300	0.0072	0.0907	0.0282	0.0013
Tax exempt	-0.0100	0.0090	0.2673	-0.0328	0.0134	0.0143	-0.0504	0.0180	0.0051	-0.0378	0.0168	0.0243	-0.0323	0.0157	0.0399

Table 6e: Firms with demand for reinsurance greater than 0.275

Demand for reinsurance and Liquidity creation ratio (2SQR)

This table provides the results of the quantile regression with panel data fixed effect on demand for reinsurance. The dependent variable is the Demand for reinsurance. The endogenous variable is the liquidity creation ratio. All the variables are defined in Table 2. Control variables are included in lagged values.

	2SQR/Quantiles(τ=0.1, 0.25, 0.50, 0.75 and 0.90)														
	0.10			0.25			0.50			0.75			0.9		
	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)	Coeff	Std. Error	Pr(>|t|)
Predicted liquidity creation ratio	-0.1732	0.0171	0.0000	-0.2480	0.0264	0.0000	-0.3771	0.0270	0.0000	-0.4680	0.0238	0.0000	-0.4289	0.0250	0.0000
Insurance leverage ratio	0.0229	0.0010	0.0000	0.0328	0.0040	0.0000	0.0444	0.0034	0.0000	0.0447	0.0027	0.0000	0.0367	0.0028	0.0000
Geographic diversification	0.0060	0.0088	0.4987	-0.0059	0.0118	0.6146	-0.0043	0.0152	0.7766	0.0124	0.0122	0.3084	0.0407	0.0120	0.0007
Regulatory pressure	-0.0933	0.0165	0.0000	-0.1461	0.0229	0.0000	-0.1682	0.0168	0.0000	-0.1474	0.0173	0.0000	-0.1407	0.0206	0.0000
Liabilities greater than liquid assets	0.0388	0.0098	0.0001	0.0452	0.0107	0.0000	0.0506	0.0105	0.0000	0.0622	0.0107	0.0000	0.0456	0.0091	0.0000
Line of business diversification	0.0179	0.0162	0.2678	0.0417	0.0254	0.1008	0.0287	0.0258	0.2654	0.0652	0.0246	0.0081	0.0954	0.0258	0.0002
Price	0.0018	0.0018	0.3094	-0.0013	0.0017	0.4684	-0.0064	0.0024	0.0083	-0.0063	0.0037	0.0867	0.0008	0.0025	0.7536
2-yr loss development	0.0001	0.0001	0.3645	0.0001	0.0002	0.4708	0.0002	0.0002	0.1708	0.0001	0.0002	0.4624	-0.0001	0.0002	0.5611
New York license	0.0060	0.0072	0.4048	0.0069	0.0090	0.4401	0.0113	0.0110	0.3060	0.0081	0.0096	0.3983	0.0079	0.0094	0.4042
Cost of capital	-0.0627	0.0195	0.0013	-0.0840	0.0247	0.0007	-0.1104	0.0281	0.0001	-0.1395	0.0293	0.0000	-0.1996	0.0333	0.0000
Firm size	0.0106	0.0008	0.0000	0.0113	0.0011	0.0000	0.0114	0.0013	0.0000	0.0133	0.0012	0.0000	0.0203	0.0012	0.0000
Firm affiliation	0.0419	0.0059	0.0000	0.0890	0.0086	0.0000	0.1214	0.0115	0.0000	0.1234	0.0121	0.0000	0.0895	0.0138	0.0000
Business mix	-0.0048	0.0198	0.8084	-0.0173	0.0283	0.5398	0.0276	0.0283	0.3295	0.0507	0.0265	0.0559	0.0558	0.0243	0.0217
Tax exempt	-0.0136	0.0126	0.2808	-0.0226	0.0154	0.1434	-0.0092	0.0162	0.5682	-0.0029	0.0143	0.8409	-0.0222	0.0135	0.0990