Self-fulfilling Runs:
Evidence from the U.S. Life Insurance Industry

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Abstract
Is shadow banking vulnerable to self-fulfilling runs? Investors typically decide to withdraw simultaneously, making it challenging to identify self-fulfilling runs. In this paper, we exploit the contractual structure of funding agreement-backed securities offered by U.S. life insurers to institutional investors. The contracts allow us to obtain variation in investors’ expectations about other investors’ actions that is plausibly orthogonal to changes in fundamentals. We find that a run on life insurers during the summer of 2007 was partly due to self-fulfilling expectations. Our findings suggest that other contemporaneous runs in shadow banking by institutional investors may have had a self-fulfilling component.

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Introduction

The financial crisis of 2007-2008 highlighted the vulnerability of shadow banking to a variety of runs. In the second half of 2007, runs by institutional investors occurred on asset-backed commercial paper (Covitz et al. 2013, Acharya et al. 2013, Schroth et al. 2014) and on repo (Gorton & Metrick 2012, Krishnamurthy et al. 2014) amid rising concerns about the quality of subprime mortgage-backed securities. Later, in the fall of 2008, another wave of runs occurred on institutional investors such as Money Market Funds (MMFs) (Chen et al. 2010, Kacperczyk & Schnabl 2013, Schmidt et al. 2014), and on large non-bank financial institutions previously thought to be on the fringes of shadow banking.1 While great progress has been made toward understanding the last financial crisis, there remains considerable debate among policy makers and academics on the actual causes of runs affecting shadow banking. Understanding the mechanisms driving these runs is vital when addressing the vulnerabilities of shadow banking. In this paper we study the role of self-fulfilling expectations in runs by institutional investors.

In seminal theoretical work, Bryant (1980) and Diamond & Dybvig (1983) show that liquid liabilities are potentially vulnerable to swift changes in investors’ beliefs about the actions of other investors.2 When investors withdraw based on their beliefs and their action leads other investors to withdraw, then the original belief is verified and a self-fulfilling run has occurred. Such a run is in contrast to a fundamental-based run, in which investors decide to withdraw based on, for example, changes in their liquidity demand, risk appetite, regulatory constraints, or information about the liquidity of an issuer.3 In this alternative theory, a change in fundamentals is the key determinant of investor behavior.

However, showing that institutions and markets are plausibly vulnerable to self-fulfilling

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1 For instance, while the popular press attributes the fall of AIG to its AIGFP unit that unidirectionally insured vast amount of subprime mortgage-backed securities before the collapse in U.S. house prices, the trigger for the largest emergency loans from the Federal Reserve came from the run by investors on the $80 billion securities lending programs from AIG’s life insurers (McDonald & Paulson 2015).

2 See also the work by Postlewaite & Vives (1987), Goldstein & Pauzner (2005) and Rochet & Vives (2004).

3 The information about fundamentals may be revealed to all agents, as in Allen & Gale (1998), or asymmetrically, as in Chari & Jagannathan (1988). Other studies of fundamental-based runs include Jacklin & Bhattacharya (1988), Calomiris & Gorton (1991), and Chen (1999).
runs is difficult outside of a laboratory setting. The main empirical challenge to identifying self-fulfilling runs is that decisions by investors whether or not to run are made simultaneously. Investors may receive information about fundamentals, such as the liquidity of an issuer or their own liquidity demand, at the same time that they are forming beliefs about the likely actions of other investors. When we observe actions taken simultaneously, it is difficult empirically to separate runs due to changes in fundamentals from runs due to changes in expectations about other investors’ decisions.

In this paper, we address this simultaneity problem using hand-collected data on the contractual terms and daily outstanding amounts of a particular type of liquid liability issued by U.S. life insurers. Liquidity creation by U.S. life insurers emerged as a response to long-run macroeconomic and regulatory changes that affected the industry. In the traditional life insurance business model, long-term illiquid liabilities are matched with liquid assets of similar duration. The profitability of this business model relies on high returns to liquid assets and low risk-based capital requirements. So, when interest rates began falling in the late 1980s and regulatory capital requirements were increased in the early 2000s, life insurers’ business model was challenged. In response, life insurers adopted new models and techniques to raise their return on equity. This includes transferring insurance risk to off-balance sheet captive reinsurers (Koijen & Yogo 2014) and funding high-yield assets with funding agreement-backed securities. For more institutional details, see Appendix A.

During the early 2000s, U.S. life insurers began issuing extendible funding agreement-backed notes (XFABN). On pre-determined recurring election dates, investors in these securities decide

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4 Garratt & Keister (2009) design an experiment that shares features of the real-world environment we describe below. See also the experiments of Madies (2006), Arifovic et al. (2013) and Kiss et al. (2012). Some classic papers have shown the importance of fundamentals to bank depositors’ withdrawal decisions during the Great Depression (Gorton (1988), Calomiris & Gorton (1991), Saunders & Wilson (1996), and Calomiris & Mason (2003)). Recent empirical work outside the laboratory has sought to identify the determinants of bank runs: Graeve & Karas (2014) specify a structural vector autoregression with cross-sectional heterogeneity while Iyer & Puri (2012) use micro-level data on depositors’ social networks. In relation to the shadow banking system during the 2007-2008 financial crisis, Covitz et al. (2013) document a collapse in the asset-backed commercial paper market, Gorton & Metrick (2012) identify a collapse in the repo market through a sharp rise in haircuts, while Chen et al. (2010) and Schmidt et al. (2014) study runs by investors on money market funds.
whether or not to extend the maturity of their holding.\footnote{There is a final maturity date beyond which no extensions are possible.} Hence, XFABN are put-able in the sense that investors have the option not to extend the maturity of any or all of their holdings. In such cases, the non-extended holdings are converted into short-term fixed maturity securities with new identifiers. Therefore, XFABN are designed to appeal to short-term investors, such as prime money market funds (MMFs), whose investment decisions may be constrained by liquidity and concentration requirements.\footnote{For example, Regulation 2a-7 generally requires MMFs to hold securities with residual maturity not exceeding 397 days (SEC 2010). The initial maturity of a typical XFABN is specified such that MMFs can hold it at issuance. Thereafter, typically once every month, MMFs may elect to extend the maturity of their holding, typically by one month. This means that, from a regulatory perspective, an MMF is continuously holding a legitimate maturity bond. From the insurer’s perspective, provided the MMF keeps extending the maturity, it is as if they had sold a long-term bond.} \footnote{XFABN are not concentrated among MMFs. On a case by case basis, we can observe individual MMF exposure to XFABN conduits through their Securities and Exchange Commission Form N-Q and N-CSR filings. For example, in the third quarter of 2007, Fidelity and JPMorgan held 3.7 percent and 0.5 percent respectively of all outstanding XFABN.}

As with other types of liquid liabilities, XFABN are vulnerable to the risk that investors jointly withdraw their funds on short notice. Investors’ sudden withdrawal from XFABN by converting their holdings into short-dated bonds maturing around the same time could then create a severe liquidity shortfall for the insurer. This is especially likely since XFABN proceeds are invested in relatively illiquid high-yield assets and other sources of liquidity could become unavailable at that time.\footnote{Private observers of the insurance industry recognised early-on the liquidity risk created by combining put-able liabilities with illiquid assets: “Moody’s believes that the put option sometimes extended to FA holders creates liquidity concerns and event risk. ... The less liquid and lower quality the asset portfolio, the higher the potential for losses and increased probability of the FA issuer becoming troubled. The longer the duration of the assets, or higher potential for duration drift (a common issue for mortgage backed securities), the less likely a company can handle a put ‘run’ ” (Moody’s 1998).} Importantly, illiquidity of an issuer of short-term instruments is of great concern to short-term investors, such as MMFs, who are extremely sensitive to the timely redemption and rating of their investments, even when the solvency of the issuer is not in doubt.\footnote{Insolvency is rarely an issue for life insurers. In the event that they breach the regulatory capital threshold, which happens much sooner than insolvency, life insurers are immediately taken over by their state regulator. Consequently, insurance liability holders can be reasonably certain they will eventually be repaid. However, there could be tremendous uncertainty over when investors will get their money back. This uncertainty is of great concern to MMFs that are extremely sensitive to possible disruption to timely redemption and the rating of their investments (Hanson et al. 2013). A useful example is the run by MMFs on General American Life in 1999 (Moody’s 1999). At that time, life insurers accessed short-term funding from the money market by issuing floating rate funding agreements, often with put options. General American, a $30 billion highly rated life insurer had $6.8 billion in funding agreements with put options, of which about $5 billion were issued to MMFs with seven-day put options. In August 1999, Moody’s downgraded General American by one notch prompting the}
as investors withdrew holdings worth about $15 billion—in a market with over $23 billion in outstanding securities.\(^\text{10}\)

We begin our analysis by modelling investors’ decisions to withdraw from the XFABN market. The key theoretical result is that, if the decision of investors to withdraw adversely affects the *expected* liquidity of the XFABN issuer, then there is a possibility of self-fulfilling runs. The main contribution of the model is to show the role of self-fulfilling expectations in runs, when investors’ decisions are sequential rather than simultaneous. The model also illustrates the main empirical difficulty when teasing out self-fulfilling effects in observed runs that may also be the outcome of fundamentals.

Turning to our empirical analysis, the key contractual characteristic we exploit is that each XFABN specifies different election dates. Data for each XFABN were collected by hand from individual security prospectuses and Bloomberg corporate action records. These new data allow us to separate the decisions of investors within each insurer, thereby avoiding the aforementioned simultaneity problem. In a reduced-form analysis of withdrawals, we find a statistically and economically significant relationship between the decisions of investors to withdraw and their expectations that other investors might withdraw in the future. This association is robust to controlling for cross-sectional and time fixed effects, as well as time-varying measures of stability of the insurers and of the financial sector. Of course, this association could well be driven by fundamental developments, rather than by self-fulfulling expectations.

To build the case that there was a self-fulfilling component to the run in 2007, we adopt an instrumental variable approach based on the contractual structure of XFABN. Our strategy uses the pre-determined XFABN election dates together with variation over time in the fraction of MMFs to exercise their put option and leading to a severe liquidity crisis. Within days General American was seized by the Missouri Department of Insurance and acquired by Metropolitan Life at a steep discount. While the rescue meant that General American would remain liquid, and the outstanding funding agreements would inherit MetLife high rating and pay a relatively attractive yield, MMFs still requested their money back from MetLife at the time the purchase was announced (Lohse & Niedzielski 1999).\(^\text{10}\)

The Securities and Exchange Commission Form N-Q and N-CSR filings of Fidelity and JPMorgan reveal that they remained exposed to XFABN conduits until the fourth and third quarters of 2008, respectively. This observation is consistent with withdrawals beginning in the summer of 2007, leading to converted bonds that matured twelve months later.
XFABN that are eligible for conversion. Specifically, our identification strategy relies on the fact that the various XFABN issued by a single insurer typically have different election dates, which are known in advance to institutional investors. Thus, an investor in a particular XFABN can form expectations about how much XFABN issued by the same insurer might be withdrawn by other investors between his election dates. Crucially, these election dates are determined when the XFABN were first issued, often years before the run, and are therefore plausibly exogenous to recent changes in fundamentals around the time of the run. This exogeneity allows us to construct an instrument for investors’ expectations that we can use to draw sharper inference about the effect of changes in expectations about other investors’ withdrawal on the withdrawal decision of an individual investor. The IV estimates suggest that self-fulfilling expectations may have played a significant role in the run on XFABN. We find that 84 percent of the observed $18 billion dollar withdrawn between the third quarter of 2007 and the end of 2008 can be attributed to the self-fulfilling component.

A significant concern in this analysis is that there could be a common shock to fundamentals affecting the U.S. life industry as a whole, or a common shock to short-term investors’ liquidity demand. This is especially likely since the run on XFABN in 2007 coincided with runs in the asset-backed commercial paper and repo markets, and liquidity was generally evaporating quickly around that time. In an effort to address this concern, the IV specifications allow for common fundamental shocks by including weekly time fixed effects. Separately, we also allow for insurer-specific time-varying shocks, by including monthly-insurer fixed effects. As further controls for time-varying fundamentals, we include daily variation in the VIX, the size of the asset-backed commercial paper market, as well as insurer-specific credit default swap spreads, expected default frequencies, and stock prices. We find that our baseline IV estimate of the self-fulfilling effect is largely unaffected by these controls.

To add weight to our IV findings, we implement a series of robustness tests to assess the likelihood that alternative mechanisms unrelated to self-fulfilling expectations may be driving
our main results. In particular, we test whether our findings are a consequence of time-series persistence in investors’ decision to liquidate their holdings. We also examine whether issuers’ choice of election dates at the time they issued their XFABN meant the market was designed to be fragile. We investigate whether other pre-determined variables might plausibly work as alternative instruments. And we present some evidence that our endogenous variable is correlated with recent market developments, while our instrument is not. Taken together, the results from these tests consistently suggest that there was a self-fulfilling component to the run on U.S. life insurers in 2007.

Institutions and markets that are vulnerable to self-fulfilling runs pose a threat to financial stability. In the traditional model of banking, individual banks fund long-term illiquid assets with short-term demand deposits. By contrast, in shadow banking, financial intermediation is performed by chains of institutions operating outside of the regulated banking sector (Cetorelli et al. 2012). For example, institutions with spare cash may park it with MMFs, who in turn invest in short-term highly rated securities backed by long-term assets, such as asset-backed commercial paper. While traditional banking is vulnerable to depositor runs, shadow banking is potentially vulnerable to runs at different links in the chain. Continuing our example, runs could occur both on MMFs by cash investors and by MMFs on the issuers of asset-backed commercial paper. While chains of shadow banking institutions facilitate greater risk sharing in the economy, the chain-links that are vulnerable to self-fulfilling runs could originate shocks that propagate through the financial system and could amplify and accelerate shocks elsewhere.

Our evidence of a self-fulfilling run on U.S. life insurers contributes to a deeper understanding of the vulnerability of shadow banking to runs. While the market for XFABN is small relative to the repo and asset-backed commercial paper markets, the same institutional investors participate in all of them. Since their behavior is likely to have been similar across markets, our study offers some evidence that there may have been a self-fulfilling component to the contemporaneous
runs by institutional investors in those larger markets.\footnote{There are two reasons why it is difficult to identify self-fulfilling runs in the repo and asset-backed commercial paper markets. First, they do not have the XFABN institutional structure. Second, unlike the run on XFABN, the run on asset-backed commercial paper and the run on repo triggered asset firesales. The absence of a firesale following the run on XFABN implies that the price of assets funded by XFABN are unlikely to have changed because of the run. The absence of this channel alleviates some of the concern that fundamentals could have biased our estimates of the effect of self-fulfilling beliefs on the decisions of institutional investors.} To our knowledge, this paper is the first attempt to identify self-fulfilling runs by institutional investors on the issuers of short-term financial instruments. It is complementary to recent papers that have studied self-fulfilling runs on institutional investors such as MMFs (Chen et al. 2010, Schmidt et al. 2014).

A better understanding of self-fulfilling runs by institutional investors is critical as the traditional methods of dealing with self-fulfilling runs by bank depositors – i.e., liability insurance and regulatory supervision of assets – are either infeasible or ineffective to cope with runs by institutional investors. Efforts to mitigate the run risk have been made at some links in the shadow banking chain by adapting the traditional methods of dealing with runs. For example, regulations adopted by Securities and Exchange Commission intended to reduce the likelihood of runs on MMFs (Cipriani et al. 2014). However, the wide range of liabilities and assets on institutional investors’ balance sheets renders liability insurance and regulatory supervision impractical for dealing with runs by institutional investors.

The remainder of the paper proceeds as follows: In Section 2 we introduce and model the XFABN issued by U.S. life insurers. Section 3 presents our data and summary statistics on these securities. Section 4 presents our main empirical results, including our IV estimates and robustness tests. We conclude in Section 5 with some remarks on broader implications and further study.

2 Investor runs on extendible funding agreement-backed notes

Life insurers issue FABS and invest the proceeds in a portfolio of high yield assets such as mortgages, corporate bonds and private label ABS, to earn a spread. In a typical FABS structure, shown in Figure 2, a hypothetical life insurer sells a single funding agreement to
a special purpose vehicle (SPV). The SPV funds the funding agreement by issuing smaller denomination FABS to institutional investors. Importantly, FABS issuance programs inherit the ratings of the sponsoring insurance company, and investors are treated pari passu with other insurance obligations since the funding agreement issued to the SPV is an insurance liability. This provides FABS investors seniority over regular debt holders, and implies a lower cost of funding for the insurer relative to senior unsecured debt. FABS are flexible instruments that may feature different types of embedded put option to meet demands from different types of investors, including short-term investors, such as money market funds (MMFs). FABS designed for short-term investors are the extendible funding agreement backed notes (XFABN) that give investors the option to extend the maturity of their investment at predetermined regular intervals (usually once a month), and were subject to a run by investors in the summer of 2007.

In this section, we construct a model of XFABN investors’ decision making to illustrate how expectations about other investors’ future actions may affect an investor’s decision to withdraw from the XFABN market. The key theoretical result is that, if the decision of investors to withdraw adversely affects the expected liquidity of the XFABN issuer, then there is a possibility of self-fulfilling runs. We then use the model to discuss the main challenges of identifying the self-fulfilling effect from the observationally equivalent effect of fundamentals using equilibrium outcome data.

We begin by formalizing the decision problem faced by XFABN investors. Time is continuous, and there is a continuum of investors indexed by $i \in I$, each endowed with a unit of an XFABN security $i \in I$. Securities are issued by a single issuer and each unit $i$ is expected to pay $c$ units of coupons on specific dates $t_i, t_i + 1, t_i + 2, \ldots, t_i + m$ and a final principal payment of 1 unit at the final maturity date $t_i + m$. Consistent with the requirements of MMFs, we assume that dividends and principal payments are not storable and must be immediately consumed to deliver

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12 Note that FABS can only be issued by life insurers since a funding agreement is a type of annuity product.

13 Moreover, since a funding agreement is an insurance obligation, issuing FABS does not affect the issuing insurer’s leverage, since it appears to be selling more policies.

14 The assumptions of the model are based on the actual contractual structure of XFABN. See Appendix D for an example of the first three pages of an XFABN prospectus; the overall prospectus totals over 900 pages.
utility. Investors are risk neutral, and discount the future at rate $\beta$. However, investors can only derive utility from consumption on the payment dates of their endowed security. Moreover, each investor $\iota$ might also receive an idiosyncratic shock preventing her from receiving any further utility from consumption. We will elaborate on this idiosyncratic shock below.

On any of the dividend payment dates of security $i$, $t_i \in \{t_i, t_i + 1, \ldots, T_i\}$, an investor has the option of converting a fraction or all of her holding of security $i$ to a spinoff bullet bond, which pays the face value of the security at date $t_i + m$. We refer to the dates on which an investor has the option to convert his investment into a short dated bullet bond as election dates.

We summarize all payments due by an issuer at time $t$, including predetermined payments and the payments resulting from investors converting their XFABN, by $q_t$.

The ability of the issuer to make payments at time $t$ is summarized by $N_t$, which we refer to as the state of fundamentals. Moreover, we assume that $N_t$ evolves according to

$$
\dot{N}_t = \alpha \cdot q_t - r_t
$$

where $r_t$ is the issuer’s revenue stream that follows a persistent stochastic process, $q_t$ is the total payments due on $t$, and $\alpha \geq 0$ is the effect of these payments on the issuer’s liquidity. Specifically, the issuer could receive a liquidity shock with arrival rate $F(N_t)$, where $F(\cdot)$ is an increasing function of $N_t$. Once the issuer receives the liquidity shock, no further payment can be made.\(^{15}\) Note that when $\alpha = 0$, the payments are unrelated to the issuer’s liquidity. We assume that at time 0 expected and predetermined payments, denoted by $\tilde{q}_t^0$, are such that $E_0r_t = \alpha q_t^0$. This implies that the expected liquidity of the issuer is constant when investors do not exercise their converting option and extend their XFABNs.\(^{16}\)

As mentioned before, each $\iota$ investor could receive a shock at any time $t$ preventing her from

\(^{15}\)Note that the issuer may not be insolvent upon receiving the liquidity shock. However, the order of payments would be disturbed. Since we assume the investors are hyper-sensitive about the timing of their consumption, the delayed payments would be useless for them.

\(^{16}\)Intuitively, $\alpha > 0$ represents the cost of early liquidation as in the literature stemming from Diamond & Dybvig (1983).
receiving any utility after time \( t + m \). The arrival rate of the shock is given by \( N_{it} \), which follows a random walk. Both \( N_{it} \) and the idiosyncratic shocks are private information. As will be clear later, this idiosyncratic shock could be interpreted as a liquidity shock, forcing the investor to exercise her option to convert her XFABN into a short-dated bullet bond, with a maturity date that is earlier than the final maturity date of the original XFABN. \(^{17}\)

The timeline of the model is summarized by Figure 3. Let \( D_{it} \) be the fraction of investor \( i \)’s holding of the security which is not extended (hence converted) on election date \( t \), and therefore will mature at date \( t + m \). It follows that at the next election date \( t + 1 \), investor \( i \) must decide whether to extend the remaining \( 1 - D_{it} \) percent of her security holding, with earliest maturity at \( t + 1 + m \). Let \( Q_i \) denote the existing queue of claims on the issuer, and \( N_{it} = (N_{it}, r_t; N_{it}) \) be the summary of fundamentals affecting the issuer’s ability to pay that are relevant to investor \( i \), as well as her own (liquidity) preferences. Conditional on not receiving an idiosyncratic (liquidity) shock and on the issuer being liquid, investor \( i \)’s decision at time \( t < t_i \) is summarized by the following Bellman equation:

\[
P(Q_t; N_{it}) = \max_{D_{it} \in [0,1]} \left[ c + D_{it} \ e^{-m \beta} \left[ 1 - \delta_m(Q_t; N_{it}) \right] \right]^{(2)}
\]

\[
+ (1 - D_{it}) e^{-\beta} \mathbb{E}_t \left\{ \left( 1 - \delta_1(Q_t; N_{it}) \right) P(Q_{t+1}; N_{it+1}) \right\}
\]

where \( 1 - \delta_m(Q_t; N_{it}) \) is the expected probability that neither the investor receives the idiosyncratic shock nor the issuer receives the liquidity shock in the next \( m \) periods. \(^{18}\) If the option is not exercised so that \( D_{it} = 0 \), the investor faces a similar decision at time \( t + 1 \) with probability \( 1 - \delta_1(Q_t; N_{it}) \), and either she receives the idiosyncratic shock or the issuer becomes illiquid with probability \( \delta_1(Q_t; N_{it}) \). Note that \( P(Q_{t_i}; N_{t_i}) = c + e^{-m \beta} (1 - \delta_m(Q_{t_i}; N_{t_i})) \) since there is no further election at time \( t_i \) and the final maturity of security \( i \) is at time \( t_i + m \).

\(^{17}\) We assume that the idiosyncratic shocks are uncorrelated. However, the model allows for correlated shocks, if we interpret \( N_t \) to contain the correlated part of the liquidity shocks to the investors, in addition to issuer’s liquidity shock.

\(^{18}\) Recall that we assume that the fair value of the investment is expected to be 1.
Lemma 2.1 Given equation (1), and under mild regulatory assumptions about \( F(\cdot) \), the relevant part of \( Q_t \) for \([1 - \delta_m(Q_t; N_{it})]\) is \( \{q_r\}_{r=t}^{t+m} \), which is the queue of payments scheduled to be made from the current period \( t \) until the maturity date of the converted bullet bond at \( t + m \).

To see this point, note that if other investors with an opportunity to exercise their option in the future choose to convert their XFABN after \( t \), the associated final maturity payments would be scheduled for a date later than \( t + m \), and thus would not affect the liquidity of the issuer in a significant way.\(^{19}\) It follows that

\[
\frac{\partial}{\partial q_t} [1 - \delta_m(Q_t; N_{it})] \approx \begin{cases} 
-\alpha \int_t^{t+m} F'(N_{\tau}) d\tau \cdot [1 - \delta_m(Q_t; N_{it})] & \text{if } \tilde{t} < t + m \\
0 & \text{otherwise}
\end{cases}
\]  

(3)

which implies that the effect of an increase in payment \( q_t \) for a \( \tilde{t} \in (t, t + m] \) is negative if and only if \( \alpha > 0 \), since \( F'(\cdot) > 0 \).

Next we study the effect of idiosyncratic and issuer liquidity shocks on investors’ decisions. Investor \( i \)'s decision is given by

\[
D_{it} = \begin{cases} 
0 & e^{-(m-1)\beta} (1 - \delta_1(Q_t; N_{it})) \leq E_t \left[ (1 - \delta_1(Q_{t+1}; N_{it+1})) P \left( Q_{t+1}; N_{it+1} \right) \right] \\
1 & \text{otherwise}
\end{cases}
\]  

(4)

where we assume that indifferent investors always extend their XFABN. Since by converting her security the investor loses the stream of coupons, she only does so if she has serious concerns about receiving a liquidity shock or about the liquidity of the issuer.\(^{20}\) That is, if \( N_{it} \) increases, so that receiving the idiosyncratic shock becomes more likely, an investor would choose to convert her holding of XFABN into a short dated bullet bond, hoping that she will receive her final payment before her idiosyncratic liquidity shock arrives and she loses her appetite for

\(^{19}\)In fact, since converting XFABN into bullet bond means that the issuer avoids payments of \( c \), the payments between \( t \) and \( t+m \) could potentially decrease. However, we assume \( c \) is small enough to not affect \( Q_t \) significantly.

\(^{20}\) The stream of coupons have a present value of \( \frac{e^{m\beta}(1-e^{-(t+1)\beta})}{(e^{n\beta} - 1)} \cdot c \).
consumption. Similarly, if the issuer’s liquidity deteriorates and $N_t$ increases, the investor might prefer to convert her XFABN and receive her final payment before the payments are disrupted.

Deterioration in the issuer’s liquidity affects all investors, and could lead a significant fraction of investors to run on XFABN. The run could result from a negative shock to $r_t$, or could be simply due to a disorderly liquidation of XFABN resulting from self-fulfilling expectations, or both. We call the negative shock to $r_t$ the fundamental effect, and we call the effect of expectations about other investors’ future actions on an investor’s decision the self-fulfilling effect. To understand the latter effect, consider the case where investors whose election date is today believe that investors with election dates in the future will choose to withdraw. This belief induces today’s decision makers to withdraw. When the resulting new additions to the payment queue induce future decision makers to withdraw on their election dates, then the belief will be self-fulfilled and a self-fulfilling run will result. Note that a small shock to $r_t$ could be amplified and accelerated by a self-fulfilling run in an interaction between the fundamental and self-fulfilling effects.

The main result of this model can be summarized by Proposition 2.2 below, relegating the proof to the appendix.

**Proposition 2.2** If the state of fundamentals, $N_t$, is not too high nor too low, and there are enough investors with election dates between $t$ and $t+1$, then there exist a self-fulfilling run on XFABN if and only if $\alpha > 0$.

The intuition for this result is as follows. For high values of $N_t$, bad fundamentals induce all investors to convert their XFABNs regardless of the decision of other investors. For low enough values of $N_t$, even if all other investors were to withdraw from XFABN, the resulting effect on the state of fundamental, following (1), would not significantly change an individual investor’s expectation about the issuer’s ability to make payments in the future, $F(N_{t+1})$. When the fundamentals, $N_t$ is neither too high nor too low, and if at time $t$ an investor $i$ expects other investors to convert their XFABN at $t'$ between $t$ and $t+1$, her expectation of the increase in the
queue of payments between $t + m$ and $t + m + 1$ would rise. While this change in expectation will not affect her expected value of converting her XFABN at $t$, captured by $1 - \delta_1(Q_t; \mathbf{N}_t)$, it will lower her expected value of extending the XFABN, denoted by $E_tP_{t+1}$, giving more incentive to convert her XFABN. Moreover, the addition of her spinoff to the queue of payment would in turn have a negative effect on the expected future liquidity of the issuer, inducing other investors’ to convert their XFABN between $t$ and $t + 1$, confirming the original expectation and giving rise to a self-fulfilling run.

This proposition highlights the feedback mechanism between expectations of other investors’ decisions and fundamentals that can arise if the decision of an investor to convert her XFABN has a negative impact on the expected value of other investors ($\alpha > 0$). This mechanism would be absent if an investor’s decision to convert her XFABN had no impact on the expected value of other investors ($\alpha = 0$).

So far we have assumed that information about the fundamentals is observable by all investors. However, asymmetric information could imply that uninformed investors act on the informed investors’ actions if they believe these actions contain information about the fundamentals, as in Chari & Jagannathan (1988). This indirect information effect could result in a positive correlation between the uninformed investors’ withdrawal decisions and the previous decisions of other investors, even when $\alpha = 0$, and thus the other investors’ decisions do not have any direct effect on the uninformed investors’ payoff. However, as we show in Appendix B, if $\alpha = 0$ then a change in beliefs about other investors’ future action has no effect on the expectation about the future liquidity of the issuer, and hence affects neither informed nor uninformed investors’ decisions. Therefore, such beliefs cannot be self-fulfilled.

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21 To see the effect of a change in the queue of payment on the expected value of extending the XFABN, recall that $N_{t+1:m}$ is determined by the law of motion in Equation (1).

22 In the setup of Chari & Jagannathan (1988), informed investors receive a signal about the issuer’s future profitability, while uninformed investors can only observe informed investors’ actions. However, informed investors also experience random liquidity needs, implying that informed investors’ motives for withdrawals cannot be perfectly inferred by the uninformed. Thus, withdrawals may be triggered by the uninformed investors, not because withdrawals by informed investors decreases the value of the uninformed investors’ investment as in Diamond & Dybvig (1983), but because of the possibility of low future returns due to bad fundamentals.
Corollary 2.3 Regardless of heterogeneity in investors’ information about fundamentals, there exist a self-fulfilling run on XFABN, if and only if $\alpha > 0$ when the state of the fundamentals, $N_t$ is neither too high nor too low, and there are enough investors with election dates between $t$ and $t + 1$.

2.1 Mapping investor decisions to observables

As we will discuss in the next section, we precisely observe the aggregate fraction of XFABN that is converted at any given election date $t$, but do not observe individual investors’ conversion decisions. A question, thus, is how to use this data to learn whether there might have been a self-fulfilling component to the run on XFABN in the summer of 2007. In this sub-section, we show how observed changes in aggregate XFABN conversion across time are related to changes in investors’ expectations and fundamentals.

Given the above framework, the aggregate fraction of XFABNs converted into short-dated bullet bonds on election date $t$ is defined as

$$D_t(Q_t; N_t) = \int D_\iota t(Q_\iota; N_\iota) d\mu(N_\iota)$$

where $N_t = (N_t, r_t)$ summarizes the aggregate state of the issuer’s liquidity, and $\mu(\cdot)$ denotes the distribution of the investors’ idiosyncratic shocks, so that $\int d\mu(N_\iota) = 1$. Furthermore, the expected increase at date $t$ in other investors’ decisions to convert their XFABN between time $t$ and $t + 1$, potentially adding to the queue of payments between $t + m$ and $t + m + 1$, is defined as

$$E_t S_{t+1} = E_t \int_{t+m}^{t+m+1} (q_\tau - \tilde{q}_\tau^t) d\tau$$

where $\tilde{q}_\tau^t$ is the predetermined payments at time $\tau \in (t + m, t + m + 1]$ known at time $t$.\(^{23}\)

\(^{23}\)Note that converting XFABN brings payments by the issuer to an earlier due date, reducing predetermined payments. That is, $\tilde{q}_\tau^t \leq \tilde{q}_\tau^0$. Conversely, when investors convert their XFABN with final maturity $\tilde{p}$ at time
Proposition 2.4 The partial derivative \( \frac{\partial D_t}{\partial E_t S_{t+1}} \) summarizes the self-fulfilling effect, and is positive if and only if \( \alpha > 0 \).

That is, at any election date \( t \), the direct effect of a change in an investor’s expectation about other investors’ decision to convert their XFABN in the future, on her decision to convert her XFABN at \( t \) captures the self-fulfilling effect.

While we observe \( D_t \) and \( S_{t+1} \), the individual investor’s expectation, \( E_t S_{t+1} \), is unobservable. We invoke rational expectations to the extent that \( S_{t+1} \) and \( E_t S_{t+1} \) are not orthogonal and are correlated. However, variation in \( S_{t+1} \) could be the result of a shock to \( r \), thereby reflecting the liquidity of the issuer, \( N \). And, since these shocks to fundamentals are persistent, the observed variation in \( D_t \) could also be the result of a shock to fundamentals. More formally, the effect of a change in observable \( S_{t+1} \) on a change in \( D_t \) can be expressed as

\[
\frac{dD_t}{dS_{t+1}} = \int \left[ \int_t^{t+1} \frac{dD_t (Q; N_{it})}{dE_t q_{t+m}} \cdot \frac{\partial E_t q_{t+m}}{\partial q_{t+m}} + \frac{\partial D_t (Q; N_{it})}{\partial N_t \cdot \partial N_{t'}} \right] d\tau \, d\mu (N_{it})
\]

where, as shown before, \( \frac{\partial D_t}{\partial N_t} \geq 0 \), and \( \frac{\partial q_{t+m}}{\partial q_{t+m}} \geq 0 \) from \( \frac{\partial D_t}{\partial N_r} \geq 0 \). Note that even if \( \alpha = 0 \), so that \( \frac{\partial D_t (Q; N_{it})}{\partial E_t q_{t+m}} = 0 \), a run on XFABN can occur since it could be that \( \frac{dD_t}{dS_{t+1}} > 0 \) from the fundamental effect.

Therefore, the self-fulfilling effect cannot be identified from the effect of fundamentals without adequately controlling for the possibly confounding effect of fundamentals. The rest of the paper

\( t' \in (t, t+1] \) to a short-dated bullet bond maturing at time \( \tau = t' + m, q \) increases while \( \tilde{q}_{t'} \) decreases.
attempts to make some progress in identifying the self-fulfilling effect in the run on XFABN.

3 Data

Before presenting the empirical results, we briefly describe our data and the magnitude of the run that occurred in the XFABN market during 2007. The main source of data about XFABN is our database of all FABS issued by U.S. life insurers.\textsuperscript{24} Our data for each XFABN was collected by hand from individual security prospectuses and the Bloomberg corporate action record. Each XFABN prospectus specifies the initial maturity date, the election window during which the periodic election dates occur, and when the maturity date of the XFABN may be extended.\textsuperscript{25} If extended, the XFABN maturity date is re-set to the election date plus some term pre-specified in the prospectus. Holders may continue to extend the duration of their security throughout the election window on the pre-specified election dates.

When partial or whole conversions occur within the extension window, a new security identifier (CUSIP) is created and assigned to the spinoff amount. We use prospectus information and Bloomberg corporate action records to construct the universe of XFABN CUSIP identifiers, and pair them with their spinoffs’ CUSIP identifiers. This new security spinoff is no longer eligible for extension and has a fixed maturity date. The remaining portion of the security is eligible for extension throughout the election window and retains its original CUSIP identifier. Thus, we obtain a complete panel of all XFABN outstanding, those still eligible for extensions, and those whose holders elected to spinoff their holdings earlier than the final maturity date.

\textsuperscript{24} Our FABS database was compiled from multiple sources, covering the period beginning when FABS were first introduced in the mid-1990s to early 2014. To construct our dataset on FABS issuers, we combined information from various market observers and participants on FABS conduits and their issuance. We then hand-collected data on contractual terms, outstanding amounts, and ratings for each FABS issue to obtain a complete picture of the supply of FABS at any point in time. Finally, we added data on individual conduits and insurance companies, as well as aggregate information about the insurance sector and the broader macroeconomy. A more detailed description of our FABS database, including funding agreement-backed notes and funding agreement-backed commercial paper, is provided in Appendix C.

\textsuperscript{25} Typically, holders only notify the XFABN dealer on or around each election date if they want to extend the maturity of their XFABN (either in part or the entire security). In the event that no notification is made, the security holder is assumed to have elected not to extend the security. See Appendix D for an example of the first three pages of an XFABN prospectus specifying the election dates and relevant conditions; the overall prospectus totals over 900 pages.
In total, we record 65 XFABN issuances during the period, from which 115 individual spinoffs were issued. The average XFABN note is $450 million at issuance, while spinoffs are on average $170 million, or almost 40 percent of their parent XFABN, when created. About 65 percent of spinoffs mature in 397 days or less, consistent with an issuance strategy that targets investment by money market funds. Summary statistics for all the variables used in the analysis are displayed in Table 1.

Figure 4 shows the daily time series of outstanding XFABN and outstanding spinoffs from 2006 to 2009. The amount of XFABN issued almost tripled from 2004 to 2006, when issuance peaked at $6.4 billion, before falling sharply during the second half of the financial crisis. The amount of XFABN outstanding as of June 2007 was about $23 billion, or just over 19 percent of total U.S. FABS outstanding. Issuance of XFABN since 2013 shows signs of recovery, but remains well below pre-crisis levels.

4 Empirical results

The discussion in Section 2 suggests that investors’ decision on election date \( t \) to convert their holdings of XFABN should be positively associated with other investors’ decisions to convert their holdings of other XFABN before the next election date. Our empirical strategy in this section begins by establishing that there is a positive correlation between investor’s decisions to convert and their expectations that holders of other XFABN will convert in future, while controlling for obvious economic fundamentals that might be driving the run. However, this correlation does not tell us whether the run is due to self-fulfilling expectations, fundamentals, or both. In the second part of our analysis, we try to draw sharper inference on the possibility that there was a self-fulfilling component using an instrumental variable (IV) approach.

The unit of observation throughout our analysis is the election date \( t \) of an individual XFABN

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26 The median initial maturity at issuance for all XFABN in our sample is about 2 years, less than one-quarter of the median duration at issue of the entire sample of FABN (roughly 8 years).
i issued by insurer $j$, yielding a sample of 1,467 security-election date observations from January 1, 2005 to December 31, 2010. We pay close attention to individual election dates and election windows that make each security eligible or not for conversion into a short-dated bullet bond. Our main specification is summarized by Equation 7 below.

$$D_{ijt} = \gamma_0 + \gamma_1 S_{ijt+1} + \gamma_2 Q_{jt} + \mathbf{x}'_{jt} \beta + \epsilon_{ijt} \quad (7)$$

The dependent variable, $D_{ijt}$, is the fraction of XFABN $i$ issued by insurer $j$ that is converted on election date $t$. The main explanatory variable, $S_{ijt+1}$, is the fraction of all XFABN from insurer $j$ that are converted between the current election date $t$ and the next election date $t+1$. This fraction, $S_{ijt+1}$, is calculated for each election date $t$ of each individual security $i$ issued by $j$ and excludes decisions made in respect of the XFABN $i$ itself. As discussed above, $S_{ijt+1}$ is an equilibrium outcome determined by self-fulfilling expectations as well as fundamentals, and is therefore likely to be endogenous. In all specifications, we control for $Q_{jt}$, the fraction of all XFABN from issuer $j$ that were converted prior to election date $t$, a number of issuer and time specific and aggregate controls, contained in the vector $\mathbf{x}_{jt}$. The error term $\epsilon_{ijt}$ likely contains unobserved fundamentals, which we deal with in Section 4.2. Throughout the empirical analysis in this paper, we specify robust standard errors.

### 4.1 Reduced form estimates

We begin our analysis by estimating the basic correlation between $S_{ijt+1}$ and $D_{ijt}$ in a reduced form specification, controlling directly for the possibly confounding effect of observable fundamentals. The reduced form results are contained in Table 2.

Column 1 of Table 2 reports the results of a regression of $D_{ijt}$, the fraction of XFABN $i$ issued by insurer $j$ that is converted on election date $t$, on $S_{ijt+1}$, the fraction of all XFABN from insurer $j$ that are converted between the current election date $t$ and the next election date $t+1$, and $Q_{jt}$, the fraction of all XFABN from issuer $j$ that were converted prior to election date $t$.
date $t$. Consistent with our discussion in Section 2, we find that conversion by other XFABN holders between $t$ and $t+1$ is positively correlated with conversion on date $t$ and is statistically significant at less than the one percent level. Column 2 of Table 2 adds insurer fixed effects to control for persistent insurer characteristics that could affect their propensity to be run on by XFABN investors. The coefficient on $S_{ijt+1}$ and the $R^2$ are not substantially different from the specification in column 1 of Table 2, suggesting the basic correlation between $S_{ijt+1}$ and $D_{ijt}$ is not simply driven by concerns about individual insurers. The coefficient suggests that, on average, a one standard deviation (20 percentage point) increase in investors’ conversion of insurer $j$’s XFABN between election $t$ and $t+1$ is associated with a 0.8 standard deviation (25 percentage point) increase in the fraction of a particular XFABN on election date $t$ that is converted.

Column 3 of Table 2 investigates whether the correlation between $D_{ijt}$ and $S_{ijt+1}$ could be due to a persistent autocorrelation process for $S_{ijt+1}$, by decomposing $Q_{jt}$ into $S_{ijt}$ and $Q_{jt-1}$.27 Finding evidence of autocorrelation in $S_{ijt+1}$, while controlling for $Q_{jt-1}$ might cast doubt on the likelihood that coordination played a significant role in the run on XFABN. For example, if news about bad fundamentals started circulating just before election date $t$, one would expect $D_{ijt}$ to be highly correlated with the most recent decisions to convert XFABN issued by the same insurer, summarized by $S_{ijt}$. The results reported in column 3 show that the coefficient on $S_{ijt}$ is positive but insignificant, while the coefficient on $Q_{jt}$ remains positive and significant at the one percent level.28 This suggests that, consistent with the argument of Section 2, the overall size of the queue of payments and future developments that might affect the queue appear to be important for $D_{ijt}$, while recent developments up to $t$ that are summarized by $S_{ijt}$ are not.

Column 4 of Table 2 controls for rollover risk stemming from insurers’ entire FABS program.

27 Recall from Section 2 that $Q_{jt-1} = \{q_{\tau}^t\}_{\tau=t-1}^{1+1+m}$ is updated to $Q_{jt} = \{q_{\tau}^{t+1+m}\}$ by adding $S_{ijt} = \{q_{\tau} - \hat{q}_{\tau}\}_{\tau=t+1+m}$ to the queue of payments.

28 However, we expect that $S_{ijt+1}$ should be correlated with $S_{ijt}$, and the coefficient on $S_{ijt}$ in a simple regression of $D_{ijt}$ on $S_{ijt}$ with or without $Q_{jt}$ is indeed significant at the one percent level. The results are available on request.
Recall that insurers issue FABS that mature at different points in time. Consequently, an insurer could appear to be risky if it had a lot of FABS maturing between an election date $t$ and the time at which the converted XFABN is set to come due, even though the amount of outstanding XFABN may be relatively small. The specification of column 4 controls for the amount of fixed maturity FABS $Q_t^{FABS}$ and $\Delta Q_t^{FABS}$ that mature before or on date $t + 1$.\textsuperscript{29} The coefficient on $Q_t^{FABS}$ is positive and significant, suggesting that a particular XFABN is more likely to be converted at election date $t$ when a large fraction of fixed maturity FABNs is known to mature in the year or so after $t$. However, the coefficient on $S_{ijt+1}$ remains materially unchanged and statistically significant at the one percent level.

Column 5 of Table 2 controls for the expansion of shadow bank liquidity creation from 2005 to early 2007. It also attempts to control for the rapid development of concerns about the stability of the financial system from mid-2007 that could be a determinant of the runs on XFABN. Specifically, variables measuring the VIX and the amount of asset-backed commercial paper outstanding are added to the reduced form regression. Recall that the run on XFABN was around the same time as the run on ABCP in August 2007 (Covitz et al. 2013) and the run on repo in September 2007 (Gorton & Metrick 2012), but more than a year before the collapse of AIG. Column 6 of Table 2 adds to column 5 quarterly fixed effects to control for any common shock to the industry.\textsuperscript{30} Column 7 controls for insurer-specific time-varying fundamentals using market-based measures of issuer financial health such as insurer holding company stock prices, 5-year credit default swap spreads and 1-year Moody’s KMV expected default probabilities.\textsuperscript{31} In all three specifications, the estimated coefficient on $S_{ijt+1}$ remains positive and significant, albeit somewhat smaller when including the time fixed effects. All these results suggest that the

\textsuperscript{29} To be precise, $Q_t^{FABS}$ refers to the amount of outstanding fixed maturity FABS that are maturing before date $t$ and $\Delta Q_t^{FABS}$ refers to the amount of outstanding fixed maturity FABS that will mature between $t$ and $t + 1$. Note that controlling for rollover risk from fixed maturity FABS requires data on the universe of FABN, not only XFABN. See Appendix C for more details on our FABS database.

\textsuperscript{30} Note that since $S_{ijt+1}$ and $D_{ijt}$ are zero when no run is occurring, a quarterly fixed effect is the highest frequency possible in our specification given the number of parameters to estimate and the number of insurer observations per quarter.

\textsuperscript{31} This specification can only be estimated on about 40 percent of the original sample, because of data availability.
most obvious signs of deteriorating fundamentals during the onset of the global crisis cannot
account for the basic correlation between $S_{ijt+1}$ and $D_{ijt}$.

Taken together, the results in Table 2 indicate that there is a robust correlation between the
probability that an investor would convert her holdings ($D_{ijt}$) and the investor’s expectations
about other investors’ likelihood of withdrawal ($S_{ijt+1}$). This correlation survives controlling
for obvious fundamentals that could affect life insurers and the broader financial system. Of
course, the correlation does not imply that there was any self-fulfilling component. In particular,
the likely presence of unobservable fundamentals prevents us from drawing inference on the
importance of self-fulfilling expectations. We next turn to an instrumental variable approach in
an effort to purge from our main explanatory variable $S_{ijt+1}$ the possibly confounding effect of
fundamentals, and to tease out the self-fulfilling component in the run.

4.2 Instrumental variable approach

The goal of this analysis is to better estimate the effect of changes in investors’ expectations about
$S_{ijt+1}$ on $D_{ijt}$. As discussed above, the effect of expectations about other investors’ conversions
between $t$ and $t+1$ on the conversion decision is ultimately a function of the externality leading
to a self-fulfilling run.\footnote{In the language of the model discussed in Section 2, $\frac{\partial f(Q_t; N_t)}{\partial q_{\tilde{t}}} \mid_{\tilde{t} \in (t, t+m]}$} That is, if investors’ decision to convert their XFABN between two
election dates $t$ and $t+1$ had no impact on the payoffs of other XFABN investors deciding
to convert their XFABN at election date $t$, then investors’ expectations about other investors,
conditional on the state of fundamentals at $t$, should have no impact on their own conversion
decision.

Before presenting the results, we discuss how the unusual contractual structure of XFABN
can be used to construct an instrument for $S_{ijt+1}$ that is plausibly unrelated to fundamentals.
We then show how this instrument can be used to estimate investors’ expectations about the
conversion decisions of other investors between $t$ and $t+1$, and thereby estimate the effect of
changes in $E_tS_{ijt+1}$ on $D_{ijt}$. Importantly, we are not testing self-fulfilling expectations against fundamentals. Rather, our test for the self-fulfilling component is conditional on the effect of fundamentals.

### 4.2.1 Constructing an instrumental variable from XFABN

Recall that $S_{ijt+1}$ is calculated for each election date $t$ of each individual security $i$ issued by $j$ and excludes decisions made in respect of the XFABN $i$ itself. Now, consider the ratio of electable XFABN, $RE_{ijt+1}$, defined as the fraction of XFABN from issuer $j$ that is up for election between election date $t$ and $t + 1$. That is, $RE_{ijt+1}$ is the maximum fraction of XFABN that can be converted into short-term fixed maturity bonds between an individual XFABN $i$’s election dates $t$ and $t + 1$. For each XFABN, election details are spelled out in the XFABN prospectuses available to all investors, so that $RE_{ijt+1}$ can be used by all investors to form expectations about $S_{ijt+1}$. For example, if there is no XFABN from issuer $j$ up for election between $t$ and $t + 1$, everyone would know investor’s expectation about $S_{ijt+1}$ to be trivially 0. On the other hand, if $RE_{ijt+1} > 0$, these investors may form non-trivial expectations about the decision of other investors to convert their XFABN between $t$ and $t + 1$, and their position in the queue of payments.

The ratio of electable $RE_{ijt+1}$ provides a link between investors’ ex-ante expectation $E_tS_{ijt+1}$ and investors’ ex-post decisions $D_{ijt}$ and $S_{ijt+1}$. By definition, $RE_{ijt+1}$ and $S_{ijt+1}$ are bounded below by 0, and $S_{ijt+1}$ is bounded above by $RE_{ijt+1}$. Furthermore, note that while $S_{ijt+1}$ tends to be 0 when there is no run, $RE_{ijt+1}$ fluctuates over time according the set of possibly non-overlapping election cycles from all XFABN issued by insurer $j$. Consequently, the greater the number of XFABN outstanding with non-overlapping election cycles, the greater the fluctuations in $RE_{ijt+1}$. Moreover, because $RE_{ijt+1}$ is the upper bound for $S_{ijt+1}$, the two variables tend to co-move positively during a run, as $S_{ijt+1} = RE_{ijt+1}$ if all investors choose to convert their XFABN.
In normal times, $RE_{ijt+1}$ is pre-determined by the contractual structure of all outstanding XFABN. However, $RE_{ijt+1}$ is not necessarily independent from changes in fundamentals once a run occurs. On the one hand, $RE_{ijt+1}$ mechanically decreases when investors begin to convert their XFABN, since an increase in $S_{ijt+1}$ necessarily implies that fewer XFABN will be up for election on future dates. Thus, if an increase in $S_{ijt+1}$ is caused by fundamentals, $RE_{ijt+1}$ would be negatively correlated with fundamentals. On the other hand, $RE_{ijt+1}$ could increase with an increase in XFABN issuance. For example, an insurer experiencing a run on its XFABN may try to secure new funding by issuing additional XFABNs, so that $RE_{ijt+1}$ would be positively correlated with fundamentals.

Thus, we construct an instrument for $S_{ijt+1}$ that retains the variation of $RE_{ijt+1}$ that is predetermined by the XFABN contractual structure and positively correlated with $S_{ijt+1}$, but we remove any innovations to $RE_{ijt+1}$ that might arise from conversion and new issues during the run period. Since the majority of XFABN in the sample are converted between August 1, 2007 and October 31, 2007, we remove any changes of $RE_{ijt+1}$ from the three months leading up to each election date $t$ ($RE_{ex3m_{ijt+1}}$). Using the variation in $RE_{ex3m_{t+1}}$ as an instrument for $S_{ijt+1}$ yields estimates of the effect of the expectation of investor liquidation decisions $ES_{ijt+1}$ on investors’ own liquidation decisions $D_{ijt}$ that are less likely to be biased by latent fundamental effects. Moreover, the variation of $RE_{ex3m_{ijt+1}}$ during the run is likely orthogonal to latent fundamental effects contributing to the conversion decision.

Importantly, $RE_{ex3m_{ijt+1}}$ is not a “sunspot”, or coordination device for investor expectations, in the sense of Shell (1987). Rather, our empirical environment provides a variable that is correlated with investor expectations, but independent of latent fundamental effects. To see this in a simple way, consider two possible distributions of beliefs about $S_{ijt+1}$ represented in Figure 6. When the overall distribution of beliefs is close to 0, as in the case $g^A(\cdot)$, then the expectations will always be close to zero and independent of $RE_{ex3m_{ijt+1}}$. But, as the case $g^B(\cdot)$ shows, sometimes the expectation of $S_{ijt+1}$ may be a function of $RE_{ex3m_{ijt+1}}$. While
we have no idea what (real or sunspot) variables are driving the entire distribution of beliefs to change, we can nevertheless potentially instrument for changes in the expectations about $S_{ijt+1}$ using $RE_{ex3m_{ijt+1}}$.

### 4.2.2 Instrumental variable estimates

Table 3 contains our main instrumental variable (IV) results estimated using a two stage least square procedure. The first-stage regression, reported in column 1 of Table 3, regresses $S_{ijt+1}$, the fraction of all XFABN from issuer $j$ that is converted between election date $t$ and $t + 1$ on $RE_{ex3m_{ijt+1}}$, the fraction of XFABN from issuer $j$ that is up for election between election date $t$ and $t + 1$. The regression includes the baseline controls from the specification in column 4 of Table 2. Consistent with the discussion above, the first stage results suggest there is a large positive association between $S_{ijt+1}$ and $RE_{ex3m_{ijt+1}}$ significant at less than the one percent level. The first stage results also show that the instrument passes the Stock & Yogo (2005) weak instrument test. From column 1 Table 3, a one standard deviation (10 percentage point) increase in $RE_{ex3m_{ijt+1}}$ is associated with a 0.3 standard deviation (9 percentage point) increase in $S_{ijt+1}$.

Column 2 of Table 3 reports the second stage regression results, with the coefficient obtained from treating $S_{ijt+1}$ with $RE_{ex3m_{ijt+1}}$. The IV coefficient estimate is larger, but not statistically different than its OLS counterpart in the reduced form specification (column 4 of Table 2). The magnitude of the IV coefficient suggests that a one standard deviation (30 percentage point) increase in the XFABN conversion rate between $t$ and $t + 1$ predicted by investors at election date $t$ raises the probability that investors convert their XFABN at election date $t$ by 3.2 standard deviations (64 percentage points).

In dollar terms, the IV coefficient suggests that the marginal effect of a one standard deviation, or 10 percent of an insurer’s outstanding XFABN, increase in expected XFABN withdrawal over the run period results in $56 million of additional withdrawal from the median...
outstanding XFABN. An alternative economic interpretation is an estimate of the overall contribution of the self-fulfilling component to total withdrawal during the run. To compute this estimate, we multiply the model-implied expectation of $S_{ijt+1}$ from the first stage regression by the estimated IV coefficient from the second stage regression and the total amount of XFABN up for election. This yields an estimate of the dollar amount of each XFABN withdrawn due to self-fulfilling expectations. Summing over the run period, this calculation suggests that 84 percent of the observed $18$ billion dollar withdrawn between the third quarter of 2007 and the end of 2008 can be attributed to the self-fulfilling component. Taken together, these estimates suggest that self-fulfilling expectations may have played a significant role in the run on XFABN.

A significant concern in this analysis is that there could be a common shock to fundamentals affecting the U.S. life industry as a whole. This is especially likely since the run on XFABN coincided with the runs in asset-backed commercial paper and repo markets, and quickly evaporating liquidity in general. In an effort to address this concern, Columns 3 and 4 of Table 3 control further for common shocks to the industry by adding weekly time fixed effects. Columns 3 and 4 of Table 3 also control for the expansion in shadow bank liquidity creation from 2005 to early 2007, and the rapid development of concerns about the stability of the financial system from mid-2007 that could be a determinant of the runs on XFABN, by including the VIX and the amount of ABCP outstanding.

Intuitively, this test assumes that news about fundamentals are either broadly good or broadly bad for a whole week. On the first day of the week in which fundamentals are bad, if the fraction of electable XFABN is high, many investors will run. On the second day, if the fraction of electable XFABN is low, few investors will run. Our identification strategy could be challenged if, systematically and within each week, good news about fundamentals coincided with days when the fraction of electable XFABN were low and bad news coincided with days

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33 Throughout, we use the estimates from the IV specification including weekly time fixed effect.
34 Note that unlike the reduced form specification of Table 2 for which quarterly time fixed effect were the highest frequency possible, the IV regression allows us to use a higher frequency because the value of $S_{ijt+1}$ treated by $RE_{ex3m_{ijt+1}}$ has much greater variation over the entire sample period.
when the fraction of electable XFABN were high. However, we argue that this is an unlikely scenario since, fundamentals were worsening across capital markets during this period.

As a further robustness check on fundamentals, Columns 5 and 6 of Table 3 allow for high-frequency idiosyncratic shocks by including monthly-insurer fixed effects. Columns 7 and 8 of Table 3 add daily variation in market-based measures of issuer financial health such as insurer holding company stock prices, 5-year CDS spreads and 1-year Moody’s KMV Expected Default Probabilities. In all these specifications, the estimated IV coefficient (\( S_{ijt+1} \) treated by \( RE_{ex3m_{ijt+1}} \)) remains positive and highly significant giving us some confidence that our estimate of the coordination failure effect is not biased in obvious ways by latent fundamental effects.

We explained above that while \( RE_{ijt+1} \) is pre-determined by the contractual structure of all outstanding XFABN in normal times, it is not necessarily independent from changes in fundamentals once a run occurs. In particular, \( RE_{ijt+1} \) mechanically decreases when investors begin to convert their XFABN, and could increase if insurers issue new XFABN during the run. Depending on which effect dominates, the first-stage coefficient estimates using \( RE_{ijt+1} \) could be biased in either direction. Our instrument, \( RE_{ex3m_{ijt+1}} \), addresses this source of potential bias by removing any innovations to \( RE_{ijt+1} \) that might arise from conversion and new issuance during the run period. Columns 7 and 8 of Table 3 investigate the potential bias by replacing our instrument with \( RE_{ijt+1} \) in the baseline IV specification. We find that the estimated IV coefficient using \( RE_{ijt+1} \) is not statistically different from the coefficient we obtained when using \( RE_{ex3m_{ijt+1}} \). Since only one company issued a relatively small amount of XFABN during the run, these results suggests that either the two biases roughly offset each other, or that developments in \( RE_{ijt+1} \) during the run are not a significant source of bias.

\[35\] This specification can only be estimated on about 40 percent of the original sample.
4.3 Robustness to alternative mechanisms

As discussed above, investors’ decisions to convert their XFABN could be shaped by the joint and largely unobservable variation in $E_t S_{ijt+1} + N_t$. Our instrumental variable approach uses the variation in $RE_{-ex3m_{ijt+1}}$ to help purge the possibly confounding effect of $N_t$ on $D_{ijt}$ from the equilibrium outcome $S_{ijt+1}$. In this sub-section, we perform a number of tests to examine further the property of our instrument, and the robustness of our proposed mechanism to alternative explanations. The results of these tests are summarized in Table 5.

A first concern is that the IV estimate of the coefficient on $S_{ijt+1}$ discussed above is driven by the time-series persistence in the instrumental variable $RE_{-ex3m_{ijt+1}}$, rather than expectation about future XFABS conversion by investors. To test this hypothesis, we consider $RE_{ijt}$, defined as the fraction of XFABS that is up for election between election date $t-1$ and the current election date $t$. Table 5 suggests that there is indeed a significant time-series persistence, with a correlation coefficient of 0.82 between $RE_{-ex3m_{ijt+1}}$ and $RE_{ijt}$ (and 0.85 between $RE_{ijt+1}$ and its lag $RE_{ijt}$), respectively. Columns 1 and 2 of Table 5 report the first and second stage regression results using $RE_{ijt}$ as an instrument for $S_{ijt+1}$, respectively. Although there is a statistically significant relationship between this alternative instrument and the endogenous variable $S_{ijt+1}$ in the first stage, the results suggest that $RE_{ijt}$ is a weak instrument for $S_{ijt+1}$. Moreover, the coefficient of $S_{ijt+1}$ treated by $RE_{ijt}$ in the second stage is not statistically significant from zero. This result is consistent with the hypothesis that $RE_{-ex3m_{ijt+1}}$ can be used to form expectation about future XFABN conversion, while $RE_{ijt}$ cannot.

A second concern is that the XFABN market could be fragile by design, which would render our instrument $RE_{-ex3m_{ijt+1}}$ correlated with fundamentals. To test this hypothesis, we define $RE@I_{ijt+1}$ as the anticipated fraction of XFABS that will be up for election between election date $t$ and $t+1$, computed when the XFABN is issued. Table 5 suggests that the correlation between $RE_{-ex3m_{ijt+1}}$ and $RE@I_{ijt+1}$ is only 0.35. Unsurprisingly, $RE@I_{ijt+1}$ is a poor instrument, as reported in column 3 and 4 of Table 5. This finding suggests that it is unlikely that insurers
designed their institutional spread margin business to fail.

A third concern is that there could be a mechanical relationship between the predetermined variables of the model and the liquidation decisions. To test this hypothesis, we investigate whether \( Q_{jt} \) mechanically affects investors’ decisions to convert their XFABN. That is, we instrument the endogenous variable \( S_{ijt+1} \) with \( Q_{jt} \), the fraction of XFABN that has been converted up until XFABN \( i \)’s election date \( t \) and that is known to come due before any amount of XFABN \( i \) converted at \( t \) comes due. Note that while \( Q_{jt} \) is predetermined, it is not independent from fundamentals and has a direct effect on \( D_{ijt} \). Column 1 of Table 5 shows that the coefficient estimates on \( Q_{jt} - S_{ijt} \) and \( S_{ijt} \) in the reduced form specification are positive and jointly significant at less than the one percent level. However, the 2SLS results reported in column 5 and 6 of Table 5 show that the coefficient estimate on \( S_{ijt+1} \) instrumented with \( Q_{jt} - S_{ijt} \) and \( S_{ijt} \) is insignificant. More generally, this test helps shed some light on how erroneously using \( Q_{jt} \) as an instrument for \( S_{ijt+1} \), a variable with a direct effect on \( D_{ijt} \), might bias our results.

A fourth concern is that \( RE_{ex3m_{ijt+1}} \) could have a direct effect on the dependent variable \( D_{ijt} \). We investigate this issue by testing whether \( S_{ijt+1} \) might a proxy for \( RE_{ijt+1} \), rather than a proxy for \( E_{t}S_{ijt+1} \). Whether \( S_{ijt+1} \) is a proxy for \( RE_{ijt+1} \) would imply \( RE_{ex3m_{ijt+1}} \) could have a direct effect on \( D_{ijt} \), which would invalidate our instrumental variable strategy. In this case, the estimated reduced form coefficient on \( S_{ijt+1} \) would not capture part of the effect of \( E_{t}S_{ijt+1} \) on \( D_{ijt} \), but instead capture the effect of \( RE_{ijt+1} \) on \( D_{ijt} \) through its effect on \( S_{ijt+1} \). We investigate this possibility by adding our instrument \( RE_{ex3m_{ijt+1}} \) to the baseline reduced-form specification. The results in column 7 of Table 5 suggests that the coefficient estimate on \( S_{ijt+1} \) is not statistically different from its counterpart in column 4 of Table 2, suggesting that \( S_{ijt+1} \) has a plausibly direct effect on \( D_{ijt} \).

Lastly, while an asset fire sale could be a source of bias in the estimate of the self-fulfilling effect, it is unlikely to be significant in the XFABN market. In principle, if life insurers had
participated in a fire sale of assets funded by XFABN then institutional investors might have worried that the losses incurred by insurers could affect their repayment, and this fundamental effect could have contributed to the run. However, XFABN issuers had access to a backstop - the Federal Home Loan Banks. As shown in Figure 5, FABS issuers accessed funding from the third quarter of 2007 by issuing funding agreements, collateralized by their real estate-linked assets, directly to one of the twelve Federal Home Loan Banks. In fact, nearly all of the increase in the Federal Home Loan Bank advances to the insurance industry from 2007 was to FABS issuers. Moreover, as shown in Figure 1 of Ashcraft et al. (2010), the cost of funding from Federal Home Loan Banks remained low and stable between June 2007 and June 2008, while the cost of funding implied by the one-month LIBOR and asset-backed commercial paper AA-rated 30 day interest rate surged, as the repo and asset-backed commercial paper markets experienced runs. Thus, the Federal Home Loan Banks played a key role in re-intermediating term funding to life insurers experiencing runs by institutional investors, such as money market funds. The availability of low-cost, stable Federal Home Loan Bank funding during the run and at the time the converted XFABN came due obviated the need for XFABN issuers to participate in asset fire sales.

Importantly, while the FHLB did provide a backstop to FABS issuers and greatly mitigated the risk of fire sale, there was considerable uncertainty at the time about the survival of the FHLB system. This uncertainty stemmed from the aggressive lending by FHLBs to thousands of member banks during the real estate boom, many of which became troubled when house prices collapsed. For example, IndyMac increased its borrowings from the Federal Home Loan Bank of San Francisco more than 500% from the end of 2004 through early 2008, before failing in July.

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36 To be a member of a Federal Home Loan Banks, a life insurer needs to have at least 10 percent of its assets linked to real estate and can obtain advances in proportion to its membership capital that are fully collateralized by real estate-linked and other eligible assets.

37 This goes beyond the point noted by Ashcraft et al. (2010) that “at the outset of the financial crisis, money market investors ran away from debt [e.g. asset-backed commercial paper] issued or sponsored by depository institutions and into instruments guaranteed explicitly or implicitly by the U.S. Treasury. As a result, the Federal Home Loan Bank System was able to re-intermediate term funding to member depository institutions through advances.”
2008; and Countrywide gambled for resurrection during 2007 by borrowing about $50 billion from the Federal Home Loan Bank of Atlanta before its near collapse in 2008 (Coy 2008). The uncertainty about the availability of a backstop to FABS issuers around the time of the run did nothing to reassure short-term institutional investors.

5 Conclusion

Shadow banking consists of institutions operating outside the regulated banking sector and linking together to form a chain of financial intermediation. While shadow banking facilitates greater risk sharing in the economy, different links in the financial intermediation chain could be vulnerable to self-fulfilling runs. These links could originate shocks that propagate through the financial system, or could amplify and accelerate shocks originated elsewhere. In this paper, we provide evidence of self-fulfilling beliefs affecting institutional investors’ decisions to run on issuers of short-term instruments. We exploit the contractual structure of a particular type of instrument issued by U.S. life insurers to access short-term funding markets, extendible funding agreement-backed notes (XFABN). We find robust evidence that the run on U.S. life insurers’ XFABN in the second half of 2007 had a significant self-fulfilling component.

Our findings suggest that there may have been a significant self-fulfilling component to other contemporaneous runs by institutional investors. While the market for XFABN is small relative to the asset-backed commercial paper (ABCP) and repo markets, the same short-term institutional investors participate in them. Identifying self-fulfilling runs on ABCP and repo is difficult because these instruments do not have the same contractual structure as XFABN and runs in these markets triggered confounding asset firesales. Nevertheless, the behavior of short-term institutional investors is likely to have been similar across short-term funding markets in the second half of 2007.

Our results also have implications for the regulation of non-bank financial institutions. A large regulatory effort since the 2008-09 financial crisis has focused on strengthening the liquidity
and solvency standards of non-bank financial institutions. However, if the self-fulfilling effect identified in this paper was a culprit for the disruptions to financial intermediation by the shadow banking sector during the crisis, more emphasis should be given to addressing the risk of self-fulfilling runs.

Finally, this paper informs the debate on the systemic risk posed by asset managers to financial markets. For example, while efforts have been made to mitigate the risk of runs on MMFs by adapting tools from traditional banking regulations—e.g., suspension of convertibility—the vulnerability of the financial system to runs by MMFs on the issuers of short-term liabilities remains largely unaddressed. Moreover, the wide and constantly evolving array of liabilities and assets on institutional investors’ balance sheets implies that tools from traditional banking regulation, such deposit insurance and asset monitoring by regulators, may be impractical or infeasible for dealing with runs by institutional investors.

References


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Moody’s (1998), ‘Funding Agreements - The New Frontier of Stable Value’, *Moody’s Investors Service Global Credit Research Special Comment (April)*.

Moody’s (1999), ‘General American: A Case Study In Liquidity Risk’, *Moody’s Investors Service Global Credit Research Special Comment (August)*.


Figures and Tables

Figure 1: FABS and Auto ABS Amount Outstanding

Source: authors’ calculations based on data collected from Bloomberg Finance LP, and Moody’s ABCP Program Index. Data as of June 1, 2015.

Figure 2: Typical FABS Structure

Figure 3: Timeline for XFABN elections

\[ S_{t+1} \in [0, RE_{ijt+1}] \]

- \( D_t \): Current extension decision
- \( D_{t+1} \): Next extension decision
- \( S_{t+1} \): Fraction of other XFABN that are spunoff
- \( Q_t \): Maturing FABS during \([t, t+m]\)
- \( Q_{t+1} \): Maturing FABS during \([t+1, t+m+1]\)

\[ \Delta Q_t^- \]

\[ \Delta Q_t^+ \]

\[ Q_{t+1} \]

\[ t + m \]: Maturity date of \( D_t \) spinoff
\[ t + m + 1 \]: Maturity date of \( D_{t+1} \) spinoff

\[ RE_{ijt} \]: Fraction of XFABN that are up for election

\[ \Delta Q_t^- \]: Other predetermined maturing FABS

\[ \Delta Q_t^+ \]: Maturing FABS before the next election

Figure 4: Run on Extendible FABN

Source: authors’ calculations based on data collected from Bloomberg Financial LLP.
Figure 5: FHLB Advances to FABS Issuers

Source: authors’ calculations based on the Federal Home Loan Bank database, provided by the FHLB Office of Finance.

Figure 6: \( RE_{ijt+1} \) is not necessarily a sunspot

\[ g^{A/B}(S_{ijt+1}) \]

This figure illustrate how \( RE_{ijt+1} \) is not necessarily a sunspot. Consider two distribution of beliefs \( g^A(S_{ijt+1}) \) and \( g^B(S_{ijt+1}) \), such that \( E_t^A S_{ijt+1} = 0 \). Shocks, real or sunspot, may switch the distribution from \( A \) to \( B \). However, identification only requires \( E_tS_{ijt+1} \not\perp RE_{ijt+1} \) during the run, and is uninformative about what causes the distribution to shift.
Table 1: Descriptive Statistics: Runs on Extendible FABN

This table displays descriptive statistics for extendible funding agreement-backed notes (XFABN) in our database where the funding agreement provider is known. There are a further eight XFABN and seven spinoffs that are issued by unknown insurer(s) under Premium Asset Trust and Structured Repackaged Asset Trust structures. Each XFABN has periodic election dates on which the holders of the security may opt to lengthen the term of the XFABN. When an XFABN is not extended, it is “spunoff” into a new security with a separate CUSIP identifier.

<table>
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<tr>
<th>Description</th>
<th>Obs.</th>
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<td>28</td>
<td>366</td>
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<td>Issuance amount of XFABN (USD million)</td>
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<td>497.8</td>
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<td>Issuance amount of spinoffs (USD million)</td>
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<td>Fraction of all XFABN that can potentially be turned into spinoffs ($RE_{ex3m_{ijt+1}}$)</td>
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<td>New predetermined maturing FABS ($\Delta Q_{ijt}^{FABS}$)</td>
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<td>0</td>
<td>.21</td>
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Source: authors’ calculations based on data collected from Bloomberg Finance LP.
This table summarizes the main reduced form results on the run on U.S. life insurers that occurred in the summer of 2007. The unit of observation is the election date $t$ of an individual XFABN $i$ issued by insurer $j$, and the sample extends from January 1, 2005 to December 31, 2010. The dependent variable $D_{ijt}$ is the fraction of XFABN $i$ issued by insurer $j$ that is converted into a fixed maturity bond at election date $t$. The main explanatory variables are $S_{ijt+1}$ the fraction of all XFABN from insurer $j$ that is converted between the current election date $t$ and the next election date $t + 1$, and $Q_{jt}$ the fraction of XFABN from insurer $j$ that were converted prior to election date $t$. Columns 2 through 7 include insurer fixed effects. Column 3 decomposes $Q_{jt}$ into a most recent and older component $Q_{jt} - S_{ijt}$ and $S_{ijt}$, respectively. Column 4 includes the amount of fixed maturity FABS $Q_{FABS}^{FABS}$ and $\Delta Q_{FABS}^{FABS}$ that matures before or on the date at which an XFABN converted at date $t$ is set to come due divided by total FABS. Column 5 includes the VIX and the amount of U.S. ABCP outstanding. Column 6 includes quarterly time fixed effects. Column 7 includes sponsoring insurer stock price, 5-year CDS, and 1-year EDF. Robust standard errors are reported in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% level, respectively.

<table>
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<tr>
<th>Dep. var.: $D_{ijt}$</th>
<th>(1)</th>
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<td>Time Fixed Effect</td>
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<td>$S_{ijt+1}$</td>
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<td>$Q_{FABS}^{FABS}$</td>
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<td>0.00428***</td>
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Source: authors' calculations based on data collected from Bloomberg Finance LP, Markit and Center for Research in Security Prices (CRSP) via Wharton Research Data Services (WRDS), Moody’s Analytics: KMV, Federal Reserve Bank of St Louis, Federal Reserve Economic Data (FRED).
This table summarizes the main instrumental variable results on the run on U.S. life insurers that occurred in the summer of 2007. The unit of observation is the election date \( t \) of an individual XFABN \( i \) issued by insurer \( j \), and the sample extends from January 1, 2005 to December 31, 2010. The dependent variable \( D_{ijt} \) is the fraction of XFABN \( i \) issued by insurer \( j \) that is converted into a fixed maturity bond at election date \( t \). The endogenous variable \( S_{ijt+1} \) is the fraction of all XFABN from insurer \( j \) that is converted between the current election date \( t \) and the next election date \( t+1 \). The instrumental variable \( RE_{ex3mijt+1} \) is the maximum fraction of XFABN that can be converted into short-term fixed maturity bonds between an individual XFABN \( i \)’s election dates \( t \) and \( t+1 \), removing any changes stemming conversion or new issue in the three months leading up to election date \( t \). All regressions include the controls included in the baseline reduced from regression (Column 4 of Table 2). Columns 3 through 8 include the VIX and the amount of U.S. ABCP outstanding. Columns 3 and 4 include weekly time fixed effects. Columns 5 through 8 include insurer specific month time fixed effects. Columns 7 and 8 include sponsoring insurer stock price, 5-year CDS, and 1-year EDF. Robust standard errors are reported in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% level, respectively.

<table>
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<tr>
<th>Dep. var.: ( D_{ijt} )</th>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( S_{ijt+1} ) (endogenous)</td>
<td>2.142***</td>
<td>2.207***</td>
<td>3.513***</td>
<td>2.326***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( RE_{ex3mijt+1} )</td>
<td>0.0946***</td>
<td>0.0739***</td>
<td>0.0490**</td>
<td>0.0691***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( Q_{ijt} - S_{ijt} )</td>
<td>-0.000216***</td>
<td>-0.000849***</td>
<td>-0.000326**</td>
<td>-0.00131***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( Q^{FABS}_{ijt} )</td>
<td>0.0542***</td>
<td>0.226*</td>
<td>0.045**</td>
<td>0.0982***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta Q^{FABS}_{ijt} )</td>
<td>0.166</td>
<td>-0.413</td>
<td>0.245</td>
<td>-0.481</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>VIX</td>
<td>-0.00261</td>
<td>0.00548</td>
<td>0.00531</td>
<td>-0.0309***</td>
<td></td>
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<tr>
<td>ABCP outstanding (USD bn)</td>
<td>0.000469</td>
<td>0.00443</td>
<td>-0.000545</td>
<td>0.000614</td>
<td></td>
<td></td>
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<tr>
<td>5-Year CDS Spread (bps)</td>
<td>-0.00233</td>
<td>0.0218***</td>
<td>-0.000545</td>
<td>0.000614</td>
<td></td>
<td></td>
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<tr>
<td>1-Year EDF (%)</td>
<td>0.0451</td>
<td>-0.992***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stock Price ($)</td>
<td>-0.00354</td>
<td>0.0329**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>921</td>
<td>921</td>
<td>921</td>
<td>921</td>
<td>921</td>
<td>921</td>
<td>383</td>
<td>383</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.284</td>
<td>-0.027</td>
<td>0.340</td>
<td>-0.152</td>
<td>0.694</td>
<td>-0.479</td>
<td>0.871</td>
<td>0.486</td>
</tr>
<tr>
<td>FA provider FE</td>
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<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Weekly FE</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Issuer-Month FE</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Robust KP Wald F-stat</td>
<td>48.64</td>
<td>15.12</td>
<td>6.57</td>
<td>8.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: authors’ calculations based on data collected from Bloomberg Finance LP, Markit and Center for Research in Security Prices (CRSP) via Wharton Research Data Services (WRDS); Moody’s Analytics: KMV, Federal Reserve Bank of St Louis, Federal Reserve Economic Data (FRED).
Table 4: Correlations Between Alternative Instruments

This table explores the correlations between variables that are closely related to the instrumental variable $RE_{ex3m_{ijt+1}}$ used in the main analysis of Table 3. The instrumental variable $RE_{ex3m_{ijt+1}}$ is the maximum fraction of XFABN that can be converted into short-term fixed maturity bonds between an individual XFABN $i$’s election dates $t$ and $t+1$, removing any changes stemming conversion or new issue in the three months leading up to election date $t$; $RE_{ijt+1}$ is the maximum fraction of XFABN that can be converted into short-term fixed maturity bonds between an individual XFABN $i$’s election dates $t$ and $t+1$; $RE_{ijt}$ is the fraction of XFABN that is up for election between election date $t-1$ and the current election date $t$; and $RE@I_{ijt+1}$ is the anticipated fraction of XFABN that will be up for election between election date $t$ and $t+1$ when the XFABN is issued.

<table>
<thead>
<tr>
<th></th>
<th>$S_{ijt+1}$</th>
<th>$RE_{ex3m_{ijt+1}}$</th>
<th>$RE_{ijt+1}$</th>
<th>$RE_{ijt}$</th>
<th>$RE@I_{ijt+1}$</th>
<th>$\Delta_{3mVIX_t}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_{ijt+1}$</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$RE_{ex3m_{ijt+1}}$</td>
<td>0.36</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$RE_{ijt+1}$</td>
<td>0.33</td>
<td>0.95</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$RE_{ijt}$</td>
<td>0.24</td>
<td>0.82</td>
<td>0.85</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$RE@I_{ijt+1}$</td>
<td>0.01</td>
<td>0.35</td>
<td>0.34</td>
<td>0.36</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>$\Delta_{3mVIX_t}$</td>
<td>0.07</td>
<td>0.02</td>
<td>0.01</td>
<td>-0.06</td>
<td>0.00</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: authors’ calculations based on data collected from Bloomberg Finance LP.
Table 5: Runs on Extendible FABN: Robustness Tests

This table investigates the robustness of the results in Table 3 to alternative mechanisms. All regressions include the controls included in the baseline reduced form regression – column 4 of Table 2. Columns 3 and 4 instrument $S_{ijt+1}$ with $RE_{ijt}$, the fraction of XFABN that is up for election between election date $t-1$ and the current election date $t$. Columns 5 and 6 instrument $S_{ijt+1}$ with $RE_{@IJ_{ijt+1}}$, the anticipated fraction of XFABN that will be up for election between election date $t$ and $t+1$ when the XFABN is issued. Column 7 includes $RE_{ex3m_{ijt+1}}$ to the baseline reduced form regression (column 4 of Table 2). Columns 8 and 9 instrument $S_{ijt+1}$ with $Q_{jt}$, the fraction of XFABN from insurer $j$ that were converted prior to election date $t$. Robust standard errors are reported in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% level, respectively.

<table>
<thead>
<tr>
<th>Dep. var.: $D_{ijt}$</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First stage</td>
<td>Second stage</td>
<td>First stage</td>
<td>Second stage</td>
<td>First stage</td>
<td>Second stage</td>
<td>First stage</td>
<td>Second stage</td>
<td>proxy for $S_{ijt+1}$</td>
</tr>
<tr>
<td>$S_{ijt+1}$ (endogenous)</td>
<td>0.685</td>
<td>0.279</td>
<td>-0.158</td>
<td>0.725***</td>
<td>2.582***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$RE_{ijt}$</td>
<td>(0.923)</td>
<td>(2.873)</td>
<td>(0.817)</td>
<td>(0.148)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$RE_{ex3m_{ijt+1}}$</td>
<td>0.0946***</td>
<td>0.211**</td>
<td>0.134***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$RE_{ijt}$</td>
<td>(0.0136)</td>
<td>(0.0927)</td>
<td>(0.0416)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$RE_{@IJ_{ijt+1}}$</td>
<td>0.0102</td>
<td>(0.0138)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Q_{jt} - S_{ijt}$</td>
<td>-0.000274***</td>
<td>0.000392</td>
<td>-0.000278***</td>
<td>0.000325</td>
<td>-0.000216***</td>
<td>0.000543***</td>
<td>-0.000225**</td>
<td>0.000972***</td>
<td></td>
</tr>
<tr>
<td>$S_{ijt}$</td>
<td>(0.000111)</td>
<td>(0.000298)</td>
<td>(0.54e-05)</td>
<td>(0.00823)</td>
<td>(9.14e-05)</td>
<td>(0.000166)</td>
<td>(9.34e-05)</td>
<td>(0.000289)</td>
<td></td>
</tr>
<tr>
<td>$Q^{FABS}_{jt}$</td>
<td>0.0768*</td>
<td>0.00729</td>
<td>0.00817**</td>
<td>0.0130</td>
<td>0.00678*</td>
<td>0.00748</td>
<td>0.00723**</td>
<td>0.000572</td>
<td></td>
</tr>
<tr>
<td>$DQ^{FABS}_{jt}$</td>
<td>(0.00428)</td>
<td>(0.00890)</td>
<td>(0.00365)</td>
<td>(0.0210)</td>
<td>(0.00356)</td>
<td>(0.00507)</td>
<td>(0.00360)</td>
<td>(0.0105)</td>
<td></td>
</tr>
<tr>
<td>$\Delta Q^{FABS}_{jt}$</td>
<td>0.0893***</td>
<td>0.333***</td>
<td>0.0928***</td>
<td>0.401</td>
<td>0.0542**</td>
<td>0.436***</td>
<td>0.303**</td>
<td>0.0581**</td>
<td>0.185</td>
</tr>
<tr>
<td>Observations</td>
<td>868</td>
<td>868</td>
<td>921</td>
<td>921</td>
<td>921</td>
<td>921</td>
<td>921</td>
<td>921</td>
<td>921</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.230</td>
<td>0.216</td>
<td>0.226</td>
<td>0.161</td>
<td>0.284</td>
<td>0.099</td>
<td>0.220</td>
<td>0.261</td>
<td>-0.207</td>
</tr>
<tr>
<td>FA provider FE</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Robust KP Wald F-stat</td>
<td>7.86</td>
<td>5.5</td>
<td>8.44</td>
<td>37.63</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Source: authors' calculations based on data collected from Bloomberg Finance LP.
A Institutional Background

Liquidity creation by U.S. life insurers emerged as a response to long-run macroeconomic and regulatory changes that affected the industry. Life insurers traditionally offer insurance to cover either the financial position of dependents in the event of the death of the main income earner, or individuals at risk of outliving their financial wealth. Under this model, policyholders make regular payments to an insurance company in exchange for promised transfers from the insurer at a future date. The promised transfers are long-term illiquid liabilities for insurers, which are backed by assets funded by the regular payments from policyholders. The assets backing insurance liabilities need to be low risk and highly liquid to pay insurance claims as required. Ideally, these assets also deliver high returns to improve insurers’ profitability.

Throughout the middle part of the twentieth century, life insurers enjoyed easy profits as high interest rates on safe long-term U.S. Treasuries that were attractive during World War II were replaced with high interest rates on long-term corporate bonds (Briys & De Varenne 2001). Soon after, however, pension funds emerged, offering high returns to savers and challenged the traditional business model of life insurers. Unlike life insurers, pension funds could afford to offer much higher returns because they could invest freely in booming equity markets. Life insurers responded to the threat from pension funds by pursuing more aggressive investment strategies and offering products with higher (sometimes guaranteed) yields and greater flexibility to withdraw funds early.

The combination of greater liability run-risk and risky assets resulted in an insurance crisis in the late 1980s. Many insurers failed as capital losses on high-risk assets caused surrender runs by policyholders, intensified by falling credit ratings of insurers (DeAngelo et al. 1994). Realizing that life insurers had overweighed their portfolios with risky assets, the National Association of Insurance Commissioners (NAIC) proposed several model reforms for state insurance regulation,
including risk-based capital (RBC) requirements, financial regulation accreditation standards, and an initiative to codify accounting principles. For their part, life insurers redressed the balance of their portfolios towards safer and more liquid assets.

Insurers’ re-focus on safe assets after the crisis of the late 1980s gave rise to a new problem as interest rates on safe assets continued the decline they had begun in the early 1980s. Faced with the prospect of persistently low interest rates, life insurers realized they were at risk of being unable to deliver the guaranteed returns promised to policyholders when the expected path of interest rates was higher. This rising interest rate risk led to important changes in life insurance regulation. In particular, insurance industry state regulators adopted the NAIC Model Regulation 830 (Regulation XXX) in January 2000 and Actuarial Guideline 38 (Regulation AXXX) in January 2003, requiring life insurers to hold higher statutory reserves in connection with term life insurance policies and universal life insurance policies with secondary guarantees. However, higher risk-based capital requirements necessarily imply a lower return on equity, as larger reserves must be backed by safe, low-yield assets.

Life insurers responded to higher capital requirements and falling interest rates by finding innovative ways to increase their return on equity. One way – the subject of this paper – is to fund a larger portfolio of high yield assets with funding agreement-backed securities (FABS), which is known in the industry as an “institutional spread business.” Another way is to reduce risk-based capital requirement by shifting insurance risk off-balance sheet to captive reinsurers.

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38 Under the state-based insurance regulation system, each state operates independently to regulate its own insurance market, typically through a state insurance department. State insurance regulators created the NAIC in 1871 to address the need to coordinate regulation of multistate insurers. The NAIC acts as a forum for the creation of model laws and regulations.

39 Life insurers themselves responded to rising interest rate risk by adopting asset liability management (ALM) tools from banking, including risk limit setting, investment strategies, consistent measures of risk, and sophisticated financial hedging instruments (Holsboer 2000).

40 The new statutory reserve requirements are typically higher than the reserves life insurers’ actuarial models suggest will be economically required to back policy liabilities. For context, insurers’ statutory reserves tend to be much higher than reserve requirements for banks under U.S. generally accepted accounting principles (GAAP).

41 Funding Agreement Backed Notes (FABN) are sometime referred to as Guaranteed Investment Contract-Backed Notes (GICBN), and were created in 1994 by Jim Belardi, former president of SunAmerica Life Insurance Company and Chief Investment Officer of AIG Retirement Services, Inc., and current Chairman & CEO of Athene Holding.

42 Captive reinsurers are onshore and offshore affiliated unauthorized reinsurers that are not licensed to sell
In a typical FABS structure shown in Figure 2, a hypothetical life insurer sells a single funding agreement (FA) to a special purpose vehicle (SPV). The SPV funds the FA by issuing smaller denomination FABS to institutional investors, who are the noteholders.\textsuperscript{43} Importantly, FABS issuance programs inherit the ratings of the sponsoring insurance company, and note holders are treated \textit{pari passu} with other insurance obligations since the FA issued to the SPV that back the FABS is an insurance liability. This provides FABS noteholders seniority over regular debt holders. The proceeds from FABS issuances are then invested in assets with higher yields than the funding cost.\textsuperscript{44}

\textsuperscript{43}FABN have coupon and maturities matching those of the underlying FA. FABN may feature different types of embedded put and call option. FABN are typically medium-term fixed income securities, but FA may also be issued to an ABCP conduit to create short-term funding agreement backed commercial papers (FABCP).

\textsuperscript{44}Life insurers earn a spread in two ways using using FABS funding: One way is to directly invest the proceeds from FABS in mortgages, other loans, and high-yield securities (corporate bonds and private label ABS). Another way is to invest the FABS proceeds in highly liquid U.S. Treasury securities and agency ABS (e.g., mortgages and student loans) that are lent against cash collateral to securities borrowers. The cash collateral is, in turn, reinvested in high-yield securities, including corporate bonds and private label ABS. The latter likely minimizes capital charges at the sponsoring insurer because the lent, highly liquid securities (i.e., the agency ABS and US Treasuries) remain on the FABS-sponsoring insurer’s balance sheet, increasing its capital relative to its risk-weighted assets.
B Proofs

Proof of Proposition 2.2 As shown in equation (3), an increase in investor $i$’s expectation of new spinoffs between her current and next election dates that could increase $q_t’$ for $t' \in (t+m, t+m+1]$ will not affect $(1-\delta_m(Q_t; N_{it}))$ significantly. However, the change in $q_t'$ could significantly affect $P(Q_{t+1}; N_{it+1})$ since:

$$\frac{\partial E_t P(Q_{t+1}; N_{it+1})}{\partial E_t q_t'} = E_t \sum_{t'=t+1}^{t'} e^{-\beta(t'+m)} \prod_{\theta=t+1}^{t'} (1 - D_{t\theta}) D_{t'} \cdot \frac{\partial(1-\delta_m(Q_t'; N_{it'}))}{\partial q_t'} + \sum_{t'=t+1}^{t'} e^{-\beta(t'+m)} \prod_{\theta=t+1}^{t'} (1 - D_{t\theta}) D_{t'} \int_{t'}^{t'+m} F'(N_{t\tau}) d\tau \cdot (1 - \delta_m(Q_t'; N_{it'}))(8)$$

which is negative if and only if $\alpha > 0$, since $F'(\cdot) > 0$.

Consider now the case of an investor $i$ who is indifferent between setting $D_{it}$ equal to 0 or 1, which from equation (4) means that $e^{-(m-1)\beta(1-\delta_m(Q_t; N_{it}))} = E_t [(1 - \delta_1(Q_t; N_{it})) \cdot P(Q_{t+1}; N_{it+1})]$. If the state of fundamentals, $N_t$, is not too high or too low, and there are enough investors with election dates between $t$ and $t+1$, then there exist such an investor. In this case, and using equation (3), an increase in expected $q_t'$ for $t' \in (t+m, t+m+1]$ would not affect $f(Q_t; N_{it})$. However, it follows from equation (8) that such a change in expectation would decrease $E_t [(1 - \delta_1(Q_t; N_{it})) \cdot P(Q_{t+1}; N_{it+1})]$ if and only if $\alpha > 0$. It follows that an increase in expected $q_t'$ for $t' \in (t+m, t+m+1]$ would cause an initially indifferent investor to withdraw and convert her XFABN to a short-dated bullet bond. This withdrawal, in turn, would add to the payment queue $Q$, which would make other investors making decision in the future more likely to withdraw.

To see how an increase in the payment queue changes investors’ likelihood to withdraw, consider again an investor indifferent between withdrawal and extending his XFABN. As before, new additions to the queue increase $q_t'$ for a $t' \in (t+m-1, t+m]$. From equation (3), the effect of
this increase on $1 - \delta_m(Q_t; N_{\iota})$ would be relatively small, since $t'$ is relatively close to $t + m$ and therefore $\int_{t'}^{t'+m} F'(N_{\tau})d\tau \cdot (1 - \delta_m(Q_t; N_{\iota}))$ cannot be too large. On the other hand, it follows from equation (8) that the effect of new additions to the payment queue on $E_t P(Q_{t+1}; N_{\iota_{t+1}})$ would be larger. To see this, note that the time between $t'$ and $t'' + m$ for $t'' \in \{t + 1, t + 2, \ldots, \bar{t}_i\}$ is longer than between $t'$ and $t + m$, which implies that the increase in $q_{t'}$ has a larger effect on the expected liquidity of the issuer, captured by $\int_{t'}^{t'' + m} F'(N_{\tau})d\tau \cdot (1 - \delta_m(Q_{t''}; N_{\iota_{t''}}))$. Thus, although an increase in $q_{t'}$ for $t' \in (t + m - 1, t + m]$ could decrease $(1 - \delta_m(Q_t; N_{\iota}))$ slightly, its effect on $E_t P(Q_{t+1}; N_{\iota_{t+1}})$ is larger and would induce an otherwise indifferent investor to withdraw.

Lastly, note that the coordination failure effect in run is present if and only if $\alpha > 0$. That is if $\alpha = 0$, the decision of other investors has no implication for $N_{\iota_{t}} = (N_{t}, r_{t}; N_{\iota_{t}})$. Thus, investor $\iota$’s value at time $t$ given by equation (2) could be simply written as $P(N_{\iota_{t}})$, which is independent from the queue of payments $Q_t$. On the other hand, there could be coordination failure among investors causing a disorderly conversion of XFABN if $\alpha > 0$.

**Proof of Corollary 2.3** We generalize Proposition 2.2 to an environment with asymmetric information, akin to the environment studied by Chari & Jagannathan (1988). Asymmetric information could imply that uninformed investors act on the informed investors’ actions if they believe these actions contain information about the fundamentals, even when $\alpha = 0$. That is, although $\alpha = 0$ means adding more claims to the queue does not affect the liquidity of the issuer, $N_{t}$, decisions of the other (possibly informed) investors to withdraw and add to the queue of claims could contain information for an uninformed investor, who does not observe the fundamentals, $r_{t}$ and $N_{t}$.

Let’s assume that there are two types of investors, informed and uninformed. Informed investors observe the variables governing the issuer’s liquidity, $(N_{t}, r_{t})$, while uninformed investors do not. Therefore, while the the Bellman equation governing the informed investors’ value function and decision, $P^{\inf}(Q_t; N_{\iota})$ and $D^{\inf}(Q_t; N_{\iota})$, remains similar to equation (2)
and equation (4), the uninformed investors do not observe the fundamentals \((N_t, r_t)\) and hence their value function and decision, \(P^{un}(Q_t; N_{it})\) and \(D^{un}(Q_t; N_{it})\), are only functions of \(N_{it} \subset N_{it}\), in addition to the publicly observable \(Q_t\). If \(\alpha = 0\), then the withdrawal decision of the agents has no bearing on the liquidity of the issuer. Hence the informed investors’ value function and decision are independent of the queue. That is, with \(\alpha = 0\), we have \(P^{inf}(Q_t; N_{it}) = P^{inf}(N_{it})\) and \(D^{inf}(Q_t; N_{it}) = D^{inf}(N_{it})\). However, unlike the environment with symmetric information, even with \(\alpha = 0\), uninformed investors’ decisions depend on \(Q_t\), which contains the informed investors’ previous actions and in turn is informative about the fundamentals, \((N_t, r_t)\).

If \(\alpha = 0\), similar to the environment with symmetric information, even uninformed investors would not change their current decision because of a change in their belief about other investors’ future actions. That is, although a change in the observed queue, \(Q_t\), contains information about the fundamentals and thus affects uninformed investors’ decisions at time \(t\), with \(\alpha = 0\), a change in belief about the other investors’ future action has no effect on the expectation about the future liquidity of the issuer, and thus affects neither informed nor uninformed investors’ decisions at time \(t\). Since neither type of investors change their current decision as a result of the belief change, the future queue remains unchanged and therefore even the uninformed investors will not change their decisions in the future. In short, their belief will not be fulfilled.

**Proof of Proposition 2.4** For ease of exposition, we assume away the effect of the coupon \(c\). Since \(D_{it}\) is an indicator function for \(e^{-(m-1)\beta(1-\delta_m(Q_t; N_{it}))}\) being larger than \(E_t\left[(1-\delta_1(Q_t; N_{it})) P(Q_{t+1}; N_{it+1})\right]\) in equilibrium, and \(D_t\) is the summary of those decisions defined by equation (5), it follows that

\[
\frac{\partial D_t}{\partial E_t\mathbf{S}_{t+1}} \approx \mu'(N_t^*) \cdot \frac{(1 - \delta_1(Q_t; N_{it})) \int_{t+m}^{t+m+1} \frac{\partial}{\partial N_{it}} E_t \left[ P(Q_{t+1}; N_{it+1}) \right] dt'}{\frac{\partial e^{-(m-1)\beta(1-\delta_m(Q_t; N_{it}))}}{\partial N_{it}}} - \frac{\delta E_t[(1-\delta_1(Q_t; N_{it})) P(Q_{t+1}; N_{it+1})]}{\delta N_{it}} |_{N_{it}=N_t^*} (9)
\]

where at \(N_{it} = N_t^*\) we have that \(e^{-(m-1)\beta(1-\delta_m(Q_t; N_{it}))} = E_t \left[(1-\delta_1(Q_t; N_{it})) P(Q_{t+1}; N_{it+1})\right].\)
Thus, $\mu'(N^*)$ is the probability density of the set of investors who are indifferent between extending and converting their XFABN.

The rest of the expression in the right hand side of equation (9) denotes how much the decision of these otherwise indifferent investors would change as a result of an increase in the expectation that other investors' would convert their XFABN in $t' \in (t, t + 1]$. Note that the denominator of the right hand side of equation (9) denotes the effect of an increase in the propensity that an investor receives an idiosyncratic shock, which is positive. The numerator of equation (9) denotes the self-fulfilling effect, as spelled out in equation (8), which is positive if and only if $\alpha > 0$. 
C  FABS database

Our FABS database was compiled from multiple sources, covering the period beginning when FABS were first introduced in the mid-1990s to early 2014. To construct our dataset on FABS issuers, we combined information from various market observers and participants on FABS conduits and their issuance. We then collected data on contractual terms, outstanding amounts, and ratings for each FABS issue to obtain a complete picture of the supply of FABS at any point in time. Finally, we added data on individual conduits and insurance companies, as well as aggregate information about the insurance sector and the broader macroeconomy.

FABS are issued under various terms to cater to different investors demand. The most common type of FABS are funding agreement-backed notes (FABN), which account for more than 97 percent of all US FABS. We first identify all individual FABN issuance programs using market reports and other information from A.M. Best, Fitch, and Moody’s. FABN conduits are used only to issue FABN with terms that match the funding agreement (FA) issued by the insurance company. This FA originator-FABN conduit structure falls somewhere between the more familiar stand-alone trust and master trust structures used for traditional asset-backed securities, such as auto loan, credit card, and mortgage ABS.\textsuperscript{45}

A substantial fraction of FABN are issued with different types of embedded put options, including Putable FABN and Extendible FABN. Extendible FABN gives investors the option to extend the maturity of their FABN (usually once a month), and are designed to for money market funds subject to Rule 2a-7.\textsuperscript{46}

Furthermore, in the same way that there are structural similarities between FABN and ABS, funding agreement backed commercial paper (FABCP) is structurally reminiscent of ABCP. In

\textsuperscript{45}While a stand-alone trust issues a single ABS deal (with multiple classes) based on a fixed pool of receivables assigned to the SPV, the master trust allows the issuer/SPV to issue multiple securities and to alter the assigned pool of collateral. Although the FABN conduit may issue multiple securities, similar to a master trust, the terms of each security are shared with the unalterable FA backing the asset, similar to the fixed pool of collateral for a stand-alone trust.

\textsuperscript{46}Extendible FABN are fundamentally different from the more common non-insurance asset-backed extendible securities (ABES). ABES typically allow the issuer to extend the duration of the asset (Fitch 2006). Thus, these securities are structurally similar to callable notes. By contrast, XFABNs give the holder the option of extending the security, thereby making them structurally similar to putable notes.
a FABCP program, the life insurer transfers FAs from the general account or separate account to a commercial paper conduit, which then issues FABCP to investors. Much like Extendible FABN, FABCP are designed for short term investors such as money market funds. The FAs typically have a longer maturity than the associated CP, so a liquidity backstop is required in case the CP cannot be rolled over. Unlike more traditional ABCP programs for which a third party financial institution provides the liquidity backstop, the liquidity backstop for FABCP is usually the sponsoring insurance company.

We link these FABS programs to the insurance companies originating the FAs used as collateral. In total, as shown in Table 6, we find that FABS programs associated with over 130 conduits, backed by FAs from 30 life insurers in the United States. Of these, there are four FABCP conduits (two of which are currently active) operated by two insurance conglomerates using FAs from five different insurers. We then use our list of FABS conduits to search Bloomberg and gather information on every FABN issue. For each FABN, we collected Bloomberg and prospectus data on contractual terms and amount outstanding to construct a complete panel of new FABN issuances and amount outstanding at a daily frequency.

We have records of 2,040 individual FABN issues, with the first issuance recorded in 1996 and about 70 new issues recorded in the first half of 2014. FABN issuance grew rapidly during the early 2000s, peaking at over $47 billion in 2006. We also collected data on FABCP, relying on end of quarter data from Moody’s ABCP Program Review since individual security information is not available.\(^{47}\) Total FABCP outstanding was less than $3 billion until 2008, growing to just under $10 billion at the end of 2013 after MetLife entered the market in late 2007. As described in the introduction, at its peak in 2007, the total outstanding value of the FABS market collateralized with FA from US based life insurers reached almost $150 billion, or more than 80 percent of the Auto ABS market (Figure 1).

Lastly, we match our data to a wide variety of firm-level, sector-level, and broader economic

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\(^{47}\) Individual issuance data on FABCP are available from DTCC but are confidential and unavailable to us.
environment data. Since these data are usually available only at a quarterly frequency, we aggregate our data for most of the analysis in this paper. We include several data-series about the FA-sponsoring life insurers, including balance sheet and statutory filings information from SNL Financial and AM Best, CDS spreads from Markit, credit ratings from S&P, and expected default frequencies (EDF) from Moody’s KMV.
Table 6: U.S. Issuers of Funding Agreement-Backed Securities (FABS)

This table shows the number and type of conduits used by U.S. life insurers to issue FABS and their ultimate parent company. 

<table>
<thead>
<tr>
<th>Funding agreement issuer name</th>
<th>Parent company name</th>
<th>No. of FABN conduits</th>
<th>No. of FABCP conduits</th>
<th>No. of FABCP conduits</th>
</tr>
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<tbody>
<tr>
<td>AIG SunAmerica Life Insurance Company</td>
<td>AIG/SunAmerica</td>
<td>3</td>
<td>15</td>
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<tr>
<td>Monumental Life Insurance Company</td>
<td>Aegon</td>
<td>3</td>
<td>.</td>
<td></td>
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<tr>
<td>Allstate Life Insurance Company</td>
<td>Allstate</td>
<td>5</td>
<td>.</td>
<td></td>
</tr>
<tr>
<td>GE Capital Assurance Company</td>
<td>Ge Capital</td>
<td>.</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Genworth Life Insurance Company</td>
<td>Genworth</td>
<td>2</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Hartford Life Insurance Company</td>
<td>Hartford</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>ING USA Annuity and Life Insurance Company</td>
<td>Voya Financial</td>
<td>1</td>
<td>.</td>
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<tr>
<td>John Hancock Life Insurance Company</td>
<td>John Hancock</td>
<td>2</td>
<td>.</td>
<td></td>
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<tr>
<td>Massachusetts Mutual Life Insurance Company</td>
<td>MassMutual</td>
<td>2</td>
<td>.</td>
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<td>Metropolitan Life Insurance Company</td>
<td>MetLife</td>
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<td>Nationwide Life Insurance Company</td>
<td>Nationwide</td>
<td>2</td>
<td>.</td>
<td></td>
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<td>Pacific Life Insurance Company</td>
<td>Pacific Life</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Principal Life Insurance Company</td>
<td>Principal Life</td>
<td>5</td>
<td>.</td>
<td></td>
</tr>
<tr>
<td>Protective Life Insurance Company</td>
<td>Protective Life</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Prudential Insurance Company of America</td>
<td>Prudential</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Reliance Standard Life Insurance Company</td>
<td>Reliance</td>
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<td>.</td>
<td></td>
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<tr>
<td>Sun Life Assurance Company of Canada (USA)</td>
<td>Sun Life Financial</td>
<td>2</td>
<td>2</td>
<td></td>
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<tr>
<td>Teachers Insurance and Annuity Association of America</td>
<td>TIAA</td>
<td>1</td>
<td>.</td>
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<tr>
<td>Travelers Life and Annuity</td>
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<td>.</td>
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<td>Transamerica Life Insurance Company</td>
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<tr>
<td>Transamerica Occidental Life Insurance Company</td>
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<tr>
<td>Other</td>
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</tr>
<tr>
<td>Unknown</td>
<td>1</td>
<td>31</td>
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<tr>
<td>Total</td>
<td></td>
<td>51</td>
<td>132</td>
<td>4</td>
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</tbody>
</table>

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*Includes Premium Asset Trust Series and Structured Repackaged Asset Trust Series issuing structures.


*Formerly Transamerica Life Insurance Company and Transamerica Occidental Life Insurance Company.

*Unmatched series issued under Premium Asset Trust and Structured Repackaged Asset Trust structure.
D  XFABN Prospectus (first three pages)

FINAL TERMS
Final Terms No. 2011-5 dated June 7, 2011

Metropolitan Life Global Funding I
Issue of $800,000,000 Extendible Notes due 2017
secured by a Funding Agreement FA-32515S issued by

Metropolitan Life Insurance Company
under the $25,000,000,000 Global Note Issuance Program

This Final Terms should be read in conjunction with the accompanying Offering Circular dated September 8, 2010 as supplemented by (i) a first base prospectus supplement dated as of November 24, 2010 (the “First Base Prospectus Supplement”), (ii) a second base prospectus supplement dated as of April 5, 2011 (the “Second Base Prospectus Supplement”) and (iii) a third base prospectus supplement dated as of May 27, 2011 (the “Third Base Prospectus Supplement”) (as so supplemented, the “Offering Circular”) relating to the $25,000,000,000 Global Note Issuance Program of Metropolitan Life Global Funding I (the “Issuer”).

PART A — CONTRACTUAL TERMS

Terms used herein and not otherwise defined herein shall have the meanings ascribed in the Offering Circular, which constitutes a base prospectus for the purposes of the Prospectus Directive (Directive 2003/71/EC) (the “Prospectus Directive”). This document constitutes the Final Terms of the Notes described herein for the purposes of Article 5.4 of the Prospectus Directive and must be read in conjunction with the Offering Circular. Full information regarding the Issuer and the offer of the Notes is only available on the basis of the combination of these Final Terms and the Offering Circular. The Offering Circular is available for viewing in physical format during normal business hours at the registered office of the Issuer located at c/o U.S. Bank Trust National Association, 300 Delaware Avenue, 9th Floor, Wilmington, DE 19801. In addition, copies of the Offering Circular and these Final Terms will be available in physical format free of charge from the principal office of the Irish Paying Agent for Notes listed on the Irish Stock Exchange and from the Paying Agent with respect to Notes not listed on any securities exchange. In addition, the Offering Circular is published on the website of the Central Bank of Ireland at www.centralbank.ie.

1. (i) Issuer: Metropolitan Life Global Funding I
(ii) Funding Agreement Provider: Metropolitan Life Insurance Company (“Metropolitan Life”)

2. Series Number: 2011-5

3. Tranche Number: 1

4. Specified Currency or Currencies: U.S. Dollar (“$” or “USD”)

5. Aggregate Principal Amount: $800,000,000

6. (i) Issue Price: 100.00% of the Aggregate Principal Amount
(ii) Net proceeds: $798,400,000 (after payment of underwriting commissions and before payment of certain expenses)
(iii) Estimated Expenses of the Issuer: $55,000

7. Specified Denominations: $100,000 and integral multiples of $1,000 in excess thereof

8. (i) Issue Date: June 14, 2011
(ii) Interest Commencement Date (if different from the Issue Date): Not Applicable

Maturity Date:

— Initial Maturity Date: July 6, 2012, or, if such day is not a Business Day, the immediately preceding Business Day, except for those Extendible Notes the maturity of which is extended on the initial Election Date in accordance with the procedures described under “Extendible Notes” below.

— Extended Maturity Dates: If a holder of any Extendible Notes does not make an election to extend the maturity of all or any portion of the principal amount of such holder’s Extendible Notes during the notice period for any Election Date, the principal amount of the Extendible Notes for which such holder has failed to make such an election will become due and payable on any later date to which the maturity of such holder’s Extendible Notes has been extended as of the immediately preceding Election Date, or if such later date is not a Business Day, the immediately preceding Business Day.

— Final Maturity Date: July 6, 2017, or, if such day is not a Business Day, the immediately preceding Business Day.

9. Election Dates: The 6th calendar day of each month, from July 6, 2011, through, and including, June 6, 2016, whether or not any such day is a Business Day.

10. Closing Date: June 14, 2011

11. Interest Basis: Floating Rate

12. Redemption/Payment Basis: Redemption at par

13. Change of Interest or Redemption/Payment Basis: Not Applicable

14. Put/Call Options: Not Applicable

15. Place(s) of Payment of Principal and Interest: So long as the Notes are represented by one or more Global Certificates, through the facilities of The Depository Trust Company (“DTC”) or Euroclear System (“Euroclear”) and Clearstream Luxembourg, sociéte anonyme (“Clearstream”)

16. Status of the Notes: Secured Limited Recourse Notes

17. Method of distribution: Syndicated

Provisions Relating to Interest (If Any) Payable

18. Fixed Rate Notes Provisions: Not Applicable

19. Floating Rate Note Provisions: Applicable
Interest Accrual Period(s)/Interest Payment Dates:
Interest Accrual Periods will be successive periods beginning on, and including, an Interest Payment Date and ending on, but excluding, the next succeeding Interest Payment Date; provided, that the first Interest Accrual Period will commence on, and include, June 14, 2011, and the final Interest Accrual Period of any Extendible Notes will end on, but exclude, the Maturity Date of such Extendible Notes.

Interest Payment Dates will be the 6th day of each January, April, July and October beginning on October 6, 2011; subject to adjustment in accordance with the Modified Following Business Day Convention, provided that the final Interest Payment Date for any Extendible Notes will be the Maturity Date of such Extendible Notes and interest for the final Interest Accrual Period will accrue from, and including, the Interest Payment Date immediately preceding such Maturity Date to, but excluding, such Maturity Date.

Business Day Convention:
Modified Following Business Day Convention, except as otherwise specified herein.

Interest Rate Determination:
Condition 7.03 will be applicable

— Base Rate:
USD 3-Month LIBOR, which means that, for purposes of Condition 7.03(i), on the Interest Determination Date for an Interest Accrual Period, the Calculation Agent will determine the offered rate for deposits in USD for the Specified Duration which appears on the Relevant Screen Page as of the Relevant Time on such Interest Determination Date; provided that the fall back provisions and the rounding provisions of the Terms and Conditions will be applicable. The Base Rate for the first Interest Accrual Period will be interpolated between USD 3-Month LIBOR and USD 4-Month LIBOR.

— Relevant Margin(s):
Plus 0.125% from and including the Issue Date to but excluding July 6, 2012
Plus 0.18% from and including July 6, 2012 to but excluding July 6, 2013
Plus 0.20% from and including July 6, 2013 to but excluding July 6, 2014
Plus 0.25% from and including July 6, 2014 to but excluding July 6, 2015
Plus 0.25% from and including July 6, 2015 to but excluding July 6, 2016
Plus 0.25% from and including July 6, 2016 to but excluding July 6, 2017
(if any such day is not a Business Day the new Relevant Margin will be effective in accordance with the Modified Following Business Day Convention)

— Initial Interest Rate:
The Base Rate plus 0.125%, to be determined two Banking Days in London prior to the Issue Date