

VALIDATING THE PUBLIC EDF™ MODEL PERFORMANCE DURING THE CREDIT CRISIS

MODELINGMETHODOLOGY

ABSTRACT

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In this paper, we validate the performance of the Moody's KMV EDF™ (Expected Default Frequency) model during the recent credit crisis. We analyze the model performance during the past two years, and compare this performance to the model's longer history (1996–2006). We focus on the model's ability to differentiate between good and bad firms, the timeliness of its default prediction, and accuracy of levels for two primary samples: North American non-financial firms and global financial firms. The current credit crisis has elevated default rates in both samples. Defaults during the current crisis are somewhat unique because added complexities involving government bailouts created, in effect, ambiguous defaults. We measure performance with predictive power, early warning, and level validation. We also compare the performance of EDF credit measures with agency ratings and credit default swap (CDS) spreads.

Overall, the EDF model's predictive power is as good as or better than in the previous ten years, and is comparable with CDS spreads on their respective samples. The model provides an early warning signal a few years before default occurs; EDF levels were conservative (higher than subsequently realized default rate) before the crisis compared with later-realized default rates, and levels were statistically consistent with later-realized default rates.

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1 OVERVIEW

In this paper, we present the results of a study validating the performance of Moody's KMV EDFTM (Expected Default Frequency) credit measures during the recent credit crisis. In this study, we analyze the EDF model performance during the past two years, and compare this performance to the model's longer history. We focus on the timeliness of the model's default prediction, its ability to differentiate between good and bad firms, and on accuracy of levels for two primary samples: North American non-financial firms and global financial firms.

Our previous EDF model validation study covered the period from 1996 through 2006.¹ In this study, we extend our review of the model's performance through 2008, with particular emphasis on performance during 2007 and 2008, a period which saw the most severe global economic downturn in 75 years. Credit analysis becomes more difficult in high default rate periods, but the severity of this credit crisis makes default prediction particularly challenging. Actions by governments in the United States and Western Europe to rescue failing financial institutions (i.e., bailouts) have resulted in several, high-profile credit events which do not typically correspond to default events, but are still important to creditors.² Consequently, we test financial companies on the default sample that includes government bailouts, and on the sample that excludes bailouts.

We follow our existing model performance testing methodology.³ We also measure performance with predictive power, early warning, and level validation. In addition, we compare the performance of EDF credit measures with agency ratings and with the credit default swap (CDS) market, which provides alternative credit risk measures.

Overall, we find the EDF model's predictive power is comparable to or better than it was in the previous ten years, better than agency ratings, and comparable with CDS spreads on their respective samples. The model provides an early warning signal a few years before default occurs; EDF levels were conservative (i.e., not too low) before the crisis compared with later-realized default rates, and levels were statistically consistent with subsequently realized default rates.

This paper is organized in the following way:

- Section 2 presents the results for the EDF model's predictive power, and compares EDF credit measures with CDS spreads.
- Section 3 discusses EDF credit measures as early warning signals for default.
- Section 4 shows the level validation results.
- Section 5 provides concluding remarks.

2 THE PREDICTIVE POWER OF EDF CREDIT MEASURES

Default prediction models should be sophisticated enough to prospectively differentiate bad (i.e., genuinely distressed) firms from good firms. In this paper, to test the power of the EDF model we use a well-known approach: the Cumulative Accuracy Profile (CAP). This approach is summarized by a measure known as the Accuracy Ratio (AR).

Typically, the higher the AR, the better the model. In extreme cases, for a totally random model that bears no information on impending defaults, $AR=0$. For a perfect model, $AR=100\%$.⁴

In this study, to assess the predictive power of the EDF credit measure, we compute Accuracy Ratios separately on the North American corporate (non-financial) sector and the global financial sector. For each sector, we compare Accuracy

¹ For further details, see Dwyer and Korablev (2007), "Power and Level Validation of Moody's KMV EDFTM Credit Measures in North America, Europe, and Asia."

² To our knowledge, companies involved with government bailouts fulfilled all of their contractual obligations. Nevertheless, it seems unlikely that they would have been able to meet these obligations without the bailout loan.

³ For further details, see Bohn, Arora, and Korablev (2005), and Dwyer and Korablev (2007).

⁴ A detailed discussion about Accuracy Profiles, as well as a related approach (Receiver Operating Characteristic (ROC)) can be found in Keenan and Sobehart (2000), and Dwyer and Korablev (2007).

Ratios between a sample encompassing 1996–2006, and a sample covering only the current credit crisis (2007-2008). We also compare the EDF model against alternative risk measures, including agency ratings and CDS spreads. For the financial sector, we compare cases including government bailouts with excluded cases.

Our findings show that the predictive power of the EDF credit measure during the recent credit crisis is comparable to historical performance, if not better. During the current credit crisis, the EDF credit measure outperforms agency ratings. For firms with a CDS spread, which is a much smaller sample, the EDF credit measure performs nearly as well as CDS spreads. Looking at the financial sector alone, all risk measures perform better when excluding bailouts.

In all tests, we use defaults included in the Moody’s KMV default database, collected and updated daily from numerous printed and online sources worldwide.⁵ As a result, Moody’s KMV employs the most extensive public company default database available. Nevertheless, small public companies often disappear without news or record before they default, or they do not publicly disclose missed payments. To reduce the problem of hidden defaults, we restrict the sample to firms with more than \$30 million in annual sales.⁶

2.1 North American Non-financial Companies

North American Corporate Firms

In this section, we calculate one-year horizon Accuracy Ratios using an overlapping cohort methodology. At the start of a cohort, we form a portfolio of all firms for the given universe, tally the defaults and non-defaults over the next 12 months, and calculate the AR for the period. When the time period rolls to the next month, we repeat the calculation for the next 12 months for firms in that cohort, and so on.

The majority of the North American corporate sector consists of U.S. firms. However, we also collect data on firms outside the U.S., including Canada, Bermuda, the Cayman Islands, the Bahamas, Panama, the Virgin Islands, and the Netherlands Antilles. During the 11-year period between 1996 and 2006, there were 1,206 unique default events; in 2007 and 2008, there were 81 defaults. Table 1 shows the countries and the number of firm-months in each country that constituted the North American module in Moody’s KMV Credit Monitor[®] and Moody’s KMV CreditEdge[®] from January 2007 through December 2008. As the table shows, outside the U.S., Canada has the most number of firm-month observations in the sample, followed by Bermuda and the Cayman Islands.

TABLE 1 Countries in the North American Database: 2007–2008

Country	Number of Observations (firm-month)
USA	112,881
Canada	28,219
Bermuda	682
Cayman Islands	240
Netherlands Antilles	63
Virgin Island	121
Bahamas	101
Panama	51

To track the solvency of each EDF observation for 12 months, for the 1996–2006 test, we use EDF credit measures between January 1996 and December 2005, and default events between January 1996 and December 2006. Similarly,

⁵We utilize government filings, government agency sources, company announcements, news services, specialized default news sources, as well as sources within financial institutions to ensure, to the greatest extent possible, that we account for all defaults.

⁶Size is measured by total annual sales for non-financial firms. Where the firm’s total sales number was not available, we used the book assets value. We used book assets for financial firms. This number was further adjusted for inflation-effect across years by adjusting the numbers to a common denomination by using a “deflation adjustor,” calculated internally by MKMV.

for the 2007–2008 test, we use EDF credit measures between January 2007 and December 2007, and default events between January 2007 and December 2008.

In Figure 1, the right panel shows the EDF model performance during 2007–2008, and the left panel presents historical results (1996–2006). During the past two years, the EDF credit measure AR is 88.1%, higher than the previous ten years’ ratio, 81.4%. Although problems may arise when comparing accuracy ratios from two different data samples, the relatively large difference in power suggests that the EDF model performed as well as or better than in the past. This result is more significant given the apparent lack of risk differentiation in the market during 2007–2008, when credit spreads and volatility reached unprecedented levels.

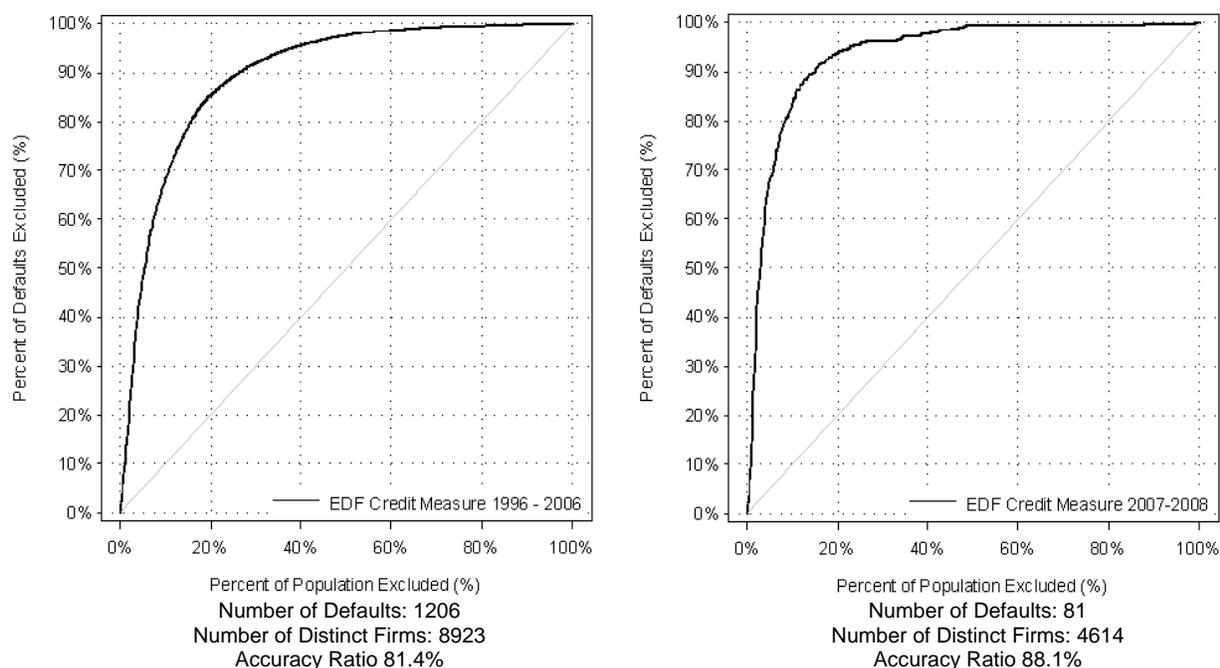


FIGURE 1 Cumulative Accuracy Profile (CAP) Curves Comparing MKMV EDF Credit Measure Historical Performance: 2007–2008

Rated Firms

In this section we focus on the subset of firms with both EDF credit measures and Moody’s credit ratings. From January 2007 through December 2008, there were 23 rated defaults and one bailout (General Motors). See the Appendix for a complete list of defaulted firms.

Figure 2 presents our results. During 1996–2006, shown in the left panel, the powers of the EDF model and ratings were 86.6% and 75.1%, respectively, derived from 319 defaults and 1,951 unique firms. During 2007 and 2008, the Accuracy Ratios were 92.8% and 82.1%, respectively, derived from 24 defaults and 998 unique firms. These results show that both Moody’s ratings and the EDF credit measure exhibit higher powers during the last two years when compared with the previous ten years. In addition, the EDF credit measure outperforms by larger margins for both sample periods.

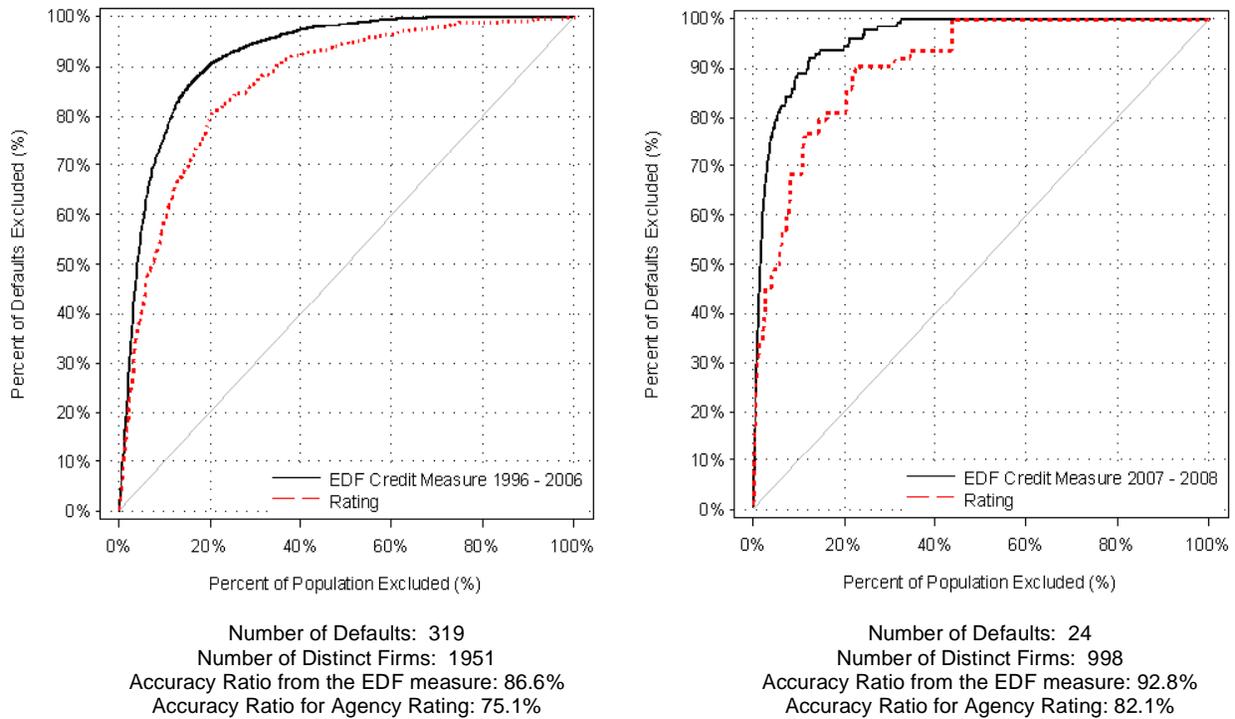


FIGURE 2 CAP curves for North American Non-financial Companies Rated by Moody's Investor Services:1996-2006 and 2007-2008

2.2 Global Financial Companies

The current financial crisis has created serious turmoil in the global financial industry, with 66 defaults occurring from January 2007 to December 2008 in the universe of approximately 6,000 public financial institutions. An important characteristic of financial firm defaults during the recent crisis is their linkage to funding liquidity. During the previous period of “cheap credit,” some financial companies relied on intraday borrowings to conduct business. When the credit crunch hit in the Fall of 2007, these banks were no longer able to borrow. Some failed altogether, while others relied on government bailouts that were initially widely regarded as liquidity support. Many of these failures were heavily influenced by adverse market conditions, and we observed a clear pattern of “correlated defaults.”

TABLE 2 Number of Financial Defaults: January 2007-December 2008

Country	Number of Unique Firms	Number of Defaults	Default Rate
United States	1465	29	2.0%
Japan	398	17	4.3%
United Kingdom	757	6	0.8%
Germany	232	3	1.3%
Iceland	8	3	37.5%
New Zealand	39	2	5.1%
Others	3058	6	0.2%
Total	5957	66	1.1%

The recent financial crisis impacted banks in many developed economies in Western Europe, North America, and Japan. Table 2 presents countries with more than one financial default, along with the number of defaults and the default rate. The default rate varies substantially, from 1.3% in Germany to 37.5% in Iceland, where three fallen banks represent a large portion of the entire Icelandic financial system. The overall default rate for financial institutions is 1.1%.

Table 3 lists rated, non-bailout financial defaults. Nine defaults (mostly bankruptcies) occurred between January 2007 and December 2008.

TABLE 3 Rated Global Financial Defaults (Non-bailouts): 2007–2008⁷

Company Name	Default Date	Country
FREMONT GENERAL CORP	3/17/2008	United States
LEHMAN BROTHERS HOLDINGS INC	9/15/2008	United States
WASHINGTON MUTUAL INC	9/27/2008	United States
GLITNIR BANKI HF	10/9/2008	Iceland
KAUPTHING BANK HF	10/9/2008	Iceland
LANDSBANKI ISLANDS HF	10/9/2008	Iceland
NEW CITY RESIDENCE INVESTMENT CORP	10/9/2008	Japan
THORNBURG MORTGAGE INC	11/15/2008	United States
DOWNEY FINANCIAL CORP	11/21/2008	United States

Table 4 presents 12 major financial bailouts by various governments.

TABLE 4 Major Financial Bailouts

Company Name	Default Date	Country
IKB DEUTSCHE INDUSTRIEBANK AG	7/31/2007	Germany
NORTHERN ROCK PLC	2/22/2008	Great Britain
FANNIE MAE	9/7/2008	United States
FEDERAL HOME LOAN MORTG CORP	9/7/2008	United States
AMERICAN INTERNATIONAL GROUP	9/16/2008	United States
FORTIS	9/28/2008	Belgium
BRADFORD & BINGLEY PLC	9/29/2008	Great Britain
HYPO REAL ESTATE HOLDING	10/6/2008	DEU
HBOS PLC	10/13/2008	Great Britain
LLOYDS TSB GROUP PLC	10/13/2008	Great Britain
ROYAL BANK OF SCOTLAND GROUP PLC	10/13/2008	Great Britain
CITIGROUP INC	11/23/2008	United States

Figure 3 presents the CAP curves for global financial institutions' EDF credit measures for 1996–2006 and 2007–2008. As seen in this figure, with the ambiguity in defaults related to government intervention during the recent crisis, the EDF model did not perform as well as it did during the previous ten years. The AR of the EDF credit measure for the recent period is 59.2%, while the AR for 1996–2006 is 79.1%.

⁷These companies were rated between January 2007 and December 2008.

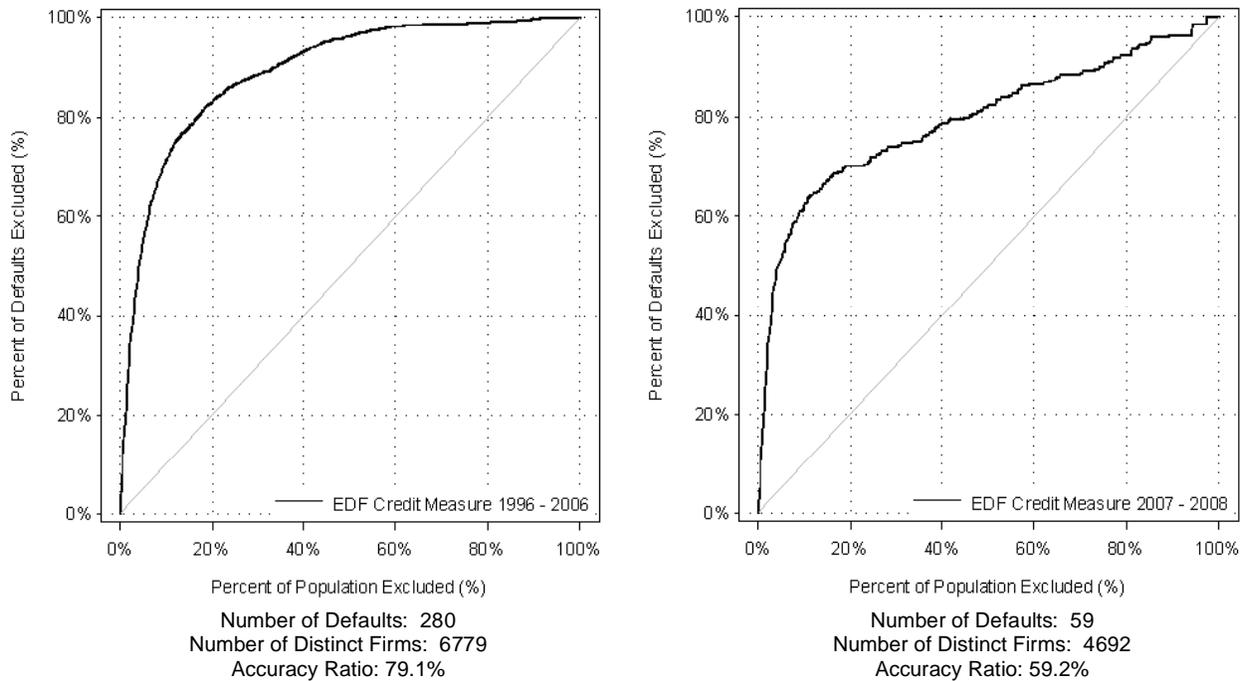


FIGURE 3 CAP Curves for Global Financial Institution EDF Credit Measures: 1996-2006 and 2007-2008

Banks bailed out by governments drove the relatively low AR during the past two years, and the equity market failed to foresee such catastrophic events a year before they happened. On the other hand, many expect the bailout funds will eventually become profitable to tax payers, implying positive intrinsic net values in these banks. Absent any government assistance, many of these banks would likely fail due to the difficulty of accessing liquidity during extreme market conditions. However, if this is the case, the bailouts are not necessarily seen as defaults, as these banks were able to avoid any missed payments due to investments made by various governments.

Because of the ambiguous nature of these bailouts, we test the model performance without treating government bailouts as defaults. As shown in Figure 4, we find that when we look at global financial companies and exclude bailouts from the default sample, the EDF credit measure AR is 78.6% during 2007 and 2008, comparable to the 79.1% AR during 1996–2006.

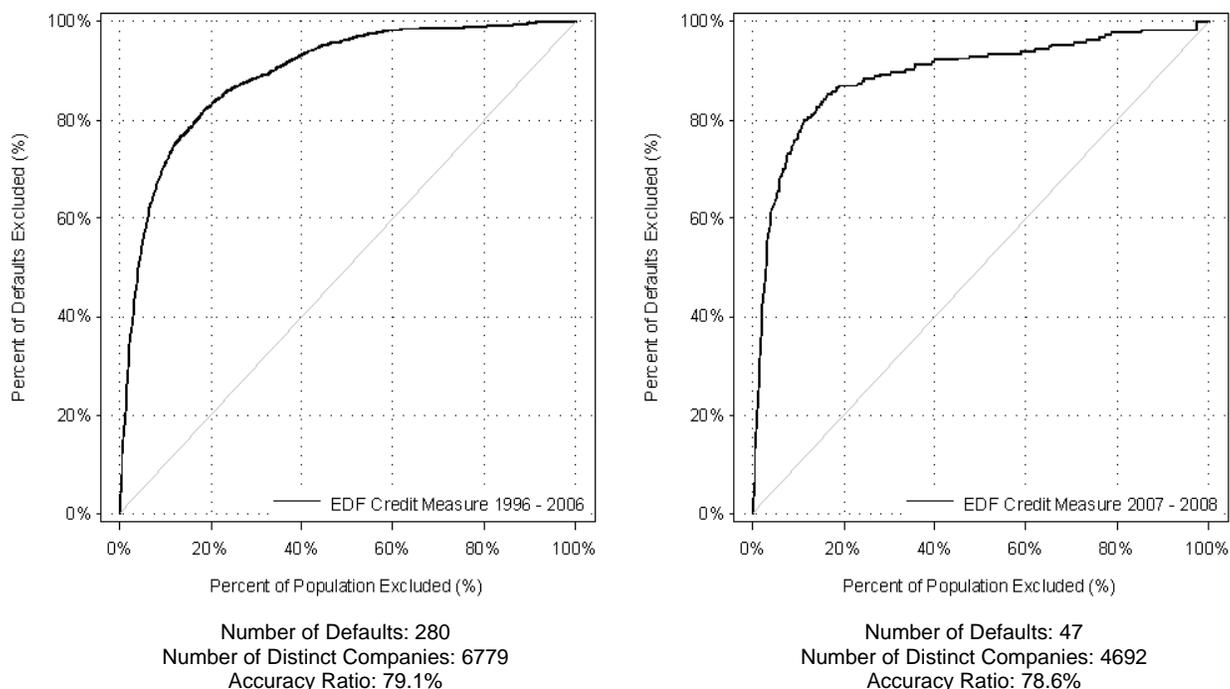


FIGURE 4 CAP Curves Comparing MKMV EDF Credit Measures for Global Financial Institutions (Bailouts Excluded): 1996-2006 and 2007-2008

We also look at the performance of EDF credit measures for rated global financial firms. During 2007 and 2008, there were 20 rated financial defaults, 11 of which were government bailouts. Given this small default sample, when we include bailouts, the power of the EDF credit measure on this sample is rather poor, and ratings are considerably worse. Excluding bailouts improves the picture, but the sample becomes too small to enable any meaningful inference.

Overall, predicting government bailouts challenges the EDF model. However, if we don't treat bailouts as defaults, the EDF model performance during the current crisis remains consistent with its track record.

2.3 EDF Credit Measure Performance Compared with CDS Spreads

In this section, we evaluate the performance of the EDF credit measure with default prediction derived from CDS spreads.

Before the credit crisis, the CDS market experienced tremendous growth. When The International Swaps and Derivatives Association (ISDA) began its market survey in mid-2001, the outstanding notional amount was \$631 billion. By the end of 2007, this amount increased to \$62.2 trillion, with an average annual increase of more than 80%, before a 38% drop to \$38.6 trillion during 2008 (Figure 5). With this huge growth, CDS spreads, as a direct observable credit measure, were increasingly perceived as a more useful tool, replacing many other traditional credit risk measures. However, a recent survey by ISDA of 500 large companies found that only 20% use credit derivatives to help manage their risk, compared with 88% using foreign exchange derivatives, and 83% using interest rate derivatives.⁸

⁸ISDA Press Release, April 23, 2009, "Over 94% of the World's Largest Companies Use Derivatives to Help Manage Their Risks, According to ISDA Survey".

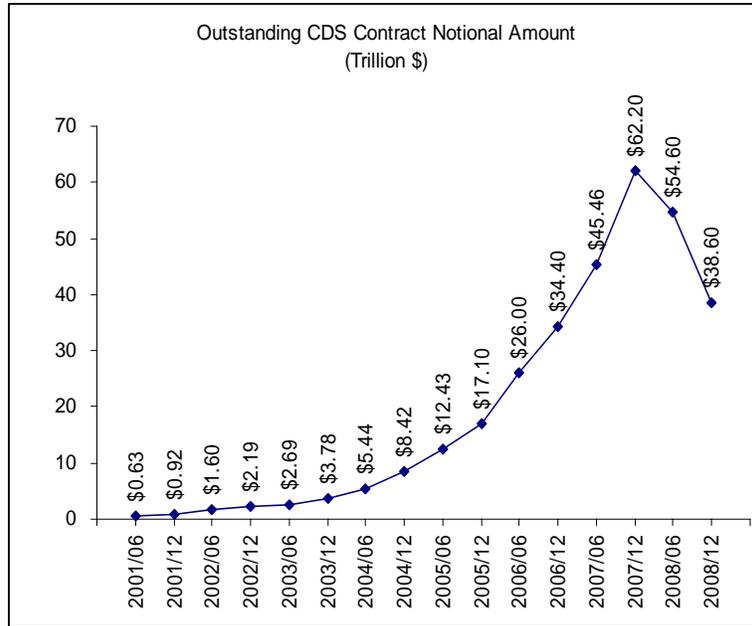


FIGURE 5 Total Notional Amount of Outstanding CDS Contracts

Source: ISDA Semi-annual Derivatives Market Surveys

Despite the CDS market's large size, because of the high concentration in reference entities (i.e., the entities on which default protections are written), coverage remains much smaller when compared to the equity market. Even at its peak, the number of public companies covered by the CDS market was well below even 10% of what is covered by MKMV EDF products, as shown in Figure 6.

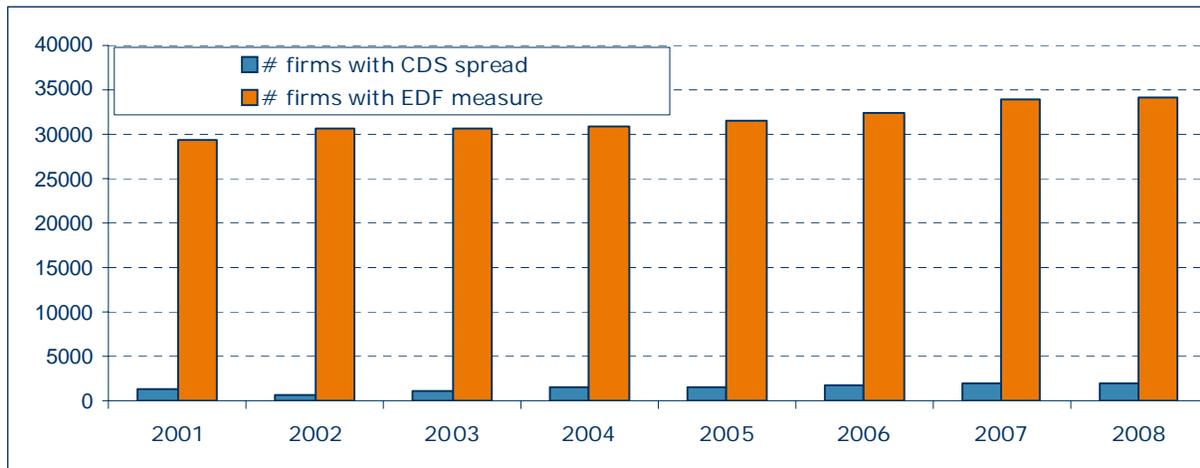


FIGURE 6 Number of Firms with EDF Credit Measures and CDS Spreads

Because most of these reference entities are investment grade firms, the default sample from the CDS population is also small, as shown in Table 5. In addition, the CDS market appears to be shrinking, as indicated by the ISDA survey and shown in Figure 5, and by transaction data from the CDS brokerage house GFI Group.

TABLE 5 Number of Firms and Defaults with CDS Spreads

	North America Corporate	Europe Corporate	Asia-Pacific Corporate	Latin America Corporate	Financials
Number of firms	740	276	481	22	385
Number of defaults	34	2	1	1	8

Nevertheless, information from the CDS market is useful. From a structural modeling viewpoint, CDS spreads are driven by three important factors: the physical default probability, the compensation required by investors to undertake such default risk, and the loss incurred if the default does occur. Leveraging its competitive advantage in measuring physical default probabilities using the EDF model, MKMV is developing a CDS-based valuation model that calibrates daily market price of risk by geographical region and rating class and computes loss given default (LGD) by region and sector. This model then uses these parameters to disentangle the three components of CDS spreads and bridge them to physical default probabilities.

We compare the power of the EDF credit measures with CDS spreads on a common sample, covering the period between January 2001 and December 2008. We select the EDF credit measures and CDS spreads through December 2007 and use defaults through December 2008. The CDS data comes from Markit Group.

For North American non-financial firms, there are 740 distinct firms and 34 default events. As Figure 7 shows, the AR of CDS spreads is 92.3%, higher than that of the EDF credit measure's 88.9%. However, we believe the fair value CDS spread, derived from firms' EDF credit measures and market- and sector-wide risk premium and LGD information, is a more relevant variable when compared with CDS spreads. This is because both fair value CDS spreads and CDS spreads include risk premium and recovery information in addition to default probabilities. As shown in Figure 7, the Accuracy Ratio of EDF-implied the fair value CDS spreads is 93.2%, slightly higher than that of CDS spreads, 92.3%.

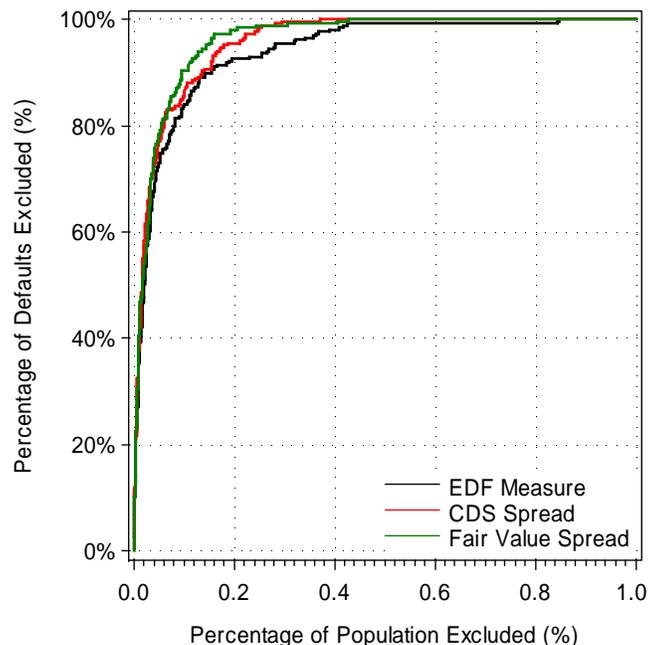


FIGURE 7 CAP Curves for North American Corporate Firms: January 2001–December 2007

We perform similar exercises on the sample of global companies, including financials. Figure 8 compares EDF credit measures, CDS spreads, and the EDF-implied fair value spreads for global firms for the period of 2001–2008. As the figure shows, there are 1,907 distinct firms and 46 defaults. Accuracy Ratios for EDF credit measures are 82.0%, 89.8% for CDS spreads, and 90.3% for fair value spreads.

In this sample and shown in Figure 8, the Accuracy Ratio of CDS spreads is higher than that of the EDF credit measure, but lower than that of the EDF-implied fair value CDS spreads.

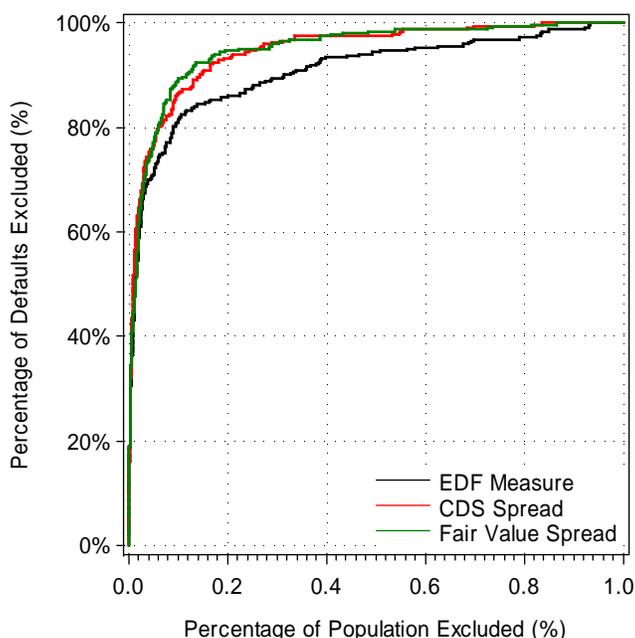


FIGURE 8 CAP Curves for Global Firms: 2001–2008

Thus, we see that both the EDF credit measures and CDS spreads are informative, and it is imprudent to assume that one measure is always better than the other. We need to understand the differences between the two measures and utilize all relevant market information to make the correct credit decision. CDS spreads are more issue-specific, and reflect the likelihood of contractual default defined by the CDS documentation. An EDF credit measure is derived from the holding company that issues the stock. Consequently, EDF credit measures are attuned to default risk anywhere in a firm's capital structure, and reflect the risk of economic default, not just contractual default. Furthermore, CDS spreads reflect more than default risk, including several other risk premia, such as LGD, liquidity, and other technical factors.

In the sample with both a CDS spread and an EDF credit measure, the CDS spread has a small advantage over the EDF. Perhaps surprisingly, the fair value spread derived from the EDF credit measure performs better than the CDS spread.⁹

When we review the power test results, we find that the predictive power of the EDF credit measure during the recent credit crisis is comparable to its historical performance, if not better. Consistent with many other studies, the EDF credit measure outperformed agency ratings. On the small CDS sample, the EDF credit measure performed comparably relative to CDS spreads. In the financial sector, all risk measures performed better when we exclude government bailouts from the default sample. The EDF credit measure is derived from an economic theory of a firm, and we should not expect it perform well when predicting events driven mainly by non-economic behaviors.

⁹In a related exercise, we compared Accuracy Ratios between EDF measures and their implied-Fair Value CDS spreads on the much larger EDF sample. We observe that the FVCDS advantage diminishes when excluding recent default episodes, which seems to indicate that the recent increase in market Sharpe Ratio (proxy for risk aversion of the market) occurred before the default wave and may have caused the closer association to defaults of CDS spreads than of EDF credit measures. The question whether market risk aversion predicts default does not have a conclusive answer, as we only one such episode appears in our data.

3 EDF CREDIT MEASURES AS EARLY WARNING SIGNALS

To test the timeliness of default prediction as an early warning signal, we create a sample of defaulted firms from January 2007 through December 2008. We compute the 25th, 50th, and 75th percentiles of the EDF credit measure for these defaulted firms dating back to December 2001. We also compute the same percentiles for the entire sample, and then plot two sets of percentiles on the same graph. If the EDF credit measure provides early warning signals, one would expect the default sample's EDF credit measure distribution to move higher and away from that of the entire population as they approach default dates. This finding is indeed what we observe.

3.1 North American Non-financial Companies

In the North American non-financial sector, 153 firms defaulted between January 2007 and December 2008.

Figure 9 presents EDF credit measure percentiles for these defaulted firms. The red lines represent 25th, 50th, and 75th percentiles of EDF credit measures for companies that defaulted between January 2007 and December 2008. The blue lines represent percentiles for the entire sector.

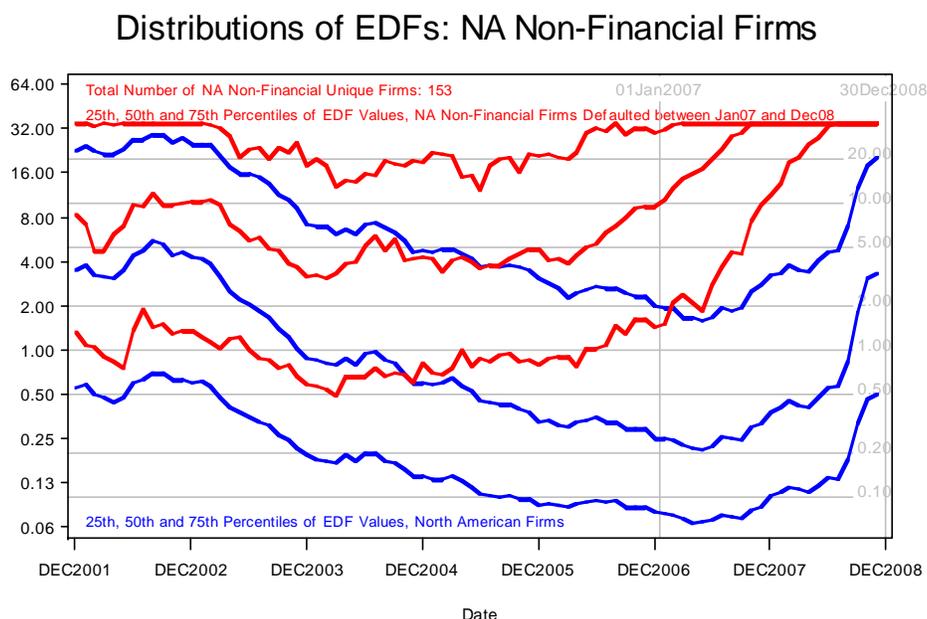


FIGURE 9 Early Warning for North American Non-financial Firms

These two distributions are distinctly different. In the beginning, defaulters were riskier than the rest of the sample. As the entire sector improved between December 2002 and February 2007, defaulters began to deteriorate in early 2004. The speed of the deterioration increased in early to mid-2006. Defaults were realized in 2007 and 2008, when the entire sector's risk began to increase.

3.2 Global Financial Companies

We also observe similar patterns in the global financial sector; EDF credit measures clearly differentiated defaulters from non-defaulters, irrespective of whether or not bailouts are treated as defaults.

Figure 10 reports the cases counting bailouts as defaults, where the EDF credit measures for the 63 firms that defaulted during 2007–2008 began increasing in mid-2006, while the entire sector was still improving. When excluding bailouts, there were 50 financial defaults during 2007–2008. Figure 11 shows that the EDF credit measure provided even earlier warning signals for these defaults, beginning around mid-2005.

Though not reported here, these findings also hold when limiting the sample to U.S. financial companies.

In Figure 10, the red lines represent 25th, 50th, and 75th percentiles of EDF credit measures for companies that defaulted between January 2007 and January 2008. The blue lines represent percentiles for the entire sector.

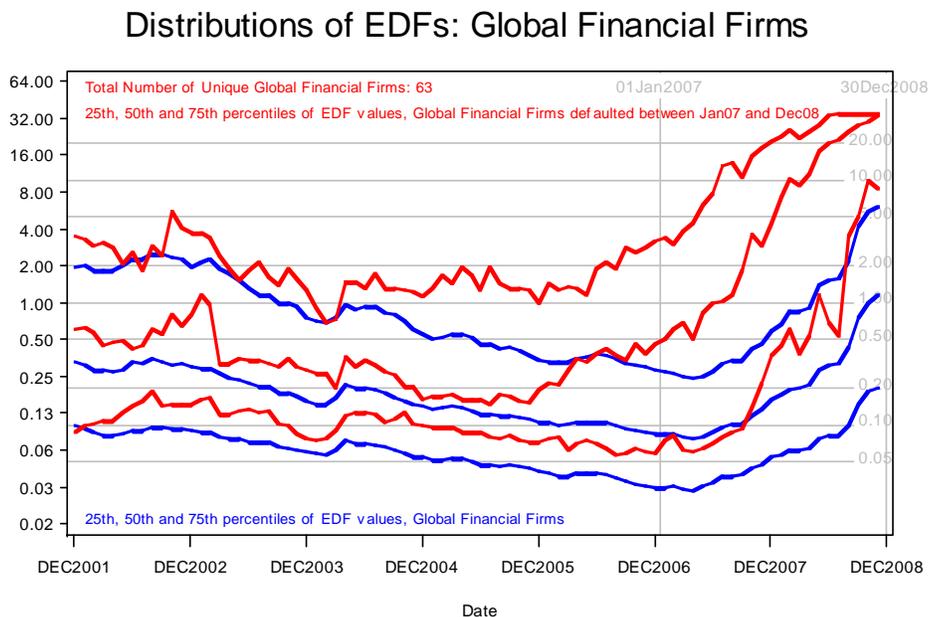


FIGURE 10 Early Warning for Global Financial Sector (bailouts included)

In Figure 11, the red lines represent 25th, 50th, and 75th percentiles of EDF credit measures for companies that defaulted between January 2007 and December 2008. The blue lines represent percentiles for the entire sector.

Distributions of EDFs: Global Financial Firms(No bailouts)

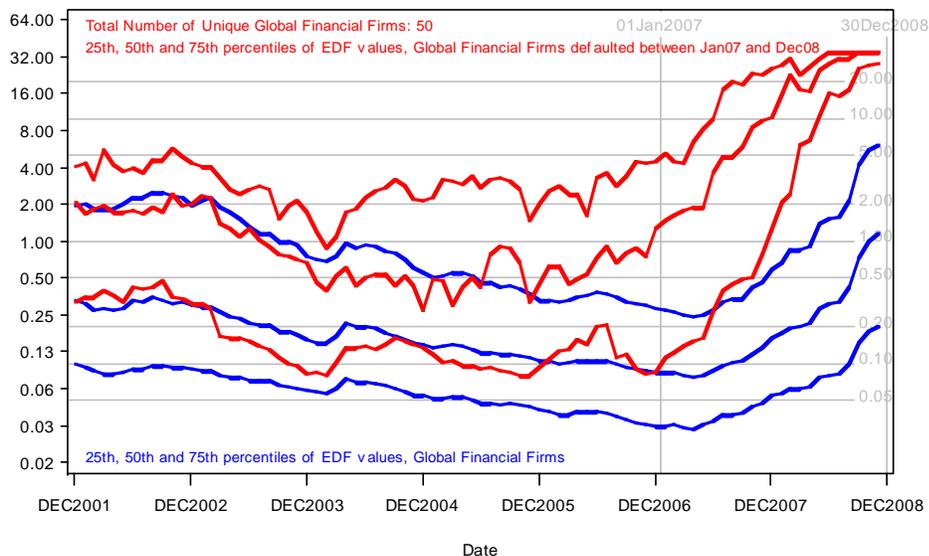


FIGURE 11 Early Warning for Global Financial Sector (bailouts excluded)

4 LEVEL VALIDATION

Level validation measures how well the EDF model's predicted default rates track realized default rates. EDF values have declined consistently since 2002, reaching their lowest levels in mid-2007. The subsequent credit crunch saw a dramatic turn in the credit environment. After observing an unprecedented increase of the EDF credit measure and elevated default rates from 2007 through 2008, we ask the following question: did the EDF model underestimate the risk during benign times? In this section, we provide evidence showing that EDF levels were not too low relative to defaults observed later.

We use the following distinct approaches to assess the EDF levels against observed default rates:

- We group firms by their EDF levels and compare realized default rates for each group. This grouping can be done at any given point in time, and can also be aggregated across time. Either way, we find that the EDF credit measure remains consistently conservative (i.e. high relative to realized defaults).
- We focus on speculative grade firms, and compare the time series of average EDF credit measures and observed default rates. We find that they generally track each other well through credit cycles.
- Even given the true default probability models, because defaults are random events and companies are correlated, realized default rates can be higher or lower than the predictions from the true model. We simulate defaults using EDF values and asset correlation, and compare the simulated default rate distribution with the observed default rate. We find that we cannot reject the hypothesis that the EDF model is the true default probability model.

4.1 Comparing EDF Levels and Realized Default Rates for EDF Groups

We begin by comparing the one-year EDF values with realized default rates for companies grouped by their EDF levels. The one-year EDF credit measure at time t is designed to describe the expected default frequency for the 12 months following time t . If the model is correct, for a group of firms with a given EDF level, the realized default rate from the group during the following 12 months should be near the average EDF level. If the model underestimates risk, the realized default rate should be higher than average EDF level.

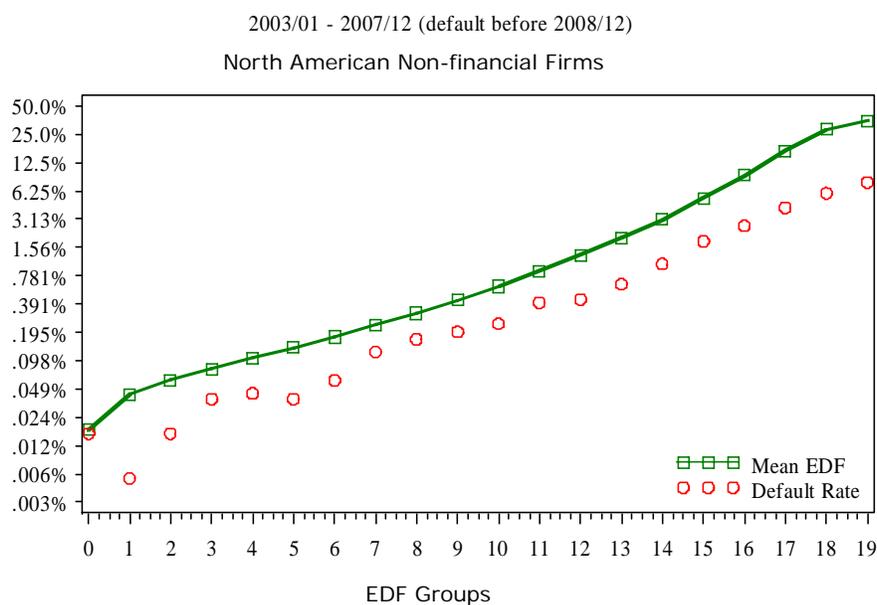


FIGURE 12 Average EDF Levels and Default Rates for EDF Groups: 2003–2008

Figure 12 provides a comparison for North American non-financial firms. The EDF credit measures are taken between January 2003 and December 2007, while defaults are taken between January 2003 and December 2008, allowing the last EDF credit measure 12 months to default. The panel data is grouped into 20 EDF groups with equal sample sizes (5%

of the sample each). Figure 12 indicates that the EDF levels are generally higher than observed default rates, as expected, due to the hidden defaults issue.

The hidden defaults issue refers to the failure of a default data set to capture all economic defaults. This failure can occur for various reasons. For example, when a debt extension occurs, it is difficult for an outsider to know if this is caused by the borrower's inability to pay, or by legitimate business need, which an outsider may not know. In other cases, when the loan amount is small, a failure to pay is simply written off by the bank, and no public announcement is released. When default data collection relies on public information to identify defaults, many default events may go missing. This is particularly true for smaller firm borrowers that draw little public attention.¹⁰

Moody's KMV default data is manually aggregated by a team of specialists utilizing multiple information sources, including, but not limited to, bankruptcy newsletters, rating agency debt monitoring publications, news media and news search engines, corporate regulatory filings, internet browsing, and targeted searching. As of December 2008, the database recorded more than 8,000 unique default events for public firms or firms that had been public before default happened. Many of these defaults were collected real-time during the past two decades. Despite being the largest public default database we are aware of, we believe a significant number of defaults occurring outside the universe of North American large non-financial firms were not captured. We calibrate the EDF model with this specific universe to circumvent the hidden default problem, and avoid underestimation of default risk.

The sample underlying Figure 12 constitutes all North American non-financial firms during 2003-2008. The observed default rates are subject to hidden defaults. This long-term picture provides a benchmark for more recent snapshots, reported in Figure 13 and Figure 14 for June 2006 (a normal period), and December 2007, shortly before defaults skyrocketed.

As seen in Figure 13, for five out of the ten EDF groups, there were no defaults between the beginning of July 2006 and the end of June 2007. Two other groups had one or two defaults, and the three riskiest groups, by EDF credit measure, had the most defaults. By historical standards, the EDF levels on June 2006 were very low (Figure 9).

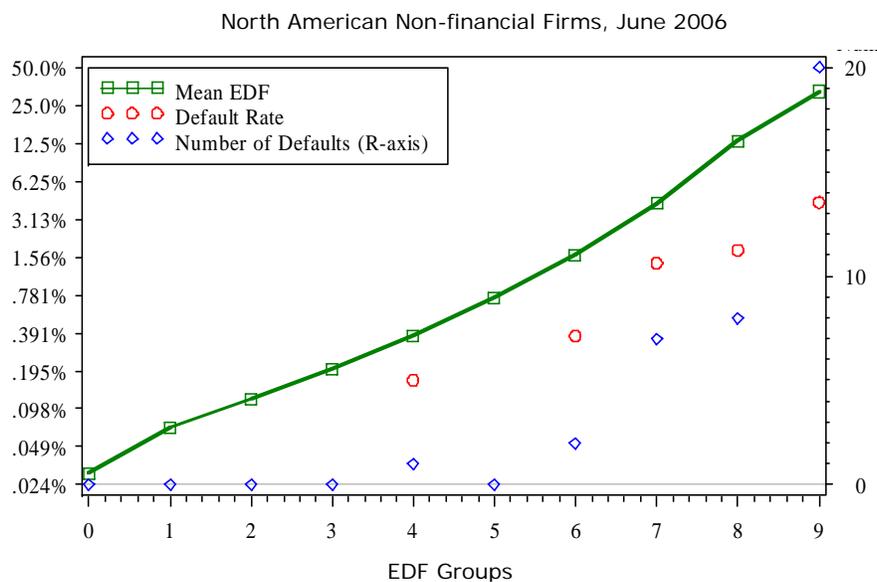


FIGURE 13 Average EDF Levels and Default Rates for EDF Groups: June 2006

¹⁰See Stein and Dwyer (2005), and Dwyer and Qu (2007), for more information about hidden defaults.

Figure 14 presents the more interesting period, December 2007. During this period, EDF levels increased from historic lows, and were followed by the most severe economic turmoil since the Great Depression. In addition, corporate defaults snowballed. Two relatively low EDF groups had no defaults, while four other relatively low EDF groups had one or two defaults. Overall, the default rates are generally much lower than average EDF values.

When the two groups with the highest EDF levels have the most defaults, the ratios between average EDF level and default rates are comparable to the long-term average, as shown in Figure 12. Two exceptional groups have default rates higher than average EDF values, but they are driven by one or two defaults caused by leveraged buyouts. It is well known that EDF credit measures are not valid when leveraged buyouts occur, because equity prices are determined by the contractual terms of the buyout transactions, rather than by business value and existing financial structure.

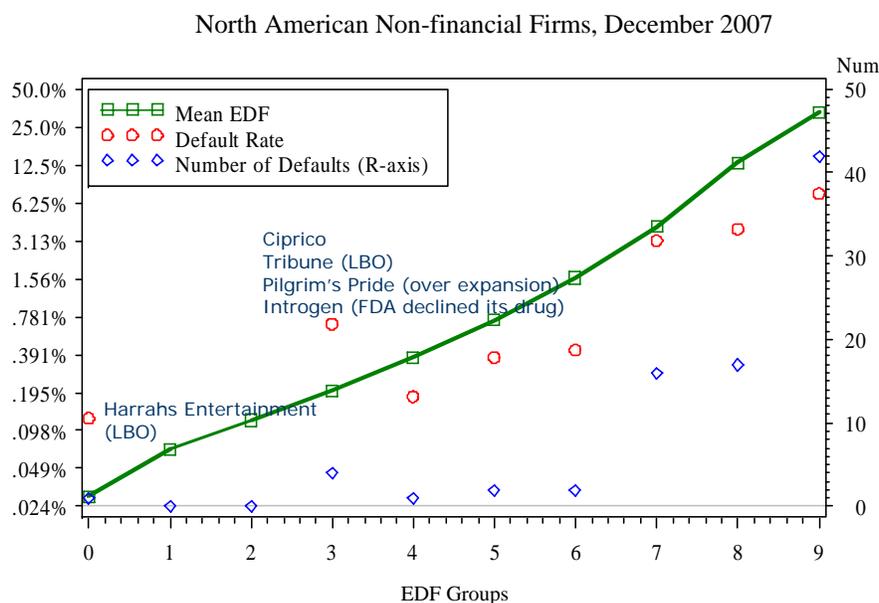


FIGURE 14 Average EDF Levels and Default Rates for EDF Groups: December 2007

For financial firms, Figure 15 provides a historical average for data during the period of 2003–2008, and is generally consistent with the corporate sector. Figure 16 shows the snapshot on December 2007, comparing average EDF values and their corresponding default rates realized during 2008. Even during the most tumultuous period and within the most turbulent sector, groups with higher EDF levels generally have higher default rates. However, out of ten EDF groups, although three groups had no defaults, five other groups experienced higher default risk than predicted by average EDF levels (two groups had one default; one group had two defaults).

During this period, government authorities were concerned about large-scale systemic risk. Systemic risk can lead to correlated defaults and further lead to default rates that are higher than the average EDF value, even if the EDF credit measures are true measures of default probabilities. Later in this document, we assess the impact of this systemic risk on EDF levels in a more rigorous setting.

2003/01 - 2007/12 (default before 2008/12)

Global Financial Firms

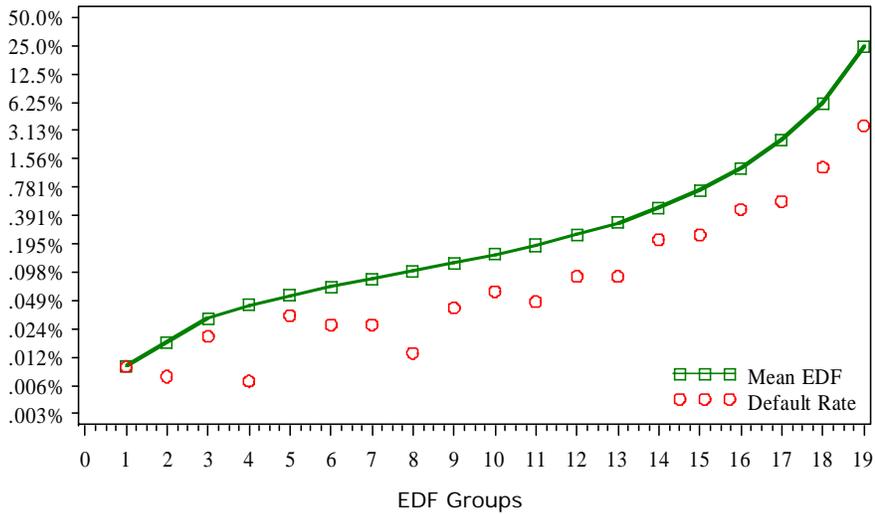


FIGURE 15 Average EDF Levels and Default Rates for EDF Groups: 2003–2008

Global Financial Companies, December 2007

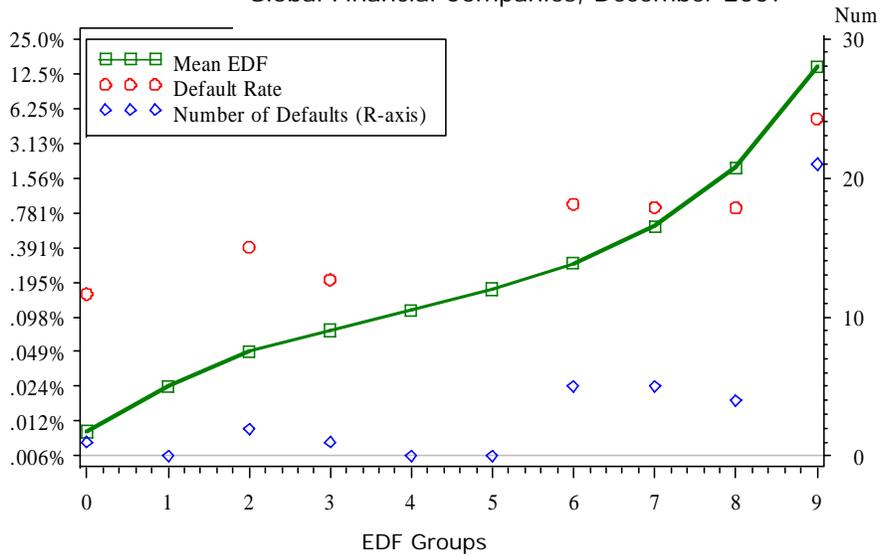


FIGURE 16 Average EDF Levels and Default Rates for EDF Groups: December 2007

4.2 Average EDF Levels and Realized Default Rates for High Yield Companies

For companies rated by rating agencies, defaults most often occur with high yield firms, and default rates for high yield companies are often used as a proxy for macro credit condition. In this section, we compare the average EDF levels for high yield companies and their realized default rates. As in the previous analysis, we measure average EDF values at the end of each month, and align them with realized default rates during the following 12 months. Note that the hidden default is not a significant issue in this sample, because firms are rated and subjected to close monitoring by the market and rating agencies.

Figure 17 provides the comparison for North American non-financial companies. At the end of October 2001 (the beginning of the sample period), the average EDF value was approximately 8%, as was the default rate observed in the following year. In late 2002, the average EDF level increased again with the stock market sell-off (the S&P 500 index bottomed in October 2002 to 800, from 1,000 in mid-2002). Levels appeared to be too pessimistic as the default rate dropped during the following 12 months, and the S&P 500 index recovered back to 1,000. Nevertheless, the default rate from October 2002 through October 2003 was still quite high by historical standards. Since then, both average EDF values and default rates experienced a long decline, until trends reverted in 2007. By the beginning of 2008, both average EDF levels and default rates increased to about 2%. At the beginning of 2009, the average EDF levels indicates default rates for high yield, non-financial companies will hit 8% by year end.

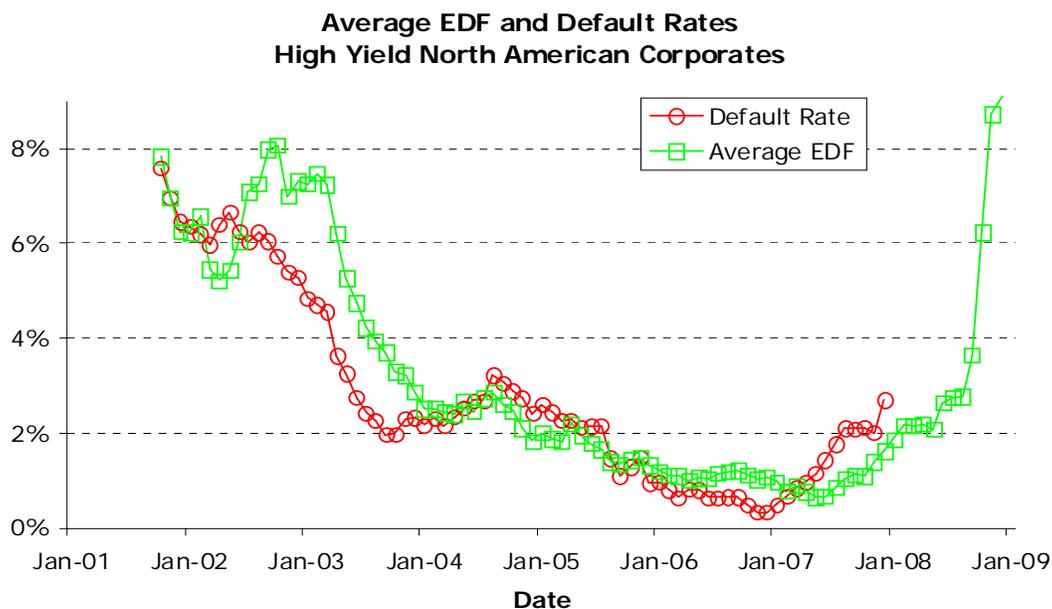


FIGURE 17 EDF Levels and Default Rates for High Yield North American Non-Financial Firms

Figure 18 presents a similar and consistent comparison for global financial companies. During the sample period, both the average EDF level and the default rate started at about the 3% level. Both dropped significantly and then began increasing quickly by the end of the sample period. Considering that they are more correlated with one another when compared with their corporate counterparties, financial firms tend to default or not default together, and the realized default rate fluctuates around the average EDF levels.

Average EDF and Default Rates High Yield Financial Companies

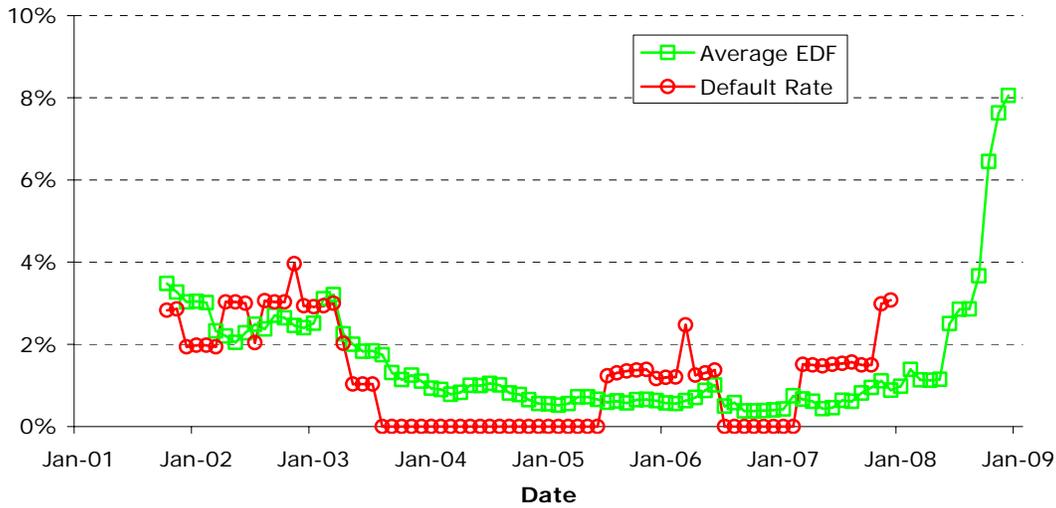


FIGURE 18 EDF Levels and Default Rates for High Yield Global Financial Firms

4.3 Validating EDF Levels with Simulated Levels

In this section, we use a structured approach to test whether we can statistically reject the hypothesis that the EDF model is a true model for default prediction.

EDF credit measures are probability measures, and, for a given portfolio of companies, the model implies a distribution of possible default rates. We test whether the observed default rate is consistent with such a default rate distribution.

We use a simple numerical example to illustrate the nature of the test. Suppose we have 100 independent companies, each with a default probability of 10%. The expected default rate is 10%, and it is possible, but not likely, to have a default rate of less than 5% (the p-value is only 5.75%).¹¹ When we actually observe a 5% default rate, we would reject, at a 10% confidence interval, the hypothesis that the default probabilities are 10%.

When companies are correlated, the implied default rate distribution is wider, in that the likelihood is higher for the realized default rate deviating from the mean prediction. For example, for two independent firms each with a 50% true default probability, the likelihood of observing no default, a negative deviation from the expectation of 50%, is only 25%. However, if these two firms are perfectly correlated, the likelihood of no default increases to 50%.

Based on the above concepts, Kurbat and Korabev (2002) developed a method that uses realized defaults for testing models of default probabilities. Specifically, they assume firm values are correlated with one common factor, and obtain a default rate distribution by simulating random realizations of a common factor and firm specific factors. In simulations, each firm's unconditional default probability is kept at the level predicted by the subject probability of default (PD) model. In this study, we use the same approach to test if the observed default rate is consistent with the default rate distribution implied by the EDF credit measures. For each year in the sample, we take EDF values calculated at the beginning of the year, use them to simulate a distribution of default rates, and compare the actual default rate during the year against the resulting distribution. We use a pair-wise asset correlation of 0.19, calibrated using long-term data from the Moody's KMV Global Correlation Model (GCorr). For each year, we run 1,000 simulations to create a distribution of 1,000 simulated default rates.

¹¹The likelihood of less than n% default is $\sum_{i=0}^n \frac{100!}{i!(100-i)!} (0.1)^i (0.9)^{100-i}$.

Figure 19 presents the results for North American non-financial firms. To avoid the hidden default issue, we limit our sample to companies with annual sales greater than \$300 million. Also, because the EDF credit measures are truncated at 35%, we exclude firms with an EDF level of 35% to avoid under-estimation of the default rate distribution. We see from the figure that for most of the past 18 years, the observed default rate is close to the median of the simulated default rate distribution. Twice, the default rate was more than 0.5% away from the simulated median; in 2003 and 2004, the rates were 0.53% and 1.20%, respectively, but both were within the intervals bounded by the 10th and 90th percentiles of the simulations.

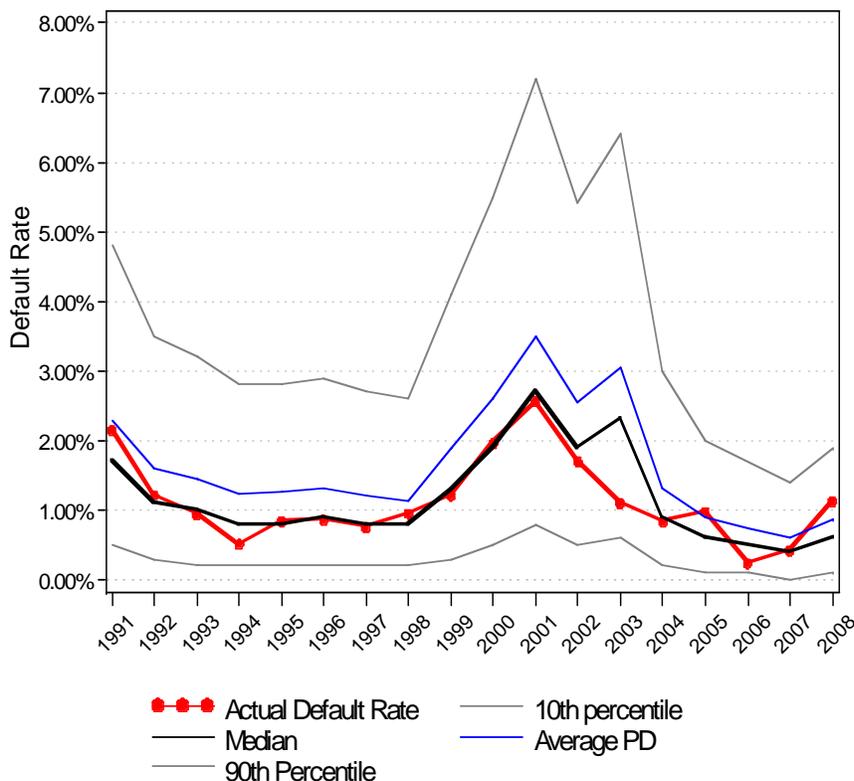


FIGURE 19 North American Non-financial Firms (EDF<35% and Book Assets >USD300 Million)

Figure 20 presents the result for global financial firms, excluding firms with book assets below \$300 million and an EDF credit measure of 35%, including all government bailouts as defaults. In this graph, we see that the observed default rates fluctuate more around the simulated medians, indicating higher underlying correlation among financial firms. It is intuitive that financial companies carry more systematic risk, because their businesses tend to be more diversified than typical industrial firms. We see this fact manifested during the current crisis, as the systemic risk in the economy brought down numerous banks together. This issue has become a major concern of U.S. and European regulators. Not surprisingly, the negative outcomes from this systemic risk led to realized default rates higher than median predictions during 2007 and 2008. Nevertheless, although we used a relatively low correlation of 0.19, the realized default rates were within the 10th and 90th percentiles of the prediction.

In this exercise, excluding government bailouts only affects realized default rates in 2007 and 2008, lowering them from 0.36% and 1.2%, to 0.33% and 0.90%. This is closer to, but still higher than, the respective median predictions for these rates.

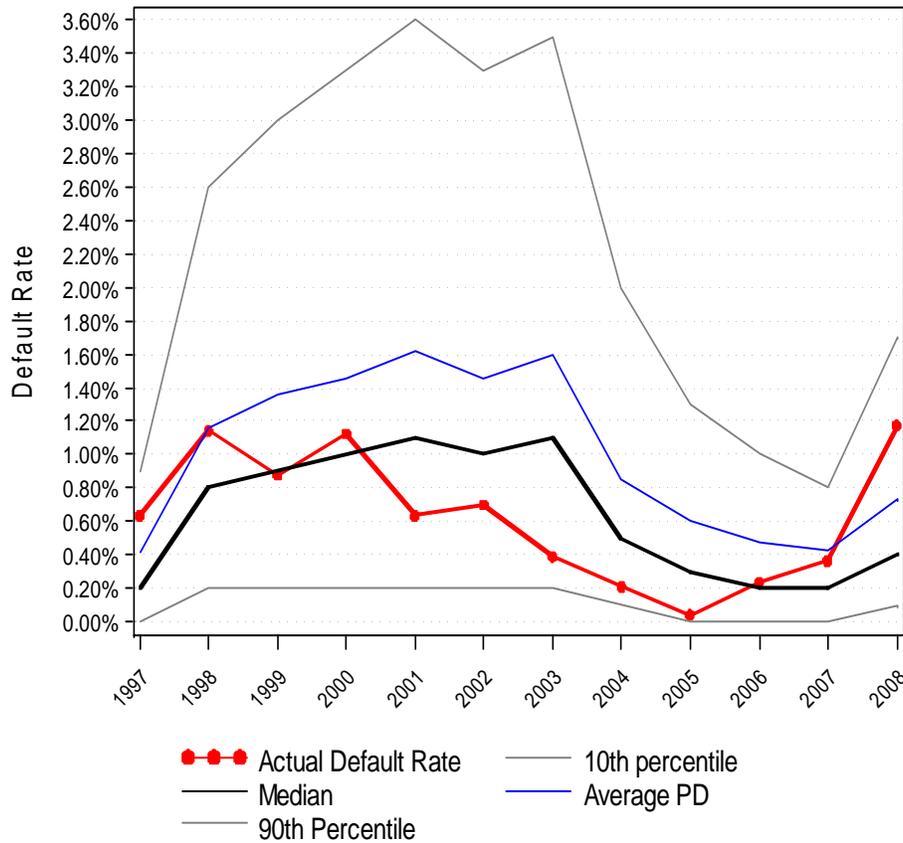


FIGURE 20 Global Financial Firms (EDF <35% and Book Assets >USD300 Million)

We can conclude from these results that the observed default rates are consistent with EDF model predictions for all years, and for both the corporate and financial sectors. It is also important to realize the role of systematic risk in default rate distribution variance.

5 CONCLUSION

In this study, we tested the public EDF model using three major performance measures: accuracy ratios in default prediction, early warning signals, and default risk levels, with attention on the most recent credit crisis.

In accuracy ratio testing, we found EDF credit measures are as powerful as they have been historically, and that they consistently outperform ratings. We questioned their performance predicting recent financial defaults when treating government bailouts as defaults. On the limited population where CDS spreads are available, we found the Accuracy Ratio of EDF credit measures are lower than that of CDS spreads. However, when considering risk premium, EDF-implied fair value spreads outperformed the CDS spreads. We believe using information from both the equity market and the credit market is preferred when managing default risk.

We also found that the EDF model provides ample early warning signals. The distribution of EDF levels for defaulters begins to emerge out of the entire population distribution a number of years before defaults occur.

We also showed that the EDF levels are consistently higher than observed default rates, due to the hidden default issue. EDF levels were not low before the crisis, except in a few pockets of the population where the EDF values were known to be invalid due to LBO events. Over the long history, for the population of speculative grade companies, realized default rates tracked the prediction of average EDF values. We believe a high correlation among financial firms led to observed

default rates that were higher or lower than average EDF values. When considering correlations, we cannot reject the hypothesis that the EDF values are true measures of default risk.

Overall, the EDF model's predictive power is as good as or better than the previous ten years, better than agency ratings, and comparable with CDS spreads on their respective samples. The model provides an early warning signal a few years before default occurs; EDF levels were conservative (i.e., not too low) before the crisis, compared with later realized default rates, and levels were statistically consistent with later realized default rates.

6 APPENDIX

Table 6 lists firms that defaulted during the period of January 2007 through December 2008.

TABLE 6 Rated Firm Defaults: January 2007–December 2008

Company Name	Default Date	Country
Bally Total Fitness Holding Corp.	4/15/2007	United States
Fedders Corp.	8/23/2007	United States
Movie Gallery Inc.	9/10/2007	United States
Pope & Talbot Inc.	10/29/2007	United States
Tousa Inc.	1/1/2008	United States
Quebecor World Inc.	1/15/2008	Canada
Atlantis Plastics Inc.	2/27/2008	United States
Interep National Radio Sales Inc.	3/30/2008	United States
Abitibibowater Inc.	4/5/2008	Canada
Abitibi Consolidated Inc.	4/5/2008	Canada
Standard Pacific Corp.	5/13/2008	United States
Primus Telecomm Group Inc.	5/22/2008	United States
Six Flags Inc.	6/16/2008	United States
Journal Register Co.	7/25/2008	United States
Ainsworth Lumber Co Ltd.	7/28/2008	Canada
Wci Communities Inc.	8/4/2008	United States
Verasun Energy Corp.	10/31/2008	United States
Pilgrim's Pride Corp.	11/3/2008	United States
Chesapeake Corp.	11/15/2008	United States
Constar International Inc.	12/1/2008	United States
Trump Entertainment resorts Inc.	12/1/2008	United States
Tribune Co.	12/8/2008	United States
General Motors Corp.	12/19/2008	United States
Level 3 Commun Inc.	12/31/2008	United States

REFERENCES

1. Arora, Navneet, Jeffery Bohn, and Irina Korablev, "Power and Level Validation of the EDF™ Credit Measure in the U.S. Market." Moody's KMV, 2005a.
2. Crosbie, Peter and Jeffrey Bohn, "Modeling Default Risk." Moody's KMV, Revised December 2003.
3. Dwyer, Douglas and Irina Korablev, "Power and Level Validation of Moody's KMV EDF™ Credit Measures in North America, Europe, and Asia." Moody's KMV, September 2007.
4. Dwyer, Douglas and Shisheng Qu, "EDF™ 8.0 Model Enhancements." Moody's KMV, January 2007.
5. Keenan, Sean and Jorge Sobehart, "A Credit Risk Catwalk." *Risk*, July 2000.
6. Kurbat, Matt and Irina Korablev, "Methodology for Testing the Level of the EDF Credit Measure." Moody's KMV, August 2002.
7. Stein, Roger and Douglas Dwyer, "Inferring the Default Rate in a Population by Comparing Two Incomplete Default Databases."} Moody's KMV, October 2005.