

Introducing the Deterioration Probability Metric (DP) – At a Glance

What is the Deterioration Probability Metric (DP)?

Ratings downgrade risk, like default risk, can have significant impacts for both risk managers and investment managers. In response to the need for improved early warning of downgrade events, we have developed and validated a transparent, quantitative model for the 1-year probability of downgrade called the Deterioration Probability (DP). The DP output ranges from 1 to 70 percentage points. The DP metric is updated daily, with coverage encompassing nearly all rated firms with publicly traded equity. The principal drivers of the model are drawn from the CreditEdge Early Warning Toolkit (EWTk), Moody's Analytics' suite of Market Implied Rating (MIR) models, and ratings outlook and history from Moody's Investors Service (MIS). A full description and validation of the DP methodology, including background on model drivers, is available in Malone, Baron, and White (2018).

Users can monitor DP through the Early Warning Toolkit template available in Moody's Add-in for Excel, and via the CreditEdge website, Data File Service (DFS) and Application Programming Interface (API).

What Differentiates the DP?

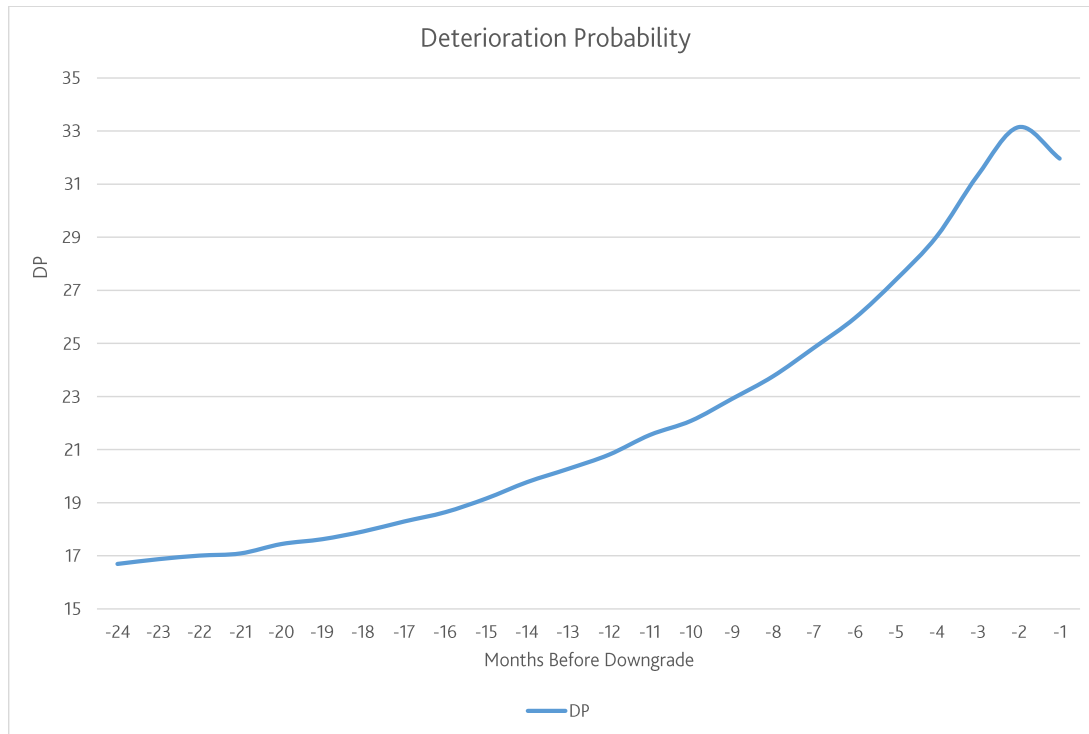
Ratings risk impacts clients through various channels. Downgrades of borrower and counterparty ratings, for example, often induce financial institutions such as banks and insurance companies to hold more required reserves and regulatory capital. Fixed income portfolio managers, on the other hand, must sell or avoid investments that do not fit with the portfolio's ratings mandate. The impact of unanticipated downgrades on the prices of bonds is also an important source of market risk in fixed income portfolios.

The DP helps risk managers and investment managers make capital allocation decisions effectively while potentially reducing unexpected costs due to downgrades. Highlights of the DP metric include the following:

- » Computed using a purely quantitative, transparent model
- » High accuracy ratios for both corporate and financial firms
- » Extensive documentation and model validation
- » Enhanced early warning capabilities from combining the DP to monitor downgrade risk with the EDF to monitor default risk
- » DPs produced daily for 44,000+ public firms
- » Historical DP data available

As a preview of the DP's capabilities, Figure 1 below plots the average DP during the 24 months prior to downgrades. As illustrated, the DP metric doubles on average during the two years prior to downgrade events, and peaks two months before downgrade occurs, thus giving risk and investment managers time to take action.

Figure 1 Run-up to Downgrade (24 months)



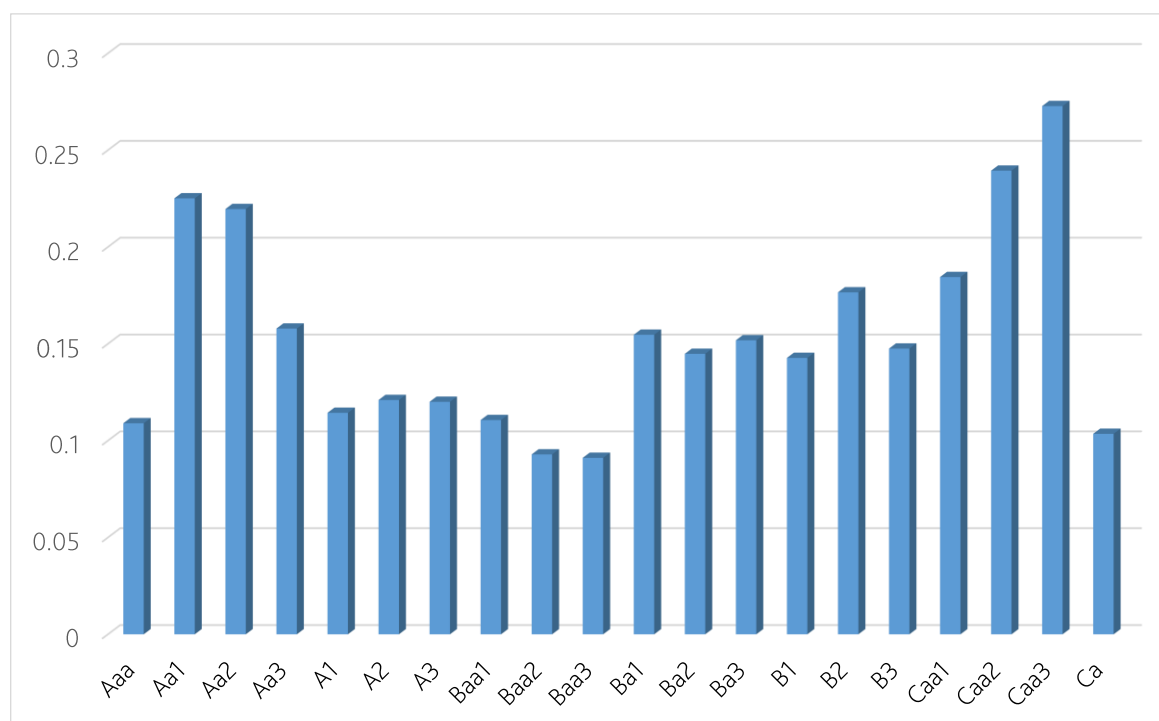
How Does the DP Model Work?

The principal drivers of the DP model are drawn from the CreditEdge Early Warning Toolkit parameters, Moody's Analytics' suite of Market Implied Rating (MIR) models and ratings outlook and history from Moody's Investors Service (MIS). Firms are then separated by status as a financial or corporate entity, as well as by initial issuer rating, to produce forward-looking probabilities of downgrade in the next 12 months.

As initial evidence to support the approach of estimating DP by rating, Figure 2 displays the empirical frequencies of downgrade events by rating for the set of Top 90 firms during the 2004-2016 period. (Top 90 firms refer to the set of firms we obtain after sorting firms by size and then selecting those whose liabilities comprise 90% of total liabilities in different sectors and geographies.)

Empirical frequencies of downgrade can vary substantially by initial rating category. Downgrade frequencies are higher on average for companies with sub-investment grade ratings than for those with investment grade ratings, with a noticeable increase in frequency of downgrades as we move from the Baa3 rating to the Ba1 rating. In particular, the investment grade universe exhibits a peak in downgrade frequencies at the Aa1 rating category, whereas the high yield universe exhibits a peak at the Caa3 rating category.

Figure 2 Downgrade Frequency by Rating Class



The DP model takes advantage of the patterns shown in Figure 2 to boost accuracy in- and out-of-sample.

CreditEdge Early Warning Toolkit Variables

The DP model is based in part upon the CreditEdge Early Warning Toolkit, namely the *1-year EDF* and its associated measures. These measures include the *Slope*, the *Relative EDF*, the *Industry Median EDF Growth Rate*, and the *Trigger Exceedance* variables.

The *Slope*, an EDF term structure metric, is defined as the 5-year EDF minus the 1-year EDF. The *Relative EDF* is the ratio of a firm's EDF to its industry median EDF. *Industry Median EDF Growth Rate* is the year-on-year percentage change in the industry median EDF. *Trigger Exceedance* is a binary variable indicating whether the company's EDF is above or below its sector group trigger. The net effect of higher EDF metrics on the DP is typically positive and nonlinear.

Ratings-Based Variables

Ratings-based drivers of the DP include the *Implied Rating Gap (IRG)* variable based on Moody's Analytics Market Implied Rating (MIR) models, as well as three ratings outlook (stable, positive and negative) variables and a binary *Recent Downgrade* variable indicating whether there was a downgrade in the last 12 months from Moody's Investors Service (MIS). The *IRG* is calculated as the difference between the firm's Moody's rating and the best available MIR. Negative IRGs, or situations where the MIR is less favorable than the MIS rating, are typically associated with higher DPs. A more negative ratings outlook and recent downgrade events are often indicators of future downgrades.

How Does the DP Model Work for Unrated Public Firms?

The DP for unrated firms is a metric ranging from 1% to 70% that estimates what the probability of a downgrade event might be if the firm were rated by Moody's Investors Service (MIS). We can estimate the DP for unrated firms based on patterns of downgrades observed in data for public rated firms with similar characteristics. The CreditEdge Early Warning Toolkit inputs are

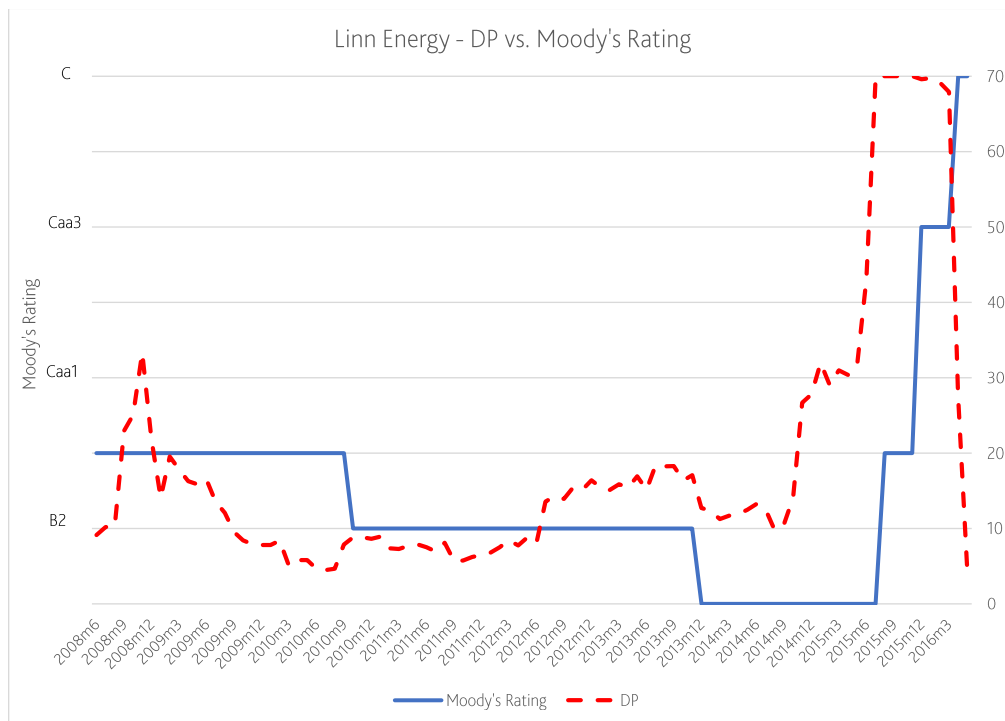
the available drivers used to calculate the DP for unrated firms. As soon as a firm becomes rated, Market Implied Ratings (MIR) data and ratings outlook and recent downgrade variables from Moody's Investors Service (MIS) are also utilized in the firm's DP calculation. The DP can be used to rank and compare both rated and unrated firms by their risk of a downgrade-like credit event.

What are Some Examples of the DP Model Output in Practice?

The DP model provides users with a forward-looking probability that a firm will experience a significant deterioration in credit quality in the next 12 months. As stated previously, users can access the DP through the Moody's Add-in for Excel and via the CreditEdge website, Data File Service (DFS) and Application Programming Interface (API).

We now present two brief case studies to illustrate the performance of the DP model in practice. The results, which consist of plotting the DP metric and Moody's rating versus time for two different companies, are displayed in Figures 3-4 below. Figure 3 shows results for Linn Energy, a US energy firm, and Figure 4 shows results for Yanzhou, a Chinese coal mining firm. Each figure is accompanied by a brief description that includes several facts about the evolution of the associated firm's credit risk during the period of study.

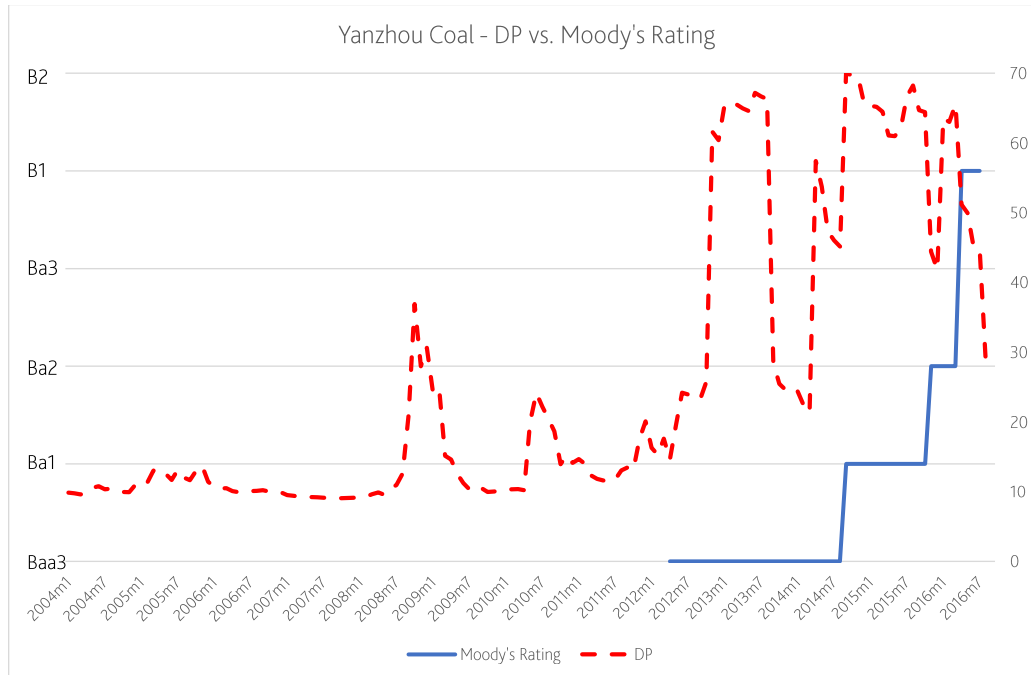
Figure 3 DP Case Study: Linn Energy



Linn Energy, founded in 2003, is an American oil and gas company. During the 2008-2013 period, Linn Energy's senior unsecured Moody's rating was upgraded twice, from B3 to B1. The DP remained low during that time.

In Q3 of 2014, the DP began a rapid ascent to its maximum value of 70% probability of downgrade, which the metric attained soon before Linn Energy was downgraded two notches from B1 to B3 around July 2015. The DP remained around 70% as Linn Energy was downgraded again to Caa3, and then fell substantially just before the firm's default, at which point its rating was withdrawn.

Figure 4 DP Case Study: Yanzhou Coal Mining Company



Yanzhou Coal Mining Company is a Chinese coal and energy company. Founded in 1997, the company mostly operates in and serves the mainland China region, with some operations in Australia. The firm was previously unrated until obtaining its initial rating of Baa3 (stable) in May 2012.

The DP exhibits a couple of short-lived spikes in parts of 2008 and 2010, prior to the conferral of the rating. However, the DP began to rise significantly and persistently shortly after the rating was published, from around 14% in May 2012 to just under 70% by mid-2013. This rise is due partly to the fact that, once the firm was rated, the DP model began incorporating information embodied in the implied ratings gap (IRG) variable, which is a valuable predictor of downgrades, and whose evolution was not favorable for Yanzhou during that time period.

As the DP approached its upper bound of 70%, the LT corporate family rating of the firm was subsequently downgraded several times: to Ba1 (September 2014), Ba2 (November 2015), and finally to B1 in April 2016. The DP sat at a still high but somewhat modest level of around 30% as of September 2016. As of March 2018, Yanzhou has not defaulted and holds a B2 (stable) rating from Moody's.

How Can the DP Model Help Your Organization?

Unanticipated downgrades can have a material impact in a variety of contexts for both risk managers and investment managers. Our transparent, purely quantitative DP metric supports the process for counterparty risk management and credit portfolio management. CreditEdge clients now have a tool for identifying heightened credit quality risk before it materializes in the form of a downgrade.

For More Information

To learn more about the Deterioration Probability metric (DP) and its applications, please contact our experts at clientservices@moodys.com.

Reference

Malone, Samuel W., Irina Baron, and Reginald White. "The Deterioration Probability (DP) Model: Methodology and Validation", Moody's Analytics Research Framework, March 2018.

© 2018 Moody's Corporation, Moody's Investors Service, Inc., Moody's Analytics, Inc. and/or their licensors and affiliates (collectively, "MOODY'S"). All rights reserved.

CREDIT RATINGS ISSUED BY MOODY'S INVESTORS SERVICE, INC. ("MIS") AND ITS AFFILIATES ARE MOODY'S CURRENT OPINIONS OF THE RELATIVE FUTURE CREDIT RISK OF ENTITIES, CREDIT COMMITMENTS, OR DEBT OR DEBT-LIKE SECURITIES, AND CREDIT RATINGS AND RESEARCH PUBLICATIONS PUBLISHED BY MOODY'S ("MOODY'S PUBLICATIONS") MAY INCLUDE MOODY'S CURRENT OPINIONS OF THE RELATIVE FUTURE CREDIT RISK OF ENTITIES, CREDIT COMMITMENTS, OR DEBT OR DEBT-LIKE SECURITIES. MOODY'S DEFINES CREDIT RISK AS THE RISK THAT AN ENTITY MAY NOT MEET ITS CONTRACTUAL, FINANCIAL OBLIGATIONS AS THEY COME DUE AND ANY ESTIMATED FINANCIAL LOSS IN THE EVENT OF DEFAULT. CREDIT RATINGS DO NOT ADDRESS ANY OTHER RISK, INCLUDING BUT NOT LIMITED TO: LIQUIDITY RISK, MARKET VALUE RISK, OR PRICE VOLATILITY. CREDIT RATINGS AND MOODY'S OPINIONS INCLUDED IN MOODY'S PUBLICATIONS ARE NOT STATEMENTS OF CURRENT OR HISTORICAL FACT. MOODY'S PUBLICATIONS MAY ALSO INCLUDE QUANTITATIVE MODEL-BASED ESTIMATES OF CREDIT RISK AND RELATED OPINIONS OR COMMENTARY PUBLISHED BY MOODY'S ANALYTICS, INC. CREDIT RATINGS AND MOODY'S PUBLICATIONS DO NOT CONSTITUTE OR PROVIDE INVESTMENT OR FINANCIAL ADVICE, AND CREDIT RATINGS AND MOODY'S PUBLICATIONS ARE NOT AND DO NOT PROVIDE RECOMMENDATIONS TO PURCHASE, SELL, OR HOLD PARTICULAR SECURITIES. NEITHER CREDIT RATINGS NOR MOODY'S PUBLICATIONS COMMENT ON THE SUITABILITY OF AN INVESTMENT FOR ANY PARTICULAR INVESTOR. MOODY'S ISSUES ITS CREDIT RATINGS AND PUBLISHES MOODY'S PUBLICATIONS WITH THE EXPECTATION AND UNDERSTANDING THAT EACH INVESTOR WILL, WITH DUE CARE, MAKE ITS OWN STUDY AND EVALUATION OF EACH SECURITY THAT IS UNDER CONSIDERATION FOR PURCHASE, HOLDING, OR SALE.

MOODY'S CREDIT RATINGS AND MOODY'S PUBLICATIONS ARE NOT INTENDED FOR USE BY RETAIL INVESTORS AND IT WOULD BE RECKLESS FOR RETAIL INVESTORS TO CONSIDER MOODY'S CREDIT RATINGS OR MOODY'S PUBLICATIONS IN MAKING ANY INVESTMENT DECISION. IF IN DOUBT YOU SHOULD CONTACT YOUR FINANCIAL OR OTHER PROFESSIONAL ADVISER.

ALL INFORMATION CONTAINED HEREIN IS PROTECTED BY LAW, INCLUDING BUT NOT LIMITED TO, COPYRIGHT LAW, AND NONE OF SUCH INFORMATION MAY BE COPIED OR OTHERWISE REPRODUCED, REPACKAGED, FURTHER TRANSMITTED, TRANSFERRED, DISSEMINATED, REDISTRIBUTED OR RESOLD, OR STORED FOR SUBSEQUENT USE FOR ANY SUCH PURPOSE, IN WHOLE OR IN PART, IN ANY FORM OR MANNER OR BY ANY MEANS WHATSOEVER, BY ANY PERSON WITHOUT MOODY'S PRIOR WRITTEN CONSENT.

All information contained herein is obtained by MOODY'S from sources believed by it to be accurate and reliable. Because of the possibility of human or mechanical error as well as other factors, however, all information contained herein is provided "AS IS" without warranty of any kind. MOODY'S adopts all necessary measures so that the information it uses in assigning a credit rating is of sufficient quality and from sources MOODY'S considers to be reliable including, when appropriate, independent third-party sources. However, MOODY'S is not an auditor and cannot in every instance independently verify or validate information received in the rating process or in preparing the Moody's Publications.

To the extent permitted by law, MOODY'S and its directors, officers, employees, agents, representatives, licensors and suppliers disclaim liability to any person or entity for any indirect, special, consequential, or incidental losses or damages whatsoever arising from or in connection with the information contained herein or the use of or inability to use any such information, even if MOODY'S or any of its directors, officers, employees, agents, representatives, licensors or suppliers is advised in advance of the possibility of such losses or damages, including but not limited to: (a) any loss of present or prospective profits or (b) any loss or damage arising where the relevant financial instrument is not the subject of a particular credit rating assigned by MOODY'S.

To the extent permitted by law, MOODY'S and its directors, officers, employees, agents, representatives, licensors and suppliers disclaim liability for any direct or compensatory losses or damages caused to any person or entity, including but not limited to by any negligence (but excluding fraud, willful misconduct or any other type of liability that, for the avoidance of doubt, by law cannot be excluded) on the part of, or any contingency within or beyond the control of, MOODY'S or any of its directors, officers, employees, agents, representatives, licensors or suppliers, arising from or in connection with the information contained herein or the use of or inability to use any such information.

NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE ACCURACY, TIMELINESS, COMPLETENESS, MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OF ANY SUCH RATING OR OTHER OPINION OR INFORMATION IS GIVEN OR MADE BY MOODY'S IN ANY FORM OR MANNER WHATSOEVER.

MIS, a wholly-owned credit rating agency subsidiary of Moody's Corporation ("MCO"), hereby discloses that most issuers of debt securities (including corporate and municipal bonds, debentures, notes and commercial paper) and preferred stock rated by MIS have, prior to assignment of any rating, agreed to pay to MIS for appraisal and rating services rendered by it fees ranging from \$1,500 to approximately \$2,500,000. MCO and MIS also maintain policies and procedures to address the independence of MIS's ratings and rating processes. Information regarding certain affiliations that may exist between directors of MCO and rated entities, and between entities who hold ratings from MIS and have also publicly reported to the SEC an ownership interest in MCO of more than 5%, is posted annually at www.moody's.com under the heading "Shareholder Relations — Corporate Governance — Director and Shareholder Affiliation Policy."

For Australia only: Any publication into Australia of this document is pursuant to the Australian Financial Services License of MOODY'S affiliate, Moody's Investors Service Pty Limited ABN 61 003 399 657 AFSL 336969 and/or Moody's Analytics Australia Pty Ltd ABN 94 105 136 972 AFSL 383569 (as applicable). This document is intended to be provided only to "wholesale clients" within the meaning of section 761G of the Corporations Act 2001. By continuing to access this document from within Australia, you represent to MOODY'S that you are, or are accessing the document as a representative of, a "wholesale client" and that neither you nor the entity you represent will directly or indirectly disseminate this document or its contents to "retail clients" within the meaning of section 761G of the Corporations Act 2001. MOODY'S credit rating is an opinion as to the creditworthiness of a debt obligation of the issuer, not on the equity securities of the issuer or any form of security that is available to retail clients. It would be dangerous for "retail clients" to make any investment decision based on MOODY'S credit rating. If in doubt you should contact your financial or other professional adviser.