Reinsurance demand and liquidity creation: Reciprocal causality[1]

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Abstract

This paper analyzes the relation between insurers' liquidity creation and reinsurance demand. Early theoretical contributions on liquidity creation propose that financial institutions enhance economic growth by creating liquidity on their balance sheet. Liquidity creation means, financing relatively illiquid assets with relatively liquid liabilities. However, liquidity creation exposes insurers to risk. There is a trade-off between getting higher returns on risky investments and being able to compensate clients at a low cost when unexpected claims happen. 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. Our main empirical results show reciprocal positive effects between liquidity creation and reinsurance demand.

Keywords:

Reinsurance demand, liquidity creation, reciprocal model, causality.

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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 their balance sheet. Liquidity creation means financial institutions invest in 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 their 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.

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? And conversely, do insurers that buy more reinsurance take more risks into illiquid assets with higher returns? 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.

We present the basic framework of liquidity creation in Section 1. Then we describe our data and econometric model. Results of the 2SLS model are discussed in Section 4. Simultaneous causality between liquidity creation and reinsurance demand is investigated in Section 5. The last section concludes the paper.

1. Liquidity creation: the basic framework

The methodology of Berger and Bouwman (2009) 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), but 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 $\frac{1}{2} \times \$1 + \frac{1}{2} \times \$1 = \$1$. 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 $-\frac{1}{2} \times \$1 - \frac{1}{2} \times \$1 = -\$1$; 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 creation 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	

2. Data and variables

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.

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 thus 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 variables

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). We also use *Liquid* to measure an insurer's liquidity creation. It is defined as LC/total admitted assets, where LC is defined as in Table 1 (step 3).

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. Our main objective is to analyze the true causality relationship.

We first treat liquidity creation as an endogenous variable in the reinsurance demand equation. 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.

We will also consider the variable *Reins* as an endogenous variable in the liquidity creation equation when we will test for simultaneous causality between the two activities.

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 concentration

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 business mix concentration Herfindahl index to reflect the degree of concentration 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 concentration (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 concentration (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 an ambiguous 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. We predict a negative sign in the demand for reinsurance equation.

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. We predict a positive sign in the demand for reinsurance equation.[2]

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

[2] Liu *et al*. (2016) consider another liquidity variable measured as the ratio of liquid assets (cash, bonds, and shares) to total assets.

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. A positive effect on the demand of reinsurance is predicted.

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 on reinsurance demand.

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 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. We propose a negative effect of capital on reinsurance demand since capital can be interpreted as a substitute to reinsurance.

Table 2

Variable definitions and construction

Variable name	Symbol	Variable definition
Insurance leverage ratio	dbs	Direct business written to surplus
Geographic concentration 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 concentration 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 concentration	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

3. Basic model

We first analyse the effect of liquidity creation on reinsurance demand. Two-Stage Least Square (2SLS) regressions are performed to obtain the desired relationship. We use the following regression model for demand for reinsurance and liquidity creation.

$$\begin{aligned}\text{Liquidty creation ratio}_{i,t-1} = \beta_0 + \beta_1 \times \text{Capital}_{i,t-1} + \beta_2 \times \text{Information asymetry}_{i,t-1} \\ + \sum \beta \text{ Control variables}_{i,t-1} + \text{Firm fixed effects} + \varepsilon_{i,t}\end{aligned} \tag{1}$$

and

$$\begin{aligned}\text{Demand of reinsurance}_{i,t} = \alpha_0 + \alpha_1 \text{Demand of reinsurance}_{i,t-1} + \alpha_2 \times \text{Predicted liquidty creation ratio}_{i,t-1} \\ + \sum \alpha \text{ Control variables}_{i,t} + \text{Firm fixed effects} + \upsilon_{i,t}\end{aligned} \tag{2}$$

In the first step, represented by Eq. (1), the liquidity creation ratio at time t-1 is regressed on the control variables at time t-1. 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 at time t-1, demand for reinsurance at time t-1, and the control variables at time *t*. The control variables in the demand for reinsurance equation include the Insurance leverage ratio, Geographic concentration, Regulatory pressure, Line of business concentration, Price, 2-yr loss development, Cost of capital, Firm size, Firm affiliation, Business mix concentration 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.

4. Results of 2SLS estimations

4.1 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. We also 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; 45% of the total number of insurers.
2. Insurers whose ceded reinsurance is greater than 27.5% of their gross premiums (higher fifty-fifth percentile). They represent 17,342 observations, which corresponds 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 it is 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, as already shown by Choi et al (2013). 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 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 in more than 27.5% of their gross premiums generate more liquidity creation than do insurers whose ceded reinsurance less 27.5% of their gross premiums. This result seems to suggest that reinsurance demand influence liquidity creation! We will come back on this issue.

Table 3
Summary statistics for all insurers

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 concentration	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 concentration	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 concentration	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

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.

Concentration variables by product, geographic area or business mix concentration 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 −3.1064% for large insurers and small insurers respectively. On average, large firms have 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.

Figure 1 does not show a clear dependence between reinsurance demand and liquidity creation, while Figure 2 and Figure 3 indicate that liquidity creation seems positively (negatively) correlated with reinsurance demand for insurers that cede less (more) of their gross premium to reinsurance. In other words, insurers in the forty-fifth percentile are more likely to use reinsurance when they are more active in liquidity creation. Finally, Figure 4 shows that larger insurers buy less insurance but are not necessarily more active in liquidity creation.

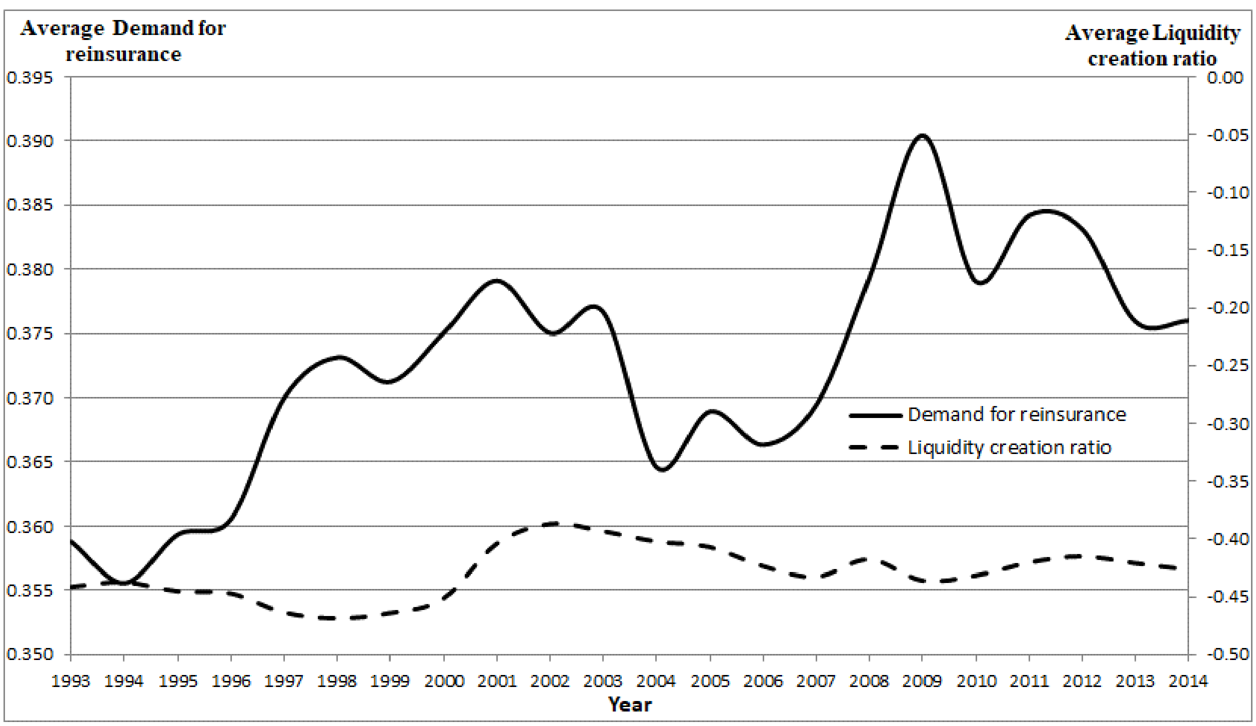

Figure 1
Average Demand for reinsurance and Liquidity creation ratio by year

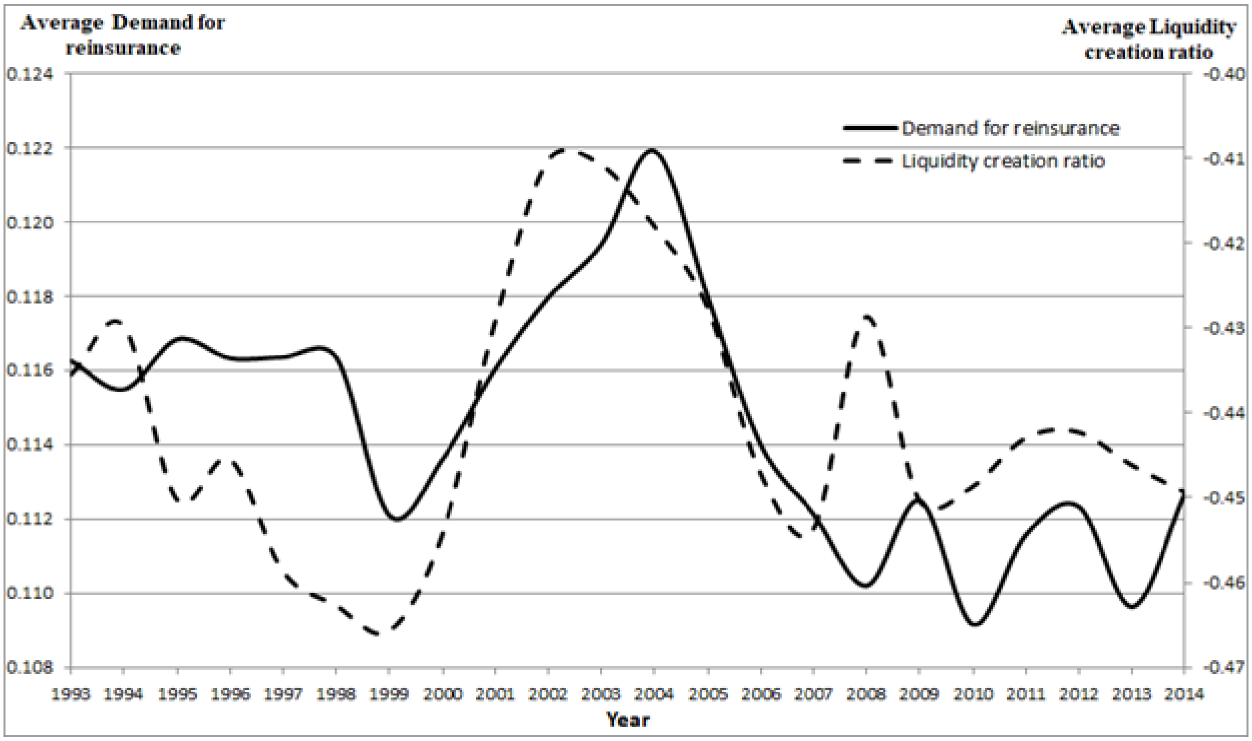

Figure 2
Insurers in the forty-fifth percentile

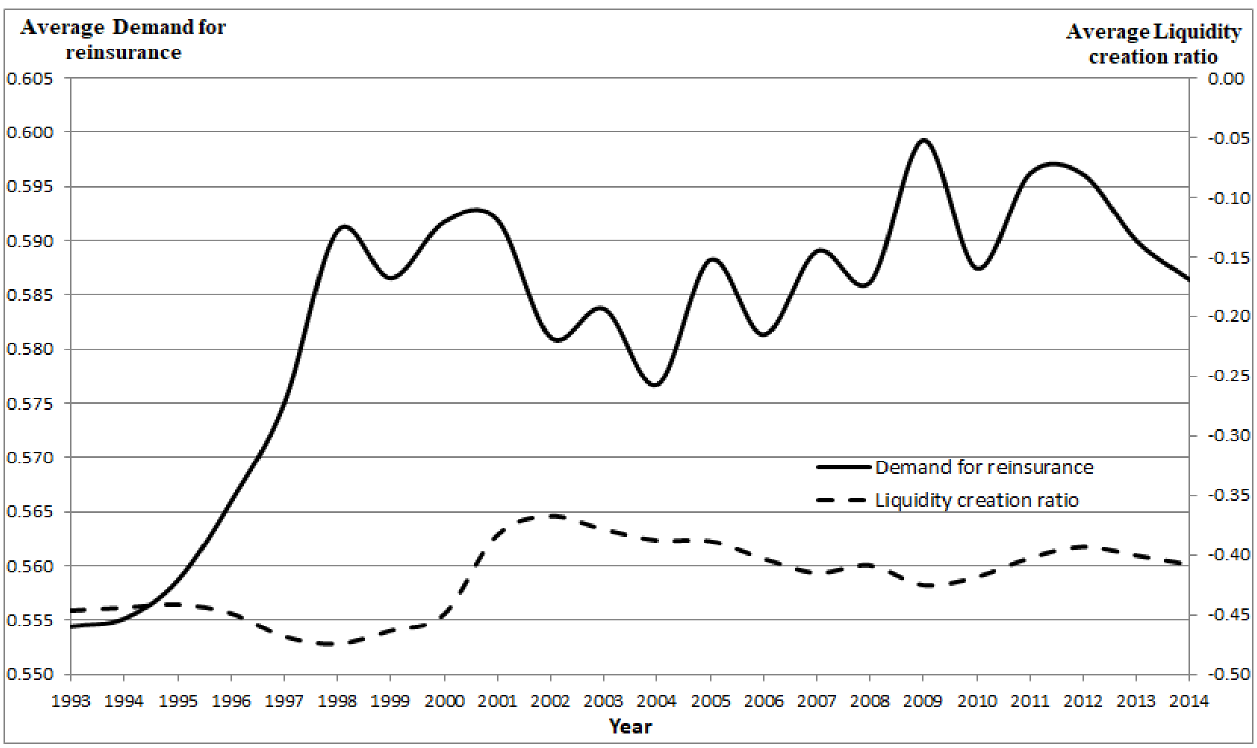

Figure 3
Insurers in the fifty-fifth percentile

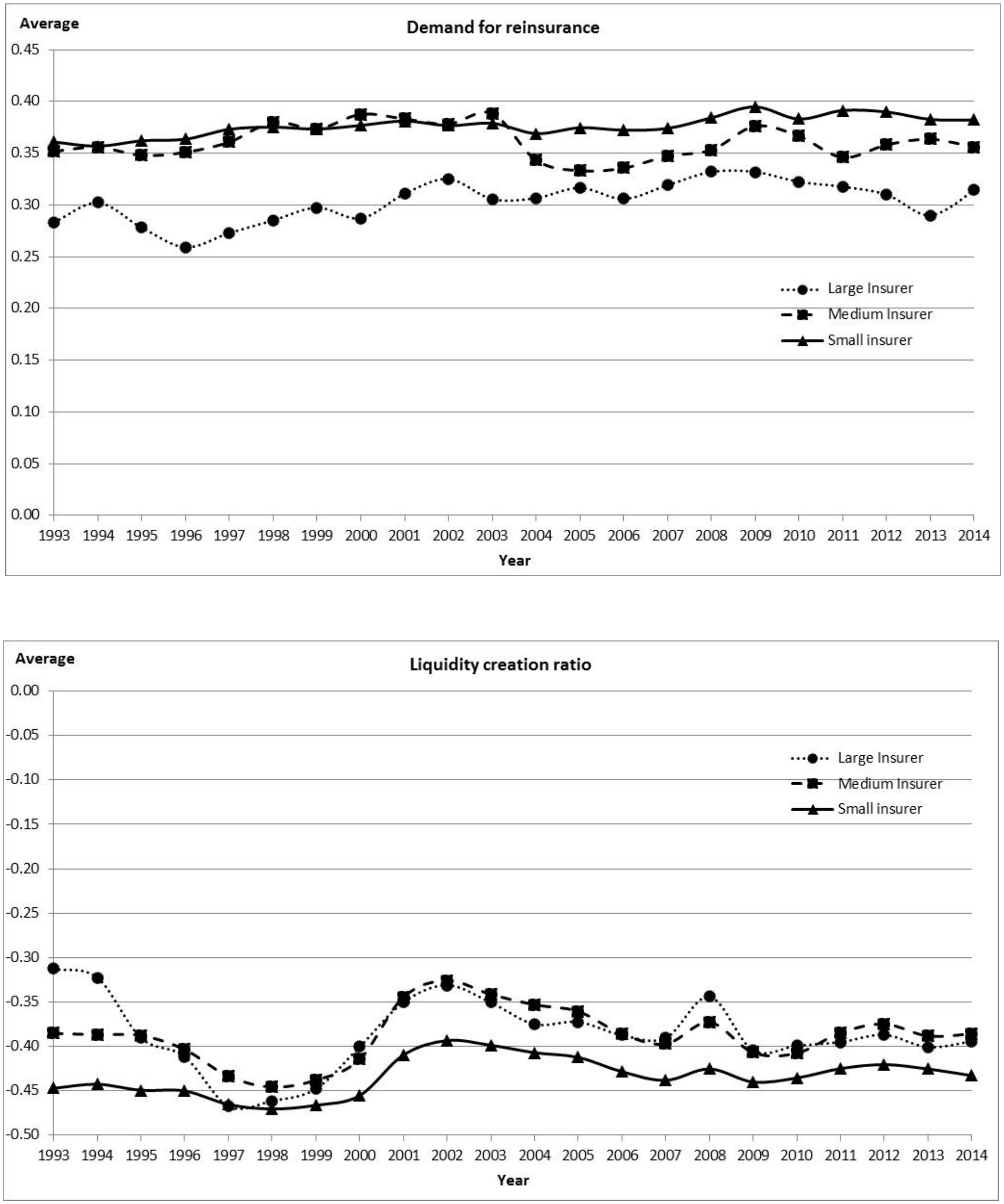

Figure 4

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

4.2 *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 (see Appendix). The results for the two groups of insurers that cede 27.5% or less of gross premiums to reinsurance or cede more than 27.5% of gross premiums to reinsurance are presented in Tables 4d and 4e respectively (see Appendix).

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. Heteroscedasticity-consistent standard errors clustered at the firm level are reported.

	First stage Liquidity creation ratio $_{t-1}$			Second stage Demand for reinsurance $_{t}$		
Variables	Coeff	Std error	P-value	Coeff	Std error	P-value
Demand of reinsurance $_{t-1}$				0.6976	0.0086	0.000
Predicted liquidity creation ratio $_{t-1}$				0.0297	0.0114	0.009
Insurance leverage ratio	0.0035	0.0007	0.000	0.0088	0.0010	0.000
Geographical concentration	-0.0245	0.0087	0.005	-0.0466	0.0085	0.000
Regulatory pressure	0.0093	0.0062	0.133	-0.0831	0.0064	0.000
Higher liabilities than liquid asset	0.0573	0.0042	0.000	0.0144	0.0041	0.000
Line of business concentration	-0.0071	0.0113	0.532	-0.0628	0.0128	0.000
Price	0.0033	0.0006	0.000	-0.0111	0.0011	0.000
2-yr loss development	0.0001	0.0000	0.192	0.0000	0.0000	0.307
New York license	-0.0023	0.0065	0.730	0.0282	0.0062	0.000
Cost of capital	-0.0513	0.0111	0.000	-0.0082	0.0096	0.396
Firm size	0.0073	0.0023	0.002	-0.0159	0.0022	0.000
Firm affiliation	0.0000	0.0053	0.996	0.0243	0.0052	0.000
Business mix concentration	-0.0208	0.0125	0.097	0.0168	0.0136	0.218
Tax exemption	-0.0062	0.0056	0.267	0.0100	0.0053	0.059
Information asymmetry	-0.8653	0.0119	0.000			
Capital	-0.0293	0.0105	0.005			
Observation	34,376			34,376		
Number of firms	2,792			2,792		
R-Square	0.6427			0.8586		

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 increases the demand for reinsurance which runs according to our prediction. In addition, the coefficient is positively significant for small insurers and not significant for large and medium insurers. These results indicate that the impact of the liquid creation ratio on reinsurance use is greater for small insurers than for the other two groups.

The results in Table 4d show a positive significant relationship between the predicted liquidity creation ratio and demand for reinsurance. Table 4e indicates a non-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 different effect depending on whether the firms fall in the lower forty-fifth percentile (low reinsurance demand) or in the higher fifty-fifth percentile (high reinsurance demand). These different results will be investigated in Section 5, when causality in the two directions will be analyzed.

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 significant relationship at 10% level of significance between leverage and demand for reinsurance for insurers in the lower forty-fifth percentile. The coefficient estimate is the lowest (0.0013) for insurers in the fifty-fifth percentile and highest for the large insurer group (0.0163).

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, and medium insurers there is no statistical relationship between insurance leverage and the liquidity creation ratio. For small insurers, the relation is negatively significant, meaning that insurers with higher insurance leverage tend to create less liquidity.

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 for small insurers and those in the lower forty-fifth percentile. However, among large firms and medium firms, we find a positive relationship between firm size and the liquidity creation ratio, but the relation is not significant for reinsurance use. Among insurers in the lower forty-fifth percentile, there is no statistical relationship between firm size and demand for reinsurance, firm size and liquidity creation ratios. Among insurers in the higher fifty-fifth percentile, there is a negative relationship between firm size and demand for reinsurance and a positive relationship between firm size and liquidity creation ratios.

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, but it is negatively significant related to liquidity creation at 10% level of significance.

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 and product concentration and demand for reinsurance or the liquidity creation ratio. However, 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, but negatively related to the liquidity creation ratio, only for geographical concentration. In addition, the group of insurers with the highest 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 positively significantly related to demand for reinsurance, at 10% level of significance. However, it is not significantly related to the liquidity creation ratio. For large insurers, tax-exempt status is not significantly related to demand for reinsurance nor is it significantly related to the liquidity creation ratio. For insurers in the lower forty-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 higher fifty-fifth percentile. For medium and small insurers, the price is significantly and negatively related to demand for reinsurance only. For insurers in the lower forty-fifth percentile, there is negative relationship between price and demand for reinsurance, and the relationship is positive for the liquidity creation ratio at 10% level of significance.

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, excepted for medium firms affiliated with a group tend to create more liquidity. For large and medium firms and for insurers in the lower forty-fifth percentile, firm affiliation is not significantly related to demand for reinsurance. However, for small insurers firm affiliation is significant, implying that small insurers affiliated with a group demand more reinsurance. Insurers in the higher fifty-fifth percentiles affiliated with a group also demand more reinsurance.

Regulatory pressure is significantly and negatively related to demand for reinsurance and is not related to the liquidity creation ratio. Accordingly, firms whose net premiums to surplus ratio is higher than 300% demand less reinsurance. We find the same results for insurers 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 small and medium insurers and those in the lower forty-fifth percentile regulatory pressure is significantly and negatively related to demand for reinsurance and positively related to 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 insurers in the higher fifty-fifth percentile.

For large and medium insurers and those in the lower forty-fifth percentile, the relationship is only significant for the liquidity creation ratio but not for demand for reinsurance. For small insurers, the relationship is only significant 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 and those in the higher fifty-fifth percentile. For insurers in the lower forty-fifth percentile, we find no relationship with demand for reinsurance or with the liquidity creation ratio. Small insurers having a license in New York State are more likely to purchase reinsurance and create less liquidity. For large insurers, we find no relationship with liquidity creation ratio but a significant and negatively relationship with demand for reinsurance.

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 and medium insurers and those in the higher fifty-fifth percentile, for which information asymmetry is not significantly related to the liquidity creation ratio.

5. Causality analysis

In the previous sections, we performed a Two-Stage Least Square (2SLS) regression to overcome the endogeneity issue that reinsurance demand and the liquidity creation ratio can influence each other, but we did not implement any causality tests because we did not find an appropriate instrument for liquidity creation. In fact without a valid instrument, the endogeneity problem cannot be overcome using the 2SLS procedure. To obtain causality effects, this estimation technique requires the use of instrumental variables so that equations (1) and (2) can be consistently estimated. 2SLS can be robust if, for one of the two equations, there exists at least one instrument such that the instrumental variable is significant in the first step estimation and is not correlated with the error term of the other estimated equation. For example, at least one of the instrumental variables should be able to influence the liquidity creation ratio but not reinsurance demand. At the end of the first stage, where the liquidity ratio is estimated, liquidity creation is predicted using all exogenous variables, including the instrument. Consequently, given the distribution of the error term, the coefficients of the resulting second-stage equation of reinsurance demand are unbiased. However, finding at least one good instrument that influences the liquidity creation ratio but not reinsurance demand is not an easy task because the two activities are almost affected by the same variables that are often decision variables for the insurer.

Our 2SLS procedure contained the assumption that the relationship between reinsurance demand and the liquidity creation ratio was unidirectional, that is, the liquidity creation ratio influences reinsurance demand but not the converse. Another estimation technique, the Cross-lagged model, examines the reciprocal causal effects between two variables. Consider the following set of equations:

$$\begin{aligned} \mathrm{y}_{i,t} &= \mu_t + \beta_1 \mathrm{x}_{i,(t-1)} + \beta_2 y_{i,(t-1)} + \varepsilon_{i,t} \\ x_{i,t} &= \tau_t + \beta_3 \mathrm{x}_{i,(t-1)} + \beta_4 y_{i,(t-1)} + \upsilon_{i,t} \end{aligned}, \quad t = 2, \cdots, T \qquad (3)$$

where μ_t and τ_t are intercepts that vary with time, $\beta_1, \beta_2, \beta_3$ and β_4 are scalar coefficients, and ε_{it} and υ_{it} are random disturbances.

The parameters (β_2, β_3) are auto-regressive coefficients that determine the stability of the rank ordering of firms on the same variable over time. The parameters (β_1, β_4) are the cross-lagged regression coefficients that tell us how much variation in one variable at time (t-1) is able to predict a change in the other variable between (t-1) and *t*. The coefficients for stability and lagged effects are, respectively, constrained to equality across waves, making these parameters equivalent to ‘average’ effects over the duration of the panel. We used the Maximum Likelihood (ML) estimation method. It tends to work best when panels are strongly balanced, T is relatively small (e.g. less than 10), and there are no missing values. To apply these conditions to our data set we separated our data into three periods: 1992 – 1999 (8 years); 2000-2007 (8 years); and 2008-2014 (7 years). We also used the Full information Maximum Likelihood (FIML, Arbuckle 1996) option dealing when data are missing at random.

The data set consists of 2,297 firms observed for more than 1 year (1992-2014, 23 years). Only 16% of the firms studied (i.e. 483) are observed over all 23 years. From 1992 to 1999, we observe, in Table 5, that there are 1,072 firms observed for all 8 years. There are 1,063 firms in 2000–2007 that are observed in all 8 years and 1,108 firms observed in all the 7 available years from 2008 to 2014.

Table 5
Number of years of observation for each firm by period

Number of years of observation	1992-1999 N	1992-1999 %	2000-2007 N	2000-2007 %	2008-2014 N	2008-2014 %
4	156	8.30	169	9.84	191	11.29
5	218	11.60	167	9.73	192	11.35
6	152	8.09	163	9.49	201	11.88
7	281	14.95	155	9.03	1,108	65.48
8	1,072	57.05	1,063	61.91	--------	--------
Number of firms	1,879	100.00	1,717	100.00	1,692	100.00

We are interested in the nature of the relationship between reinsurance demand, represented by the variable x in equation (3), and the liquidity creation ratio, represented by the variable y. Reinsurance demand is defined as (affiliated reinsurance ceded + non-affiliated reinsurance ceded)/(direct business written plus reinsurance observed). To measure the liquidity creation ratio we use the definition developed by Berger and Bouwman (2009), namely liquidity creation to total admitted assets. The liquidity creation variable developed by Berger and Bouwman (2009) is defined for insurers in Table 1.

Table 6 gives the results for the three periods separately and by number of years of observation. We find positive and significant cross-lagged coefficients running in both directions, for all three periods and by considering the data with missing values. These results support a reciprocal effects model in which each variable exerts a causal influence on the other over time. But these estimations do not contain any control variable.

Table 6
Estimates for reciprocal model with lagged effects

ML Method	1992-1999 N	1992-1999 time t-1 L.Reins	1992-1999 time t-1 L.Liquid	2000-2007 N	2000-2007 time t-1 L.Reins	2000-2007 time t-1 L.Liquid	2008-2014 N	2008-2014 time t-1 L.Reins	2008-2014 time t-1 L.Liquid
Nb of years ≥ 4	1,879	LL	= 20,739	1,717	LL	= 18,758	1,692	LL	= 19,790
Reinsurance demand		0.9308	0.0248		0.9349	0.0223		0.9539	0.0278
at time t		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)
Liquidity creation ratio		0.0096	0.9176		0.0205	0.8914		0.0089	0.9488
at time t		(0.001)	(0.000)		(0.000)	(0.000)		(0.001)	(0.000)

ML Method	1992-1999			2000-2007			2008-2014		
	N	time t-1		N	time t-1		N	time t-1	
		L.Reins	L.Liquid		L.Reins	L.Liquid		L.Reins	L.Liquid
Nb of years ≥ 5	1,723	LL	= 20,401	1,548	LL	= 18,677	1,501	LL	= 19,239
Reinsurance demand		0.9321	0.0258		0.9372	0.0238		0.9561	0.0273
at time t		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)
Liquidity creation ratio		0.0085	0.9151		0.0169	0.8926		0.0081	0.9497
at time t		(0.004)	(0.000)		(0.000)	(0.000)		(0.002)	(0.000)
Nb of years ≥ 6	1,505	LL	= 19,627	1,381	LL	= 17,910	1,309	LL	= 18,219
Reinsurance demand		0.9343	0.0232		0.9379	0.0238		0.9586	0.0238
at time t		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)
Liquidity creation ratio		0.0074	0.9172		0.0169	0.8926		0.0102	0.9481
at time t		(0.014)	(0.000)		(0.000)	(0.000)		(0.000)	(.000)
Nb of years ≥ 7	1,353	LL	= 18,848	1,218	LL	= 16,978	1,108	LL	= 16,354
Reinsurance demand		0.9351	0.0235		0.9383	0.0209		0.9630	0.0203
at time t		(0.000)	(0.000)		(.000)	(0.000)		(0.000)	(0.000)
Liquidity creation ratio		0.0075	0.9201		0.0154	0.8887		0.0080	0.9465
at time t		(0.015)	(0.000)		(0.000)	(0.000)		(0.006)	(0.000)
Balanced data	1,072	LL	16,654	1,063	LL	= 15,594	1,108	LL	= 16,354
Reinsurance demand		0.9386	0.0205		0.9374	0.0199		0.9630	0.0203
at time t		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)
Liquidity creation ratio		0.0073	0.9303		0.0159	0.8890		0.0080	0.9465
at time t		(0.021)	(0.000)		(0.000)	(0.000)		(0.006)	(0.000)

LL = Log Likelihood

In other words, equation (3) cannot completely take into account the unobserved heterogeneity problem (Halaby 2004, Allison 2005, Allison 2009, Firebaugh et al. 2013). Unobserved heterogeneity is the variation (differences) among firms that is not measured. One way to solve the problem is to incorporate in equation (3) the fixed effects terms α_i and η_i, which vary across firms. The fixed effects method can eliminate the effects of confounding variables without measuring them as long as they are stable over time. This generates the following equation:

$$\begin{array}{l} y_{i,t} = \mu_t + \beta_1 x_{i,(t-1)} + \beta_2 y_{i,(t-1)} + \alpha_i + \varepsilon_{i,t} \\ x_{i,t} = \tau_t + \beta_3 x_{i,(t-1)} + \beta_4 y_{i,(t-1)} + \eta_i + \upsilon_{i,t} \end{array}, \quad t = 2, \cdots, T \tag{4}$$

Unfortunately, attempting to combine the fixed effects model with cross-lagged models leads to serious estimation problems. The estimation difficulties include error terms that are correlated with predictors, the so-called incidental parameters problem. Equations in (4) cannot allow for simultaneous estimation of causation. The two equations in (4) must be estimated separately. The fixed effects in each equation must be modeled as a latent variable that is allowed to be correlated with all time-varying predictor variables. The rationale for the method is described in the studies by Teachman et al. (2001) and Allison and Bollen (1997). The assumption of sequential endogeneity is modelled by allowing the error term at each point in time to be correlated with the future values of the time-dependent covariates, but without past values (Woolridge, 2002).

The results presented in Table 7 indicate that there is still reciprocal causality between liquidity creation and the reinsurance demand.

We may also add vectors of control variables w_{it}, s_{it}, which vary over both firms and time. They are included in equation (5).

$$\begin{aligned} y_{it} &= \mu_t + \beta_1 x_{i(t-1)} + \beta_2 y_{i(t-1)} + \delta_1 w_{it} + \alpha_i + \varepsilon_{it} \\ x_{it} &= \tau_t + \beta_3 x_{i(t-1)} + \beta_4 y_{i(t-1)} + \delta_2 s_{it} + \eta_i + \upsilon_{it} \end{aligned}, \ t = 2, \cdots, T \qquad (5)$$

Maximum likelihood (ML) estimations for structural equation modelling (SEM) sometimes fail to converge. We therefore include in the model only the variables that improve the fit. A wide array of fit indices was developed (Schermelleh-Engel and Moosbrugger, 2003; Ding et al., 1995; Sugawara and MacCallum, 1993): Root Mean Square Error of Approximation; Comparative Fit Index; Tucker-Lewis Index; and Standardized Root Mean Square Residual.

Root Mean Square Error of Approximation (RMSEA) Index: An index of the difference between the observed covariance matrix per degree of freedom and the hypothesized covariance matrix. A value less than .08 is generally considered a good fit (Hu & Bentler, 1999). Good fit indicated by Browne and Cudeck (1993) is RMSEA < 0.06.

The *Comparative Fit Index* (CFI) is an incremental fit index that produces values between 0 – 1; high values are indicators of good fit. An acceptable fit is provided when the CFI value is larger than 0.95 (Schermelleh-Engel et al, 2003). This index is relatively independent from sample size and yields better performance when small samples are studied (Chen, 2007; Hu and Bentler, 1998).

The *Tucker-Lewis Index* (TLI) is an incremental index that is not required to be between 0 and 1. A higher TLI value indicates better fit, and values larger than 0.95 are interpreted as acceptable fit.

The *Standardized Root Mean Square Residual* (SRMR) is a measure of the average difference between the observed and model implied correlations. It will be close to 0 when the model fits well. Hu and Bentler (1999) suggest values of about .08 or under.

Table 7
Estimates for Reciprocal Model with Fixed and Lagged Effects

ML Method	1992-1999			2000-2007			2008-2014		
	N	time t-1		N	time t-1		N	time t-1	
		L.Reins	L.Liquid		L.Reins	L.Liquid		L.Reins	L.Liquid
Nb of years ≥ 4	1,879	LL=21,241=	LL=20,110	1,717	LL=21,000	LL=17,298	1,692	LL=21,422	LL=18,407
Reinsurance demand at time t		0.8776 (0.000)	0.2206 (0.000)		0.9236 (0.000)	0.1775 (0.000)		0.9097 (0.000)	0.1466 (0.000)
Liquidity creation ratio at time t		0.1346 (0.000)	0.8972 (0.000)		0.1451 (0.000)	0.8928 (0.000)		0.1084 (0.000)	0.8982 (0.000)
Nb of years ≥ 5	1,723	LL=20,677	LL=19,565	1,548	LL=20,485	LL=16,952	1,501	LL=20,549	LL=17,677
Reinsurance demand at time t		0.8760 (0.000)	0.2197 (0.000)		0.8931 (0.000)	0.1758 (0.000)		0.9037 (0.000)	0.1417 (0.000)
Liquidity creation ratio at time t		0.1319 (0.000)	0.8908 (0.000)		0.1327 (0.000)	0.8201 (0.000)		0.0968 (0.000)	0.8672 (0.000)
Nb of years ≥ 6	1,505	LL=19,541	LL=18,532	1,381	LL=19,347	LL=15,760	1,309	LL=19,041	LL=16,488
Reinsurance demand at time t		0.8731 (0.000)	0.2093 (0.000)		0.8770 (0.000)	0.1568 (0.000)		0.8899 (0.000)	0.1440 (0.000)
Liquidity creation ratio at time t		0.1275 (0.000)	0.8868 (0.000)		0.1177 (0.000)	0.8019 (0.000)		0.0929 (0.000)	0.7727 (0.000)
Nb of years ≥ 7	1,353	LL=18,430	LL=17,575	1,218	LL=17,865	LL=14,801	1,108	LL=17,062	LL=14,244
Reinsurance demand at time t		0.8704 (0.000)	0.2264 (0.000)		0.8692 (0.000)	0.1511 (0.000)		0.8812 (0.000)	0.1388 (0.000)
Liquidity creation ratio at time t		0.1342 (0.000)	0.8715 (0.000)		0.0985 (0.000)	0.7485 (0.000)		0.0883 (0.000)	0.7396 (0.000)
Balanced data	1,072	LL=15,652	LL=15,543	1,063	LL=15,924	LL=13,295	1,108	LL=17,062	LL=14,244
Reinsurance demand at time t		0.8797 (0.000)	0.2322 (0.000)		0.8546 (0.000)	0.1494 (0.000)		0.8812 (0.000)	0.1388 (0.000)
Liquidity creation ratio at time t		0.1299 (0.000)	0.8816 (0.000)		0.0944 (0.000)	0.7656 (0.000)		0.0883 (0.000)	0.7396 (0.000)

LL = Log Likelihood

When the model is having trouble converging, we standardize the control variables in the model to have mean 0 and variance 1. Table 8 summarizes the definitions and construction for the control variables used in equation (5).

Table 8
Variable definitions, construction

Variable Name	Variable Symbol	Variable definition
Insurance leverage ratio	dbs	Direct business written to surplus
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
Economic loss ratio	price	$\frac{Net\,premium\ written - \exp - divp}{D \times losses\ incured}$ where exp = Commissions, expenses paid and aggregate write-ins for deduction; divp = Dividend paid D is the Discount factor used by Winter (1994) to calculate the economic loss ratio. Losses incurred in current year. For a detailed discussion on constructing the ratio see Winter (1994)
Tax-exempt investment income	tax_ex	Bond interest exempt from federal taxes plus seventy percent 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 years
Capital	surplus_ratio	Ratio of surplus to total admitted assets

Variables are strictly exogenous (by assumption) if they are uncorrelated with the error terms at all points. They are not affected by prior values of the dependent variables. The strict exogeneity used in the linear panel model for y_{it} with fixed effects can be stated as $E\left(\varepsilon_{it}|\mathrm{w}_i,\alpha_i\right)=0$; (see Wooldrige, 2010 p. 288). An equivalent condition exists for x_{it}. A test of strict exogeneity using fixed effects, when T > 2, is obtained by estimating equation (6):

$$\mathrm{y}_{it} = \delta w_{it} + \varphi z_{it+1} + \alpha_i + \varepsilon_{it}, \qquad t = 1, 2, \cdots, T-1 \tag{6}$$

where w_{it} is a vector of explanatory variables and z_{it+1} is a subset of w_{it+1}. Under strict exogeneity, $\varphi = 0$. We can carry out the test using fixed effects estimation. Predetermined variables can be affected by prior values of the dependent variable. An equivalent equation can be used for x_{it}.

Table 9 presents p-values for the test $H_0 : \varphi = 0$. We can see that the type of control variable changes depending on which period is analyzed.

Table 9
P-values for the test: $H_0 : \varphi = 0$

P-values for the test: $H_0 : \varphi = 0$	1992-1999 *time t* Reins	1992-1999 *time t* Liquid	2000-2007 *time t* Reins	2000-2007 *time t* Liquid	2008-2014 *time t* Reins	2008-2014 *time t* Liquid
At time t+1						
Insurance leverage ratio	0.007	0.090	0.001	0.011	0.168	0.001
Regulatory pressure	0.201	0.279	0.012	0.881	0.009	0.741
Liabilities greater than liquid assets		0.072		0.769		0.195
Price	0.093	0.002	0.036	0.000	0.013	0.183
Tax exempt investment income	0.069		0.838		0.883	
Information asymmetry		0.101		0.000		0.999
Capital	0.066		0.316		0.847	

Reins: Demand for reinsurance; Liquid: Liquidity creation ratio

For the period 1992–1999, we observe that regulatory pressure is a strictly exogenous variable of reinsurance demand, and that insurance leverage ratio, price, tax-exempt investment income and capital are predetermined variables of reinsurance demand (at 10%). In the liquidity creation ratio equation, we observe that regulatory pressure and information asymmetry are strictly exogenous variables, and that insurance leverage ratio, liabilities greater than liquid assets and price are predetermined variables.

For the period 2000–2007, we observe that tax-exempt investment income and capital are strictly exogenous variables of reinsurance demand and insurance leverage ratio, regulatory pressure while price is a predetermined variable of reinsurance demand. In the liquidity creation ratio equation, we observe that regulatory pressure and liabilities greater than liquid assets are strictly exogenous variables and that insurance leverage ratio, price and information asymmetry are predetermined variables.

For the period 2008–2014 we observe that insurance leverage ratio, tax exempt investment income and capital are strictly exogenous variables of reinsurance demand and that regulatory pressure and price are predetermined variables of reinsurance demand. In the liquidity creation ratio equation, we observe that, regulatory pressure, liabilities greater than liquid assets, price and information asymmetry are strictly exogenous variables and that insurance leverage ratio is a predetermined variable.

Table 10 presents the results with control variables included in the model following the interpretation of the results in Table 9. We still find positive and significant cross-lagged coefficients running in both directions for all three periods except for period 2000 – 2007, where the relationship between reinsurance demand at time t-1 with liquidity creation at time *t* is only significant at 0.20. These findings support a reciprocal effects model in which each variable exerts a causal influence on the other over time.

The coefficient of the insurance leverage ratio is positively and significantly related to reinsurance demand, which suggests that firms that write more business relative to surplus have a greater need for reinsurance because they have a higher probability of insolvency. The relationship between insurance leverage ratio and liquidity creation ratio is also positively significant, implying that insurers with a higher insurance leverage ratio tend to reinsure to a greater extent and create more liquidity.

Regulatory pressure is significantly and negatively related to the reinsurance demand and positively related to the liquidity creation ratio. Consequently, firms with a net premiums to surplus ratio higher than 300 percent demand less reinsurance and create more liquidity.

Firms with higher liabilities than liquid assets tend to create more liquidity. The price measured by the inverse of the economic loss ratio is significantly and negatively related to reinsurance demand, and for the period 2000–2007 is significantly and positively related to the liquidity creation ratio.

Tax exempt is not significantly related to reinsurance demand except for the period 2008–2014, where being tax exempt is significantly and positively related to reinsurance demand. Information asymmetry is significantly and negatively related to the liquidity creation ratio, and capital is significantly and positively related to reinsurance demand. All regressions respect the goodness of fit criteria with few exceptions.

Table 10
Estimates for reciprocal model with fixed and standardized control variables

ML Method	1992-1999		2000-2007		2008-2014	
	At time t		*At time t*		*At time t*	
Balanced data	Reins	Liquid	Reins	Liquid	Reins	Liquid
At time t-1						
Reinsurance demand	0.7974	0.0998	0.7973	0.0138	0.7973	0.0516
	(0.000)	(0.000)	(0.000)	(0.187)	(0.000)	(0.000)
Liquidity creation ratio	0.2799	0.7098	0.1204	0.6021	0.1200	0.5732
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control variables at time t						
Insurance leverage ratio	0.0310	0.0267	0.0356	0.0314	0.0218	0.0486
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Regulatory pressure	-0.0092	0.0059	-0.0114	0.0080	-0.0102	0.0016
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.168)
Liabilities greater than liquid assets		0.0213		0.0220		0.0174
		(0.000)		(0.000)		(0.000)
Price	-0.0100	0.0017	-0.0159	0.0038	-0.0111	0.0009
	(0.000)	(0.192)	(0.000)	(0.055)	(0.000)	(0.398)
Tax exempt	0.0056		0.0024		0.0051	
	(0.178)		(0.374)		(0.033)	
Information asymmetry		-0.0040		-0.0044		-0.0045
		(0.002)		(0.046)		(0.001)
Capital	0.0516		0.0257		0.0261	
	(0.000)		(0.000)		(0.000)	
Number of firms	1,072		1,063		1,108	
Goodness of Fit Model						
RMSEA	0.049	0.063	0.038	0.066	0.037	0.074
CFI	0.973	0.952	0.982	0.940	0.987	0.937
TFI	0.949	0.920	0.971	0.900	0.979	0.911
SRMR	0.007	0.013	0.007	0.015	0.005	0.011

Reins: Reinsurance demand Liquid: Liquidity creation ratio

Tables 11 and 12 present the same analysis when we modify the specifications. In our previous results, surplus is included in the dependent variable liquidity creation divided by total admitted assets, so the capital ratio (surplus/total admitted asset) could not be an exogenous variable. We construct a new liquidity creation measure that excludes surplus and we add capital as explanatory variable in the Liquid equation. The main results are not affected.

Table 11
P-values for the test: $H_0 : \varphi = 0$

P-values for the test: $H_0 : \varphi = 0$	1992-1999		2000-2007		2008-2014	
	time t		*time t*		*time t*	
	Reins	Liquid	Reins	Liquid	Reins	Liquid
At time t+1						
Insurance leverage ratio	0.774	0.712	0.001	0.024	0.168	0.001
Regulatory pressure	0.198	0.261	0.012	0.756	0.009	0.797
Liabilities greater than liquid assets		0.019		0.676		0.798
Price	0.000	0.000	0.036	0.004	0.013	0.054
Tax exempt investment income	0.026		0.838		0.883	
Information asymmetry		0.042		0.483		0.082
Capital	0.000	0.000	0.316	0.004	0.847	0.030

Reins: Demand for reinsurance; Liquid: Liquidity creation ratio (surplus is excluded)

Table 12
Estimates for reciprocal model with fixed and standardized control variables

ML Method	1992–1999		2000-2007		2008-2014	
	At time t		*At time t*		*At time t*	
Balanced data	Reins	Liquid	Reins	Liquid	Reins	Liquid
At time t-1						
Demand of reinsurance	0.7876	0.0733	0.7916	0.0209	0.8034	0.0317
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Liquidity creation ratio	0.2692	0.6007	0.1342	0.5426	0.1191	0.4930
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control variables at time t						
Insurance leverage ratio	0.0318	0.0042	0.0341	0.0034	0.0281	0.0153
	(0.000)	(0.053)	(0.000)	(0.161)	(0.000)	(0.000)
Regulatory pressure	-0.0101	-0.0001	-0.0095	0.0002	-0.0067	-0.0018
	(0.000)	(0.928)	(0.000)	(0.836)	(0.000)	(0.039)
Liabilities greater than liquid assets		0.0149		0.0112		0.0073
		(0.000)		(0.000)		(0.000)
Price	-0.0107	0.0027	-0.0158	0.0061	-0.0109	-0.0001
	(0.000)	(0.008)	(0.000)	(0.000)	(0.000)	(0.903)
Tax exempt	0.0032		0.0030		-0.0050	
	(0.438)		(0.507)		(0.305)	
Information asymmetry		-0.0089		-0.0022		-0.0062
		(0.000)		(0.047)		(0.000)
Capital	0.0362	-0.0439	0.0160	-0.0543	0.0308	-0.0579
	(0.000)	(0.000)	(0.007)	(0.000)	(0.000)	(0.000)
Number of firms	1,072		1,063		1,108	
Model Goodness of Fit						
RMSEA	0.054	0.062	0.039	0.065	0.039	0.087
CFI	0.967	0.942	0.983	0.923	0.988	0.922
TFI	0.938	0.900	0.969	0.877	0.977	0.859
SRMR	0.008	0.011	0.007	0.013	0.004	0.010

Reins: Demand for reinsurance; Liquid: Liquidity creation ratio (policyholders surplus is excluded)

Conclusion

This study analyzes how liquidity creation affects demand for reinsurance, a relationship that has not been studied adequately in the literature. The first results we obtained are mixed. Our statistical analysis indicates that predicted liquidity creation has a positive effect on reinsurance demand for most firms. Insurers that create more liquidity are less likely to purchase reinsurance. Moreover, the effect is also positive for the insurers in the lower forty-fifth percentile, representing insurers that cede less than 28% of gross premiums to reinsurance but is not significant in the higher fifty-fifth percentile. This result seems to indicate a causality effect of reinsurance demand on liquidity creation but we do not have an appropriate instrumental variable in the liquidity creation equation.

Technically, to obtain such causality we must find an exogenous variable that explains liquidity creation but not reinsurance demand. Such instrument is very difficult to find because all variables in our data are mainly affected by the insurers. In Section 5, we estimate a more general model and find simultaneous causality between liquidity creation and demand for reinsurance. We are now investigating GMM estimations as robustness analysis.

References

Adams, M., Hardwick, P., and Zou, H., 2008. Reinsurance and corporate taxation in the United Kingdom life insurance industry. *Journal of Banking and Finance* 32, 101-115.

Allison, P., 2005. *Fixed Effects Regression Methods for Longitudinal Data Using SAS*. Cary, NC: The SAS Institute.

Allison, P., 2009. *Fixed Effects Regression Models*. Thousand Oaks, CA: Sage Publications.

Allison, P. and Bollen, K.A., 1997. Change Score, Fixed Effects, and Random Component Models: A Structural Equation Approach. Paper presented in the *Annual Meeting of the American Sociological Association*.

Aon Benfield report, 2012, 2013, 2014. Reinsurance Market Outlook.

Arbuckle, J.L., 1996. Full Information Estimation in the Presence of Incomplete Data. In: G.A. Marcoulides and R.E. Schumacker (Eds.), *Advanced Structural Equation Modeling* (pp. 243–277). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Ayuso, J., Perez, D., and Saurina, J., 2004. Are capital buffers pro-cyclical? Evidence from Spanish panel data. *Journal of Financial Intermediation* 13, 259-264.

Baltagi, B.H. and Li, Q., 1995. Testing AR(1) against MA(1) disturbances in an error component model. *Journal of Econometrics* 68, 133-151.

Berger, A. N., and Bouwman C. H. S., 2009. Bank liquidity creation. *The Review of Financial Studies* 22(9), 3779-3837.

Breusch, T. and Pagan, A., 1979. A simple test of heteroskedasticity and random coefficient variation. *Econometrica* 47, 1287-1294.

Browne, M.W. and Cudeck, R., 1993. Alternative Ways of Assessing Model Fit. In: Bollen, K.A. and Long, J.S. (Eds.), *Testing Structural Equation Models* (pp. 136–162). Newbury Park, CA: Sage.

Bryant, J., 1980. A model of reserves, bank runs, and deposit insurance. *Journal of Banking and Finance* 4, 335-344

Calabrese, R., 2012. Regression model for proportions with probability masses at zero and one. Working Paper.

Carneiro, L.A., and Sherris, M., 2005. Demand for reinsurance: Evidence from Australian insurers. Working paper, University of New South Wales.

Carson, J. M., and Hoyt, R. E., 1995. Life insurer financial distress: classification models and empirical evidence. *Journal of Risk and Insurance* 6(2), 764-775.

Chang, V.Y., 2015, Determinants of the demand for reinsurance for the US property-liability insurance industry: quantile regression analysis. *Management Review* 24, 125-138

Chang, V.Y., Jeng, V.S. and Tzeng, L.Y., 2103. The Relationship among the Demand for Reinsurance, Liquidity and Leverage in the U.S. Property-Liability Insurance Industry. Working Paper.

Chen, F.F. (2007). Sensitivity of Goodness of Fit Indexes to Lack of Measurement Invariance. *Structural Equation Modeling: A Multidisciplinary Journal* 14(3), 464-504.

Choi, B.P., Park, J., and Ho, C. L., 2013. Liquidity creation or de-creation evidence from US property and liability insurance industry. *Managerial Finance* 39(10), 938-962.

Christensen, T.E., Hoyt, R. E and Paterson, J. S., 1999. Ex ante investigation of the performance of the u.s. property-liability insurance industry. *Journal of Business Finance and Accounting* 64, 371-381

Cole, C.R., and McCullough, K.A., 2006. A reexamination of the corporate demand for reinsurance. *The Journal of Risk and Insurance* 73(1), 169-192.

Cook, D.O., Kieschnick, R., and McCullough, B.D., 2008. Regression analysis of proportions in finance with self selection. *Journal of Empirical Finance* 15, 860–867

Cummins, D., Dionne, G., Gagné, R., and Nouira, A., 2009. Efficiency of insurance firms with endogenous risk management and financial intermediation activities. *Journal of Productivity Analysis* 32(2), 145-159.

Cummins, J. D., and Danzon, P. M., 1997. Price, financial quality, and capital flows in insurance markets. *Journal of Financial Intermediation* 6, 3-38.

Cummins, J. D., and Nini, G. P., 2002. Optimal capital utilization by financial firms: evidence from the property-liability insurance industry. *Journal of Financial Services Research* 21, 15-53.

Cummins, J.D., Dionne, G., Gagné, R., and Nouira, A., 2008. The Costs and Benefits of Reinsurance. Working Paper 08-01, Canada Research Chair in Risk Management, HEC Montréal.

Cummins, J.D., Lewis, C., and Wei, R. 2006. The market impact of operational risk events for U.S. banks and insurers. *Journal of Banking and Finance* 30, 2609-2634.

D'Arcy, S. P., and. Garven, J. R, 1990, Property-Liability Insurance Pricing Models: An Empirical Evaluation. *Journal of Risk and Insurance* 57, 391-430.

Diamond, D. W., and Dybvig, P. H., 1983. Bank Runs, Deposit Insurance and Liquidity. *Journal of Political Economy* 91, 401-419.

Dionne G., and Triki, T., 2013. On Risk Management Determinants: What Really Matters? *Europ. J. Finance* 19(2), 145-164.

Firebaugh G., Warner C., and Massoglia M., 2013. Fixed Effects, Random Effects, and Hybrid Models for Causal Analysis. In: S.L. Morgan (Ed.), *Handbook of Causal Analysis for Social Research*, (pp. 113-131). New-York: Springer.

Froot, K.A., Scharfstein, D.S., and Stein, J.C., 1993. Risk Management: Coordinating corporate investment and financing policies. *Journal of Finance* 48(5), 1629-1658.

Garven, J.R., and Lamm-Tennant, J., 2003. The Demand for Reinsurance: Theory and Empirical Tests. *Insurance and Risk Management* 7(3), 217-237.

Garven, J.R., MacMinn, R., 1993. The underinvestment problem, bond covenants, and insurance. *The Journal of Risk and Insurance* 60(4), 635-646.

Gaver J. J., and Paterson, J. S., 1999. Managing Insurance Company Financial Statements to Meet Regulatory and Tax Reporting Goals. *Contemporary Accounting Research* 16, 207-241.

Grace, E. V., 1990. Property-Liability Insurer Reserve Errors: A Theoretical and Empirical Analysis. *Journal of Risk and Insurance* 57, 28-46.

Graham, J.R., and Rogers, D.A., 2002. Do firms hedge in response to tax incentives? *Journal of Finance* 57, 815-839.

Green W.H., 2008. Econometric analysis. 6th ed., Upper Saddle River, N.J.: Prentice Hall.

Grubisic, E., and Leadbetter, D., 2007. The Determinants of Capital in the P&C Insurance Industry, Working Paper, ARIA Annual Meeting, Quebec City.

Halaby, C. 2004. Panel Models in Sociological Research: Theory into Practice. *Annual Review of Sociology* 30, 507-544.

Harrington, S. E., and Danzon, P. M., 1994. Price Cutting in Liability Insurance Markets. *The Journal of Business* 67(4), 511-538.

Hoerge, T.J., Sloan, F.A. and Hassan, M., 1990. Loss Volatility, Bankruptcy and the Demand of Reinsurance, *Journal of Risk and Uncertainty* 3, 221-245.

Holmstrom, B., and Tirole, J., 1998. Public and Private Supply of Liquidity. *Journal of Political Economy* 106 1-40.

Hoyt, R. and Kang, H., 2000. On the demand of Corporate Property Insurance. *The Journal of Risk and Insurance* 67(1), 91-1007.

Hu, L. T. and Bentler, P.M., 1999. Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria versus New Alternatives. *Structural Equation Modeling: A Multidisciplinary Journal* 6(1), 1-55.

Hu, L.T. and Bentler, P.M., 1998. Fit Indices in Covariance Structure Modeling: Sensitivity to under Parameterized Model Misspecification. *Psychological Methods* 3(4), 424-453.

Jean-Baptiste, E. L., and Santomero, A. M., 2000. The design of Private Reinsurance Contracts. *Journal of Financial Intermediation* 9(3), 274-297.

Jokipii, T., and Milne, A., 2008. The Cyclical Behaviour of European Bank Capital Buffers, *Journal of Banking and Finance* 32(8), 1440-1451.

Kashyap, A. K., Rajan, R. G., and Stein, CJ. C., 2002. Banks as Liquidity Providers: An Explanation for the Coexistence of Lending and Deposit-Taking. *Journal of Finance* 57, 33-73.

Kim, W. J., Mayers, D., and Smith, C.W., 1996. On the Choice of Insurance Distribution Systems. *Journal of Risk and Insurance* 63, 207-227.

Koenker, R, and Bassett, G. W., 1982 An Empirical Quantile Function for Linear Models with iid Errors, *Journal of the American Statistical Association* 77, 401–415

Lin, Y., Yu, J., and Peterson, M.O., 2014. Reinsurance networks and their impact on reinsurance decisions: Theory and empirical evidence. *The Journal of Risk and Insurance*.

Liu, H. H., Shiu, Y.M. and Liu, T. C., 2016. Reinsurance and Liquidity: Evidence from the United Kingdom General Insurance Industry. *The Geneva Papers* 41, 307-324.

MacMinn, R., Garven, R., 2013. On the demand for corporate insurance – creating value. In: Dionne, G. (Ed.), Handbook of Insurance, 2nd edition. Springer, New York.

Mayers, D., and Smith, C.W. Jr., 1982. On the corporate demand for insurance. *The Journal of Business* 55(2), 140-144.

Mayers, D., and Smith, C.W. Jr., 1990. On the corporate demand for insurance: Evidence from the reinsurance market. *The Journal of Business* 63(1), Part 1, 19-40.

Morellec, E., and Smith, C.W., 2004. Investment policy, financial policies, and control of agency conflicts. Working paper, University of Rochester.

Mosteller, F., 1946. On some useful “inefficient” statistics. *Annals of Mathematical Statistics* 17, 377–408.

NAIC, 2014, Insurance Regulatory information System (IRIS) Ratios Manual.

Ospina, R. and Ferrari, S. L. P., 2010. Inflated beta distributions. *Statistical Papers* 51, 111–126.

Ospina, R. and Ferrari, S.L.P., 2012. A general class of zero-or-one inflated beta regression models. *Computational Statistics and Data Analysis* 56, 1609–1623.

Petroni, K. R., 1992. Optimistic Reporting in the Property-Casualty Insurance Industry. *Journal of Accounting and Economics* 15, 485-508.

Powell, L. S., and D. W. Sommer, 2002. Internal Versus External Capital Markets in the Insurance Industry: The Role of Insurance Working Paper.

Powell, L. S., and D. W. Sommer, 2007, Internal Versus External Capital Markets in the Insurance Industry: The Role of Reinsurance, *Journal of Financial Services Research* 31(3), 173-188.

Schermelleh-Engel K., Moosbrugge H., and Müller H., 2003. Evaluating the Fit of Structural Equation Models: Tests of Significance and Descriptive Goodness-of Fit Measures. *Methods of Psychological Research Online* 8 2, 23-74.

Scordis, N. A., and Steinorth, P., 2012. Value from Hedging Risk with Reinsurance. *Journal of Insurance Issues* 35(2), 210-231.

Shin, Hyun-Han, Stulz, and Rene M. 2000. Firm value, risk, and growth opportunities. National Bureau of Economic Research Working Paper 7808, Cambridge, MA.

Shiu, Y. M., 2011. Reinsurance and Capital Structure: Evidence from the United Kingdom Non-life Insurance Industry. *Journal of Risk and Insurance* 78, 475-494.

Shortridge, R. T., and Avila, S. A., 2004. The Impact of Institutional Ownership on the Reinsurance Decision, *Risk Management and Insurance Review* 7(2), 93-106.

Smithson, C., and Simkins, B.J., 2005. Does Risk Management Add Value? A Survey of the Evidence. *Journal of Applied Corporate Finance* 17, 8–17.

Sommer, D.W, 1996. The impact of firm risk on property-liability insurance prices. *Journal Risk of Insurance* 63(3), 501-514

Teachman, J., Duncan, G.J., Yeung W. J., and Levy D., 2001. Covariance Structure Models for Fixed and Random Effects. *Sociological Methods & Research* 30, 271-288.

Wang, J. L., Chang, V. Y., Lai, G. C., and Tzeng, L. Y., 2008. Demutualization and Demand for Reinsurance. *The Geneva Papers on Risk and Insurance – Issues and Practice* 33, 566-584.

Weiss, M., 1985. A Multivariate Analysis of Loss Reserving Estimates in Property-Liability Insurers. *Journal of Risk and Insurance* 52, 199-221.

Weiss, M.A., and Chung, J.-H., 2004. U.S. reinsurance prices, financial quality, and global capacity. *The Journal of Risk and Insurance* 71(3), 437-467.

White, H., 1980. A Heteroscedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroscedasticity. *Econometrica* 48, 817-838.

Winter, R.A., 1994. The Dynamics of Competitive Insurance Markets. *Journal of Financial Intermediation* 3, 379-415.

Woolridge, J., 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.

Yanase, N., and Limpaphayom, P., 2015. Organization Structure and Corporate Demand for Reinsurance: The Case of the Japanese Keiretsu. *The Journal of Risk and Insurance* 1-31.

Appendix

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.

The 34,376 insurer-years comprise 1,329 large insurers, 2,235 medium insurers and 30,812 small insurers.

	Firm category		
	Small	Medium	Large
Number	30,812	2,235	1,329
%	89.63	6.50	3.87

Table 3a
Summary statistics Large firms

This table provides summary statistics for the 100 firms for the period 1993-2014. Variables are defined in Table 2.

Variables	Obs	Mean	Median	Std	Min	Max
Demand for reinsurance	1,236	0.3055	0.2472	0.2549	0.0000	0.9486
Liquidity creation ratio	1,236	-0.3854	-0.3810	0.1388	-0.9915	0.2610
Insurance leverage ratio	1,236	0.7712	0.5821	0.8243	0.0000	7.1079
Geographic concentration	1,236	0.1835	0.0733	0.2632	0.0327	1.0000
Regulatory pressure	1,236	0.0146	0.0000	0.1198	0.0000	1.0000
Liabilities greater than liquid assets	1,236	0.3317	0.0000	0.4710	0.0000	1.0000
Line of business concentration	1,236	0.3766	0.3060	0.2377	0.1038	1.0000
Price	1,236	1.3769	1.1513	1.5169	0.0000	12.0000
2-yr loss development	12,36	0.5619	-1.7156	17.1751	-73.7500	80.6200
New York license	1,236	0.8115	1.0000	0.3913	0.0000	1.0000
Cost of capital	1,236	0.1176	0.1155	0.1011	-0.4648	0.4745
Firm size	1,236	22.7750	22.5459	0.7757	21.8253	25.7466
Firm affiliation	1,236	0.9693	1.0000	0.1727	0.0000	1.0000
Business mix concentration	1,236	0.5549	0.4971	0.2028	0.2567	1.0000
Tax exempt	1,236	0.3841	0.3766	0.2076	0.0000	0.9782
Information asymmetry	1,236	0.0963	0.0710	0.0877	0.0028	1.1110
Capital	1,236	0.3671	0.3348	0.1472	0.0172	0.9893

Table 3b
Summary statistics Medium firms

This table provides summary statistics for the 235 firms for the period 1993-2014. Variables are defined in Table 2.

Variables	Obs	Mean	Median	Std	Min	Max
Demand for reinsurance	1,993	0.3603	0.3291	0.2578	0.0000	0.9958
Liquidity creation ratio	1,993	-0.3886	-0.3862	0.1396	-0.9061	0.2396
Insurance leverage ratio	1,993	1.2150	0.9508	1.1176	0.0000	13.2395
Geographic concentration	1,993	0.3364	0.1374	0.3592	0.0320	1.0000
Regulatory pressure	1,993	0.0146	0.0000	0.1198	0.0000	1.0000
Liabilities greater than liquid assets	1,993	0.1766	0.0000	0.3814	0.0000	1.0000
Line of business concentration	1,993	0.4293	0.3366	0.2646	0.1012	1.0000
Price	1,993	1.2855	1.1655	0.8095	0.0000	12.0000
2-yr loss development	1,993	-2.8469	-3.2536	16.2065	-73.7500	80.6200
New York license	1,993	0.6307	1.0000	0.4827	0.0000	1.0000
Cost of capital	1,993	0.1125	0.1051	0.1180	-0.4648	0.5280
Firm size	1,993	21.1905	21.1692	0.2923	20.7238	21.8108
Firm affiliation	1,993	0.9498	1.0000	0.2184	0.0000	1.0000
Business mix concentration	1,993	0.6059	0.5242	0.2290	0.2521	1.0000
Tax exempt	1,993	0.3623	0.3398	0.2375	0.0000	0.9922
Information asymmetry	1,993	0.1029	0.0744	0.1204	0.0024	1.1110
Capital	1,993	0.3595	0.3303	0.1358	0.0469	0.9986

Table 3c
Summary statistics Small firms

This table provides summary statistics for the 2,658 firms for the period 1993-2014. Variables are defined in Table 2.

Variables	Obs	Mean	Median	Std	Min	Max
Demand for reinsurance	30,753	0.3758	0.3229	0.2832	0.0000	0.9992
Liquidity creation ratio	30,753	-0.4346	-0.4191	0.2128	-1.2663	0.6950
Insurance leverage ratio	30,753	2.0328	1.3129	2.9057	0.0000	33.0000
Geographic concentration	30,753	0.6220	0.6940	0.3747	0.0303	1.0000
Regulatory pressure	30,753	0.0298	0.0000	0.1701	0.0000	1.0000
Liabilities greater than liquid assets	30,753	0.0848	0.0000	0.2786	0.0000	1.0000
Line of business concentration	30,753	0.5680	0.5088	0.2852	0.1139	1.0000
Price	30,753	1.4481	1.2083	1.2976	0.0000	12.0000
2-yr loss development	30,753	-3.1064	-2.1991	19.3894	-73.7500	80.6200
New York license	30,753	0.2774	0.0000	0.4477	0.0000	1.0000
Cost of capital	30,753	0.0826	0.0797	0.1313	-0.4648	0.5280
Firm size	30,753	17.6779	17.7570	1.6199	11.1812	20.7212
Firm affiliation	30,753	0.6094	1.0000	0.4879	0.0000	1.0000
Business mix concentration	30,753	0.6810	0.6167	0.2483	0.2505	1.0000
Tax exempt	30,753	0.2376	0.1646	0.2426	0.0000	1.0000
Information asymmetry	30,753	0.1197	0.0811	0.1372	0.0020	1.1110
Capital	30,753	0.4430	0.4002	0.1921	0.0000	1.0000

Table 3d
Summary statistics:
Firms with demand for reinsurance lower than or equal to 0.275

This table provides summary statistics for the 1,547 firms for the period 1993-2014. Variables are defined in Table 2.

Variables	Obs	Mean	Median	Std	Min	Max
Demand for reinsurance	13,951	0.1062	0.0996	0.0809	0.0000	0.2750
Liquidity creation ratio	13,951	-0.4456	-0.4309	0.1948	-1.1061	0.5745
Insurance leverage ratio	13,951	1.1887	0.9291	1.3955	0.0000	33.0000
Geographic concentration	13,951	0.6682	0.8526	0.3655	0.0303	1.0000
Regulatory pressure	13,951	0.0346	0.0000	0.1828	0.0000	1.0000
Liabilities greater than liquid assets	13,951	0.0562	0.0000	0.2303	0.0000	1.0000
Line of business concentration	13,951	0.6060	0.5319	0.2983	0.1139	1.0000
Price	13,951	1.5552	1.2320	1.4666	0.0000	12.0000
2-yr loss development	13,951	-5.4330	-3.5072	21.0183	-73.7500	80.6200
New York license	13,951	0.2307	0.0000	0.4213	0.0000	1.0000
Cost of capital	13,951	0.1015	0.0949	0.1352	-0.4648	0.5280
Firm size	13,951	18.0862	17.9265	2.0488	12.3182	25.7466
Firm affiliation	13,951	0.5297	1.0000	0.4991	0.0000	1.0000
Business mix concentration	13,951	0.6996	0.6477	0.2616	0.2511	1.0000
Tax exempt	13,951	0.2662	0.2084	0.2427	0.0000	1.0000
Information asymmetry	13,951	0.1200	0.0825	0.1372	0.0020	1.1110
Capital	13,951	0.4482	0.4105	0.1861	0.0000	0.9999

Table 3e
Summary statistics:
Firms with demand for reinsurance greater than 0.275

This table provides summary statistics for the 1,874 firms for the period 1993-2014. Variables are defined in Table 2.

Variables	Obs	Mean	Median	Std	Min	Max
Demand for reinsurance	17,342	0.5970	0.5761	0.1943	0.2751	0.9989
Liquidity creation ratio	17,342	-0.4196	-0.4032	0.2151	-1.2663	0.6950
Insurance leverage ratio	17,342	2.6159	1.6348	3.5125	0.0000	33.0000
Geographic concentration	17,342	0.5139	0.4095	0.3877	0.0338	1.0000
Regulatory pressure	17,342	0.0205	0.0000	0.1418	0.0000	1.0000
Liabilities greater than liquid assets	17,342	0.1357	0.0000	0.3425	0.0000	1.0000
Line of business concentration	17,342	0.5000	0.4366	0.2653	0.1012	1.0000
Price	17,342	1.3370	1.1755	1.1062	0.0000	12.0000
2-yr loss development	17,342	-1.0285	-1.5430	16.6863	-73.7500	80.6200
New York license	17,342	0.4012	0.0000	0.4902	0.0000	1.0000
Cost of capital	17,342	0.0765	0.0760	0.1214	-0.4648	0.5280
Firm size	17,342	18.1711	18.1661	1.9721	11.1812	24.5182
Firm affiliation	17,342	0.7488	1.0000	0.4337	0.0000	1.0000
Business mix concentration	17,342	0.6421	0.5747	0.2310	0.2511	1.0000
Tax exempt	17,342	0.2443	0.1720	0.2466	0.0000	1.0000
Information asymmetry	17,342	0.1122	0.0755	0.1287	0.0020	1.1110
Capital	17,342	0.4251	0.3783	0.1902	0.0136	1.0000

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

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

	First stage			Second stage		
	Liquidity creation ratio $_{t-1}$			Demand for reinsurance $_t$		
Variables	Coeff	Std error	P-value	Coeff	Std error	P-value
Demand of reinsurance $_{t-1}$				0.7702	0.0250	0.000
Predicted liquidity creation ratio $_{t-1}$				-0.0734	0.0487	0.135
Insurance leverage ratio	0.0142	0.0143	0.323	0.0163	0.0085	0.057
Geographical concentration	-0.0767	0.0361	0.036	-0.0757	0.0194	0.000
Regulatory pressure	-0.0422	0.0131	0.002	0.0014	0.0091	0.880
Higher liabilities than liquid asset	0.0330	0.0103	0.002	0.0035	0.0074	0.634
Line of business concentration	0.0278	0.0432	0.521	-0.1235	0.0290	0.000
Price	0.0036	0.0039	0.370	-0.0070	0.0042	0.095
2-yr loss development	-0.0001	0.0002	0.679	-0.0003	0.0002	0.093
New York license	-0.0287	0.0389	0.463	-0.0421	0.0129	0.001
Cost of capital	0.0383	0.0579	0.510	0.0388	0.0423	0.362
Firm size	0.0418	0.0131	0.002	0.0108	0.0105	0.309
Firm affiliation	0.0401	0.0246	0.106	0.0224	0.0235	0.341
Business mix concentration	0.0466	0.0553	0.401	0.1016	0.0377	0.008
Tax exemption	-0.0026	0.0280	0.926	0.0036	0.0258	0.889
Information asymmetry	0.0124	0.0535	0.817			
Capital	-0.8300	0.0689	0.000			
Observation	1,236			1,236		
Number of firms	100			100		
R-Square	0.6007			0.5638		

Table 4b Medium firms
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. Heteroscedasticity-consistent standard errors clustered at the firm level are reported.

	First stage			Second stage		
	Liquidity creation ratio $_{t-1}$			Demand for reinsurance $_t$		
Variables	Coeff	Std error	P-value	Coeff	Std error	P-value
Demand of reinsurance $_{t-1}$				0.6514	0.0368	0.000
Predicted liquidity creation ratio $_{t-1}$				-0.0131	0.0410	0.749
Insurance leverage ratio	0.0048	0.0058	0.415	0.0088	0.0040	0.030
Geographical concentration	-0.0314	0.0322	0.331	-0.0305	0.0423	0.472
Regulatory pressure	-0.0351	0.0104	0.001	-0.0278	0.0081	0.001
Higher liabilities than liquid asset	0.0336	0.0081	0.000	-0.0063	0.0115	0.583
Line of business concentration	-0.0074	0.0354	0.834	0.0452	0.0538	0.402
Price	-0.0041	0.0038	0.286	-0.0301	0.0081	0.000
2-yr loss development	0.0000	0.0001	0.808	-0.0002	0.0001	0.109
New York license	0.0074	0.0175	0.674	0.0534	0.0276	0.054
Cost of capital	-0.0126	0.0340	0.712	0.0148	0.0255	0.562
Firm size	0.0489	0.0127	0.000	-0.0150	0.0137	0.275
Firm affiliation	0.0448	0.0183	0.015	0.0074	0.0082	0.370
Business mix concentration	0.0007	0.0375	0.985	-0.0371	0.0367	0.313
Tax exemption	-0.0330	0.0202	0.104	-0.0089	0.0190	0.642
Information asymmetry	-0.0252	0.0212	0.236			
Capital	-0.8892	0.0640	0.000			
Observation	1,993			1,993		
Number of firms	235			23		
R-Square	0.5887			0.4404		

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. Heteroscedasticity-consistent standard errors clustered at the firm level are reported.

	First stage			Second stage		
	Liquidity creation ratio $_{t-1}$			Demand for reinsurance $_t$		
Variables	Coeff	Std error	P-value	Coeff	Std error	P-value
Demand of reinsurance $_{t-1}$				0.6988	0.0083	0.000
Predicted liquidity creation ratio $_{t-1}$				0.0275	0.0111	0.013
Insurance leverage ratio	-0.0222	0.0092	0.016	0.0083	0.0009	0.000
Geographical concentration	0.0103	0.0065	0.112	-0.0404	0.0083	0.000
Regulatory pressure	0.0615	0.0048	0.000	-0.0855	0.0061	0.000
Higher liabilities than liquid asset	-0.0090	0.0122	0.463	0.0167	0.0044	0.000
Line of business concentration	0.0034	0.0006	0.000	-0.0643	0.0126	0.000
Price	0.0001	0.0000	0.242	-0.0102	0.0009	0.000
2-yr loss development	-0.0012	0.0069	0.861	0.0000	0.0000	0.442
New York license	-0.0518	0.0120	0.000	0.0312	0.0061	0.000
Cost of capital	0.0064	0.0026	0.015	-0.0158	0.0096	0.101
Firm size	-0.0012	0.0054	0.829	-0.0157	0.0022	0.000
Firm affiliation	-0.0206	0.0135	0.126	0.0246	0.0052	0.000
Business mix concentration	-0.0055	0.0059	0.347	0.0106	0.0141	0.451
Tax exemption	-0.0310	0.0114	0.006	0.0077	0.0054	0.156
Information asymmetry	-0.8721	0.0127	0.000			
Capital	-0.0222	0.0092	0.016			
Observation	30,753			30,753		
Number of firms	2,658			2,658		
R-Square	0.6328			0.5547		

We divided the observations into two groups:

1) Insurers whose ceded reinsurance is 27.5% or less of their gross premiums (lower forty-fifth percentile), corresponding to 15,436 firm-year observations; and
2) Insurers whose ceded reinsurance is greater than 27.5% of their gross premiums (upper fifty-fifth percentile), corresponding to 18,940 firm-year observations.

Table 4d
Firms with demand for reinsurance lower than or equal to 0.275
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. Heteroscedasticity-consistent standard errors clustered at the firm level are reported.

	First stage			Second stage		
	Liquidity creation ratio $_{t-1}$			Demand for reinsurance $_{t}$		
Variables	Coeff	Std error	P-value	Coeff	Std error	P-value
Demand of reinsurance $_{t-1}$				0.5498	0.0142	0.000
Predicted liquidity creation ratio $_{t-1}$				0.0177	0.0060	0.003
Insurance leverage ratio	0,0052	0,0025	0,040	0.0013	0.0007	0.052
Geographical concentration	-0,0327	0,0116	0,005	-0.0120	0.0050	0.018
Regulatory pressure	0,0202	0,0085	0,018	-0.0065	0.0032	0.040
Higher liabilities than liquid asset	0,0625	0,0080	0,000	-0.0005	0.0028	0.854
Line of business concentration	-0,0208	0,0176	0,237	-0.0479	0.0092	0.000
Price	0,0011	0,0006	0,092	-0.0013	0.0003	0.000
2-yr loss development	0,0001	0,0001	0,010	0.0000	0.0000	0.558
New York license	-0,0012	0,0095	0,900	0.0037	0.0035	0.288
Cost of capital	-0,0609	0,0145	0,000	-0.0060	0.0051	0.236
Firm size	0,0032	0,0034	0,342	-0.0011	0.0013	0.421
Firm affiliation	0,0022	0,0066	0,738	-0.0019	0.0023	0.406
Business mix concentration	-0,0313	0,0208	0,133	0.0273	0.0095	0.004
Tax exemption	-0,0149	0,0068	0,029	-0.0021	0.0031	0.499
Information asymmetry	-0,0445	0,0141	0,002			
Capital	-0,8747	0,0186	0,000			
Observation	13,951			13,951		
Number of firms	1,547			1,547		
R-Square	0.6548			0.3378		

Table 4e
Firms with demand for reinsurance greater than 0.275
Demand for reinsurance and Liquidity creation ratio (2SLS)

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

	First stage			Second stage		
	Liquidity creation ratio $_{t-1}$			Demand for reinsurance $_{t}$		
Variables	Coeff	Std error	P-value	Coeff	Std error	P-value
Demand of reinsurance $_{t-1}$				0.6046	0.0119	0.000
Predicted liquidity creation ratio $_{t-1}$				0.0003	0.0117	0.979
Insurance leverage ratio	0.0035	0.0008	0.000	0.0065	0.0008	0.000
Geographical concentration	-0.0212	0.0143	0.138	-0.0494	0.0100	0.000
Regulatory pressure	-0.0151	0.0100	0.132	-0.0922	0.0082	0.000
Higher liabilities than liquid asset	0.0589	0.0051	0.000	0.0072	0.0034	0.037
Line of business concentration	-0.0150	0.0154	0.331	-0.0084	0.0135	0.531
Price	0.0050	0.0010	0.000	-0.0131	0.0015	0.000
2-yr loss development	0.0000	0.0001	0.630	0.0001	0.0001	0.382
New York license	-0.0021	0.0088	0.816	0.0252	0.0073	0.001
Cost of capital	-0.0323	0.0177	0.069	-0.0102	0.0112	0.365
Firm size	0.0101	0.0034	0.003	-0.0165	0.0022	0.000
Firm affiliation	0.0043	0.0103	0.673	0.0166	0.0071	0.020
Business mix concentration	-0.0144	0.0157	0.358	0.0176	0.0150	0.242
Tax exemption	-0.0097	0.0081	0.227	0.0089	0.0058	0.127
Information asymmetry	-0.0166	0.0173	0.339			
Capital	-0.8337	0.0175	0.000			
Observation	17,342			17,342		
Number of firms	1,874			1,874		
R-Square	0.5936			0.4508		