Determinants of Asset-Backed Security Prices in Crisis Periods

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Agenda for Today’s Talk

• ABS prices in crisis periods
• Fitting term structures
• Results
• Conclusions
ABS Prices in Crisis Periods
Why Look at Prices in Crisis Period?

1. We need to understand the crisis we are in.
2. Feedback through prices is the reason why a fairly circumscribed set of events spiralled into a major crisis.
3. Crisis periods are times when policy interventions may be necessary so understanding how markets work is important.
4. Prices in crisis periods may provide particularly clear insights into the determinants of prices more generally.
Literature of Pricing in Crisis Time


• Mitchell, Pederson and Pulvino (2007) studies three crisis periods, documenting the behaviour of arbitrageurs and deviation of prices and suggesting no paradigm of frictionless economy.

• Joutz and Maxwell (2002) models the yields of noninvestment grade bonds taking into account influences from financial crisis and other external shocks.
Literature briefing the 2007 Subprime Crisis

Prediction from Altman (2007)

- Benign credit environment
- Confluence of record low yields and plentiful capital
- Increased liquidity from traditional and non-traditional institutions

- Low default rates, low yields and high recovery

- New paradigm or great credit bubble?
Turnbull (2008) and Fender Hordahl (2007) describe the early development of the crisis and how it has spread throughout the financial system.

Chomsisengphet and Penning-Cross (2006) discuss recent development in subprime market.

Discussion about contributors to the crisis:

- Abuses from brokers and lenders (Morgenson 2007)
- Agency Problem (Mian and Sufi 2008, Keys et al 2008)
- Decline in loan performance with securitizers aware of it (Demyanyk and Hemert 2007)
Comparisons between Two Crises

In this paper, we look at determinants of the cross-sectional variation of prices in the ABS market.

We focus on:
1. Home Equity Loan (HEL) backed ABS (especially over the last eighteen months)
2. Manufactured Housing backed ABS (especially around 2002-2003 when that sector experienced distress, a major rise in volatility and a collapse in new issue volumes)
Possible Determinants

- We hypothesize that the cross-sectional pattern of prices for a given rating category is explained by
  (i) risk premiums,
  (ii) liquidity premiums,
  (iii) divergence between the market's and the ratings agencies' assessment of the collateral quality of ABS deals.
Fitting Techniques

• To adjust for maturity, we fit term structures to a set of large cross sections of ABS prices.
• In so doing, we employ a new approach to estimating credit term structures based on fitting risk-adjusted transition matrices to bond prices (see also Harfush-Pardo, Perraudin and Wu (2008)).
• This is better at fitting ordered term structures such as yields on similarly-rated defaultable debt than widely-used approaches for modelling government bond term structures, such as spline fits or Nelson-Siegel techniques.
Fit Error Regressions

- Having estimated term structures for ABS tranches, we regress the residuals from the credit spread fits to see how, controlling for maturity, individual ABS securities of a particular rating category deviate from the market's average pricing for that category.

- The regressors we employ are designed to differentiate between different possible influences on pricing, in particular: risk premiums, liquidity premiums, differences between the market and the ratings-agency evaluations of deals.
Fitting Term Structures
Details of Spread Fits

• To simplify the exposition, we explain the approach initially for a general defaultable, fixed-rate bond.

• Consider a set of bonds with ratings from the set \{1,2,...,R\} and prices \(B_i\) \(i=1,2,...,N\).

\[B_i = \sum_{j=1}^{J_i} c_{i,j} \exp[-(r \tau_{i,j} + S(r) \tau_{i,j})\tau_{i,j}]\]

• where \(c_{i,j}\) for \(j=1,2,...,J_i\) are the cash flows of bond \(i\) and the \(\tau_{i,j}\) are the cash flows dates.
Suppose that the $\tau$ dates are discretized so that the $\tau_{i,j}$ are all integers and that ratings evolve accordingly to a Markov chain with transition matrix $M$:

$$M = \begin{bmatrix}
\theta_{1,1} & \theta_{1,2} & \cdots & \theta_{1,R} & \theta_{1,D} \\
\theta_{2,1} & \theta_{2,2} & \cdots & \theta_{2,R} & \theta_{2,D} \\
\vdots & \vdots & \ddots & \vdots & \vdots \\
\theta_{R,1} & \theta_{R,2} & \cdots & \theta_{R,R} & \theta_{R,D} \\
0 & 0 & \cdots & 0 & 1
\end{bmatrix}$$

where $\theta_{i,j}$ denotes the probability of a bond moving from rating $i$ to rating $j$ in one year, for $j,i=\{1,2,\ldots,R\}$.
Survival Probabilities

- The last column and row of the transition matrix $M$ represent the probability of defaulting and it is denoted by $\theta_{i,D}$ for $i=\{1,2,...,R\}$.
- The default probabilities at horizons 1,2,...,30 years are the right hand column of powers of $M$.
- Let $\theta^{(j)}_{i,D}$ be the right hand column of the $j$th power of $M$, for $j=\{1,2,...,30\}$ and for $i = \{ 1,2,...R \}$.
- The survival probability of a bond at time $j$ conditional on rating $i$ at time zero, denoted by $P^{(j)}_i$, is:

$$S_{1^{+m'}} \atop 4^¥ \overset{+m'}{\leftarrow G}$$
Pricing Bonds

Given a time homogenous transition matrix $M$, we can price a bond $i$ as

$$\tilde{B}_i = \sum_{j=1}^{J_i} c_{i,j} \exp[-r_{jj}][\gamma + P(j)_{i} (1 - \gamma)]$$

where $\gamma$ is the expected recovery rate and it is constant across all rating categories; and $r_{jj}$ is Treasury zero-coupon interest rate for a bond with maturity $j$. 
Parameterise $M$ Appropriately

\[
M(\tilde{\theta}) = \begin{bmatrix}
1 - \Phi(\tilde{\theta}_{1,2}) - \Phi_1 \\
\Phi(\tilde{\theta}_{2,1}) \\
\vdots \\
0
\end{bmatrix}
\begin{bmatrix}
\Phi(\tilde{\theta}_{1,2}) \\
1 - \Phi(\tilde{\theta}_{2,1}) - \Phi(\tilde{\theta}_{2,3}) - \Phi_2 \\
\vdots \\
0
\end{bmatrix}
\begin{bmatrix}
0 \\
\Phi(\tilde{\theta}_{2,3}) \\
\vdots \\
0
\end{bmatrix}
\begin{bmatrix}
\Phi_1 \\
\Phi_2 \\
\vdots \\
\Phi_R
\end{bmatrix}
\begin{bmatrix}
\Phi(\tilde{\theta}_{1,D}) \\
\Phi(\tilde{\theta}_{1,D}) + \Phi(\tilde{\theta}_{2,D}) \\
\vdots \\
\sum_{i=1}^R \Phi(\tilde{\theta}_{i,D})
\end{bmatrix}
\]

where,

\[
\begin{bmatrix}
\Phi_1 \\
\Phi_2 \\
\vdots \\
\Phi_R
\end{bmatrix}
= \begin{bmatrix}
\Phi(\tilde{\theta}_{1,D}) \\
\Phi(\tilde{\theta}_{1,D}) + \Phi(\tilde{\theta}_{2,D}) \\
\vdots \\
\sum_{i=1}^R \Phi(\tilde{\theta}_{i,D})
\end{bmatrix}
\]
Like Fitting a Pricing Model

• This is like parameterizing a ratings-based credit derivative pricing model such as those of Jarrow, Lando, Turnbull (1997), Kijima, Komoribayashi (1998) and Lamb, Harfush-Pardo, Perraudin (2007).

• These models assume that time-varying (rather than time-homogeneous, as in our case) ratings transition matrices are fitted to market price data and then use the inferred risk-adjusted processes to price credit derivatives.

• In the context of this paper, we prefer to think of our approach as an interpolation technique for ordered credit spreads rather than as an implementation of a model.
Home Equity and Manufactured Housing ABS

- The difference between mortgage-backed ABS and conventional coupon bonds is that cash flows in each period for the former comprise not just interest but also principal repayment and principal pre-payment.

\[
CPR = \text{constant prepayment rate} \\
WAL = \text{weighted average life} \\
c = \text{coupon rate} \\
m = \text{coupon frequency}
\]
HEL and MH Cash Flows

- The cash flows used in the pricing expressions above may then be calculated as:

\[
\begin{align*}
\text{Payment}_t &= \frac{\text{Balance}_t \cdot c / m}{1 - (1 + c / m)^{-(WAL - t)}} \\
\text{Interest}_t &= \text{Balance}_t \cdot \frac{c}{m} \\
\text{Scheduled Payment}_t &= \text{Payment}_t - \text{Interest}_t \\
\text{Amortized Balance}_t &= \text{Balance}_t - \text{Scheduled Payment}_t \\
\text{SMM} &= 1 - (1 - \text{CPR})^{1/m} \\
\text{Prepaid Principal}_t &= \text{SMM}(\text{Amortized Balance}_t) \\
\text{Balance}_1 &= 1
\end{align*}
\]
Algorithm 1

1. Calculate the cash flows for each ABS using the approach described above.

2. We start off by guessing some values for $\theta$ to obtain the monthly transition matrix $M(\theta)$.

3. We compute the default probabilities at monthly horizons 1, 2, ..., 360 by taking the right hand column of powers of $M$.

4. From the default probabilities we calculate the survival probabilities at time $j$ for a tranche rated $i$ at time zero, denoted by $P^{(j)}_{i}$.

5. We price the tranche using the survival probabilities to obtain the estimated price.
6. We minimize the mean of squared price errors.
7. Once the optimization routine converges or the maximum number of 500 iterations is exceeded, we report the vector of parameters $\theta$ such that the function is minimized.
8. Once the optimal parameters are calculated, we compute model prices for each rating category and for each time to maturity (from 1 to 30 years).
9. The spread of an ABS tranche with rating $r$ and time to maturity $\tau_i$ is calculated:

$$V_{1}^{+u} @ \ Y \ \cap \ j + \tau . s + 4 \ Y \ \tau , , \frac{4}{1}$$
Data

• We study components of the Merrill Lynch US Fixed Rate Asset Backed Securities Index (R0A0) made up of US-dollar, investment-grade, fixed-rate ABS publicly issued in the US domestic market.

• Qualifying securities must have an investment grade rating (based on an average of Moody's, S&P and Fitch).

• In addition, qualifying securities must have at least one year remaining term to final stated maturity, an original deal size of at least $250m, a current outstanding deal size or at least $25m.
Number of Deals

• Merrill Lynch classifies the ABS in the index into six categories according to the security's collateral.
• We only consider tranches backed by Home Equity Loans (HEL) and Manufactured Housing Loans (MH).
• In total, the index data yields 133,213 bond-months. Of these, 58,560 are HEL and 20,197 are MH observations.
• In fitting the term structure, we drop BBB-rated tranches and filter out AAA, AA and A-grade ABS tranches with: market price less than $10, weighted average life less than 3 months, longer than 30 years or having a missing value.
• The number of tranche-month observations we use to fit the term structures is 51,395 for HEL ABS and 16,798 for MH ABS.
Results
HEL ABS Spreads

3-year maturity spreads

5-year maturity spreads
Spread Term Structures

Average Spread from Feb 2007 to Jan 2008

Average Spreads from Feb 2006 to Jan 2007
Fits Errors of MH ABS
AAA MH ABS

AAA-Rated Manufactured Housing ABS Tranches
AA MH ABS

AA-Rated Manufactured Housing ABS Tranches

Imperial College
London
TANAKA BUSINESS SCHOOL
Fits Errors of HEL ABS

AAA-Rated Home Equity Loan ABS Tranches

AA-Rated Home Equity Loan ABS Tranches

A-Rated Home Equity Loan ABS Tranches
AAA HEL ABS

AAA-Rated Home Equity Loan ABS Tranches
AA HEL ABS

AA–Rated Home Equity Loan ABS Tranches
Explanatory Variables of Fits Error Regression

- Estimated Maturity Dummies
- Sub-rating Dummies
- Down-graded last year dummy
- Issue year dummies (for HEL ABS)
- Distressed issuer dummy (for HEL ABS)
- Sticky price
- Relative size
- Common risk factors
- Omitted category: >5 years, high sub-rating, not down-graded last year, issued prior to 2001 and no distressed issuer
### MH Regression Results 1999-2002

**Jan 1999 to Aug 2002**

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## MH Regression Results 2002-2004

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## HEL Regression Results 1999-2007

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### HEL Regression Results 2007-2008

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Liquidity Effects Month-by-Month

Panel B: Coefficients of Sticky Price and Relative Size in AA Regression

Panel C: Coefficients of Sticky Price and Relative Size in A Regression

Panel D: 3-Month USD LIBOR over Treasury

Imperial College
London
TANAKA BUSINESS SCHOOL
Issue Year Effects Month-by-Month

Panel B: Coefficients of Issue Year in AA Regression

Panel C: Coefficients of Issue Year in A Regression
Conclusions
Conclusions

• Liquidity proxies generally have the right sign and significant statistics for HEL. But the consistency is not satisfactory.
• Year of origination effects have predicted effects but significant only for 2005, 2006 and for 2007-8 in HEL crisis period.
• Fama-French betas not significant, inconsistent signs
• Distressed issuer, sub-rating right signs
• Down-graded last year has negative sign (could suggest ratings momentum effect)
Broader Conclusions

• Here we perform elaborate matrix pricing analysis, valuing ABS according to assumptions on prepayments, maturity etc. and then see how characteristics explain pricing errors.

• This is very different from the bottom up pricing that many people have in mind right now when they advocate looking at collateral and waterfalls of ABS to assess value.

• In crises price changes only partly reflect reassessments of cash flows. Liquidity and risk premiums are also driving values.

• One must still consider cash flows if one is holding for a long period (e.g., to maturity!) and wishes to compare quality/risk.

• So there is role for both bottom up and top down pricing exercises.