Prediction of financial distress for multinational corporations: Panel estimations across countries

Abstract

This research predicts ex-ante financial distress and analyses the link between financial distress, performance, employment, and research and development (R&D) investment in the case of multinational companies (MNCs). The conditional logit and hazard models are employed to predict financial distress, while a conditional mixed process model is employed to obtain consistent and efficient estimates. Financial distress generates contractions in performance, employment, and R&D investment. Hedging against risk mitigates the effect of financial distress on R&D. Our findings vary across countries, for example, we find MNCs in Canada, Israel and the U.S. benefit from hedging against risk. The findings also indicate that ex-ante financial distress is detrimental to employment for Canada, the U.K., the Netherlands and the U.S. The findings indicate the MNCs play different roles across countries in contributing jobs, investment in R&D during the distress period.

JEL Classification: F23, G33, L25, O31

Keywords: Financial distress; multinationals; discrete time; hazard model; performance and employment

Nicholas Apergis
Department of Banking and Financial Management, University of Piraeus, Greece
napergis@unipi.gr
Department of Economics and Finance, University of Derby, UK
n.apergis@derby.ac.uk
Mita Bhattacharya
Department of Economics, Monash University, Caulfield, 3145, Australia
mita.bhattacharya@monash.edu

John Inekwe
Centre for Financial Risk, Macquarie University, Sydney, NSW, Australia
john.inekwe@mq.edu.au

1. Introduction

In 2008-2009, the world economy experienced the worst global financial crisis since World War II. During this period, sales of foreign affiliates and multinational companies (MNCs) decreased by 4.6 percent, in sharp contrast to the 24 percent growth experienced in the previous year (UNCTAD 2009). Production dropped from 20% in 2007 to -4.4% in 2008. Conversely, exports by foreign affiliates sustained a robust growth rate of 15 percent despite the collapse of world trade, indicating that MNCs had a complex pattern of responses to the crisis.

Analysing financial distress is a significant research topic for business practitioners, managers, and academia. It may give early warnings to the MNCs for corporate governance purposes and may save on the direct and indirect costs associated with bankruptcy.[1] While extensive research exists on financial distress (see, for example, Shumway 2001; Campbell, Hilscher, and Szilagyi 2008; Fitzpatrick and Ogden 2011; Powell and Yawson 2012), the prediction and analysis of the effects of financial distress among MNCs remain in its infancy.

Why did we choose MNCs for our analysis? Early predictions of financial distress may have a significant effect on other performance indicators and investment decisions of the MNCs with a feedback effect. Moreover, the implementation of hedging strategies by MNCs can influence R&D investments in distressed conditions. Broader reporting on the likelihood of financial distress would permit a better understanding of the financial dimension of multinationals that is typically only revealed in moments of crisis in host countries.

In general, the MNCs experience higher agency costs, lower bankruptcy costs and are more greatly influenced by local factors (i.e., political, foreign exchange and inflation risks) in

[1] Multinational companies, multinational firms and multinationals are used here interchangeably.

comparison to domestic firms. The leverage and capital structure of foreign affiliates are different from those of their domestic competitors. Multinationals can lower the cost of capital expenditure and enhance their debt capacity in comparison to their peers, while exchange rate exposure and political risks may affect their leverage due to the probability of wealth loss. MNCs operate an international intelligence system for the acquisition and collection of basic proprietary knowledge relevant to R&D, and the exploitation of the commercially applicable knowledge generated by R&D. Therefore, the possession of proprietary information is a key reason why MNCs can survive the competition of domestic companies (DCs) in host countries. We posit that financial stress experienced by multinationals is expected to have significant detrimental effects on their profitability, employment, and R&D investments. The combined effects of these factors are significant for growth and development for any economy.

The primary objective of this research is to predict ex-ante financial distress for MNCs from eleven countries, i.e., Australia, Canada, France, Germany, Ireland, Israel, Japan, Mexico, The Netherlands, the U.K. and the U.S. To this end, this research considers an ex-ante approach in predicting financial distress across MNCs. This ex-ante approach to financial distress captures low states in which the firm incurs losses, but may or may not become insolvent.

We contribute to the literature by covering four major aspects. First, we establish a link between financial distress and the indirect costs associated with financial distress. We examine the indirect effects of financial distress on profitability, employment, and R&D investments. These three indicators are significant in analysing corporate governance of the MNCs and their overall contribution towards any economy.

Second, we extend the prediction model in a simultaneous equation framework. The choice is based on the fact that efficient and consistent estimates are obtainable using simultaneous equation technique. Following Roodman (2011), we use the conditional mixed process (CMP) model to incorporate simultaneity and endogeneity issues across distress variables, in combination with performance, employment and R&D investment as controls. In predicting financial distress, we employ both hazard and conditional logit models for prediction purposes.

Our third contribution is to analyse the role of hedging and its ameliorating effects. We test whether a hedging strategy can be used in minimising the detrimental consequences of financial distress on R&D investments. Finally, we analyse a cross-country comparison and attempt to provide some explanations in variations of findings across countries.

This paper proceeds as follows. A brief review of the literature on financial distress risk models is presented in Section 2. In Section 3, we discuss the prediction model in detail, the sample selection procedure and variable measures. Section 4 covers the empirical findings. In the final section, we cover the major conclusions and policy implications of this research.

2. Literature and hypothesis development

A unified approach was taken in reviewing the literature, and three strands will be combined here to relate financial distress with performance, employment, and R&D investment.[2] The review first focuses on the prediction models.

The financial distress of a company usually describes the situation where operating cash flow cannot supersede the negative net assets of the company. The prediction of financial

[2] Bhattacharya and Bloch (2004) analyse the link between R&D and performance. We consider employment as an additional control variable.

distress has recently been of major research interest (Wanke, Barros, and Faria 2015). Most studies have concentrated on the predictive accuracy of a diverse range of models. Beaver (1966); (Beaver 1968) considered univariate analysis focusing on accounting ratios and market price changes as predictors of financial distress. Also, accounting ratios provide investors' price expectations and are of significant relevance for investment decisions.

The literature in this field is rife with fundamental variables for prediction purposes. Multivariate discriminant analysis (MDA) is employed by researchers in default-prediction models. The seminal models which have employed discriminant (quadratic and linear) analyses have been criticized for the assumption of multivariate normality.[3] The mixed logit model is superior for model-fits and out-of-sample forecasts in comparison to the standard logit model.

Most prediction models rely on a static framework or single period but include multiple bankruptcy observations. Furthermore, they routinely fail to incorporate the dynamics of firms, therefore generating inconsistent and biased estimates. This issue is due to changes in the characteristics of firms over time, which are not included for prediction purposes in static models. The evolution of financial distress risk models has followed the path of methodological improvements and the choice of variables that can generate models with high predictive ability. The accounting-based models utilise information from accounting ratios to predict distress.

Other researchers have developed a composite measure that statistically combines several different accounting variables, such as the Z-Score (Altman 1968) and O-Score (Ohlson 1980). Wruck (1990) examined the effects of financial distress on organisational efficiency.

[3] Altman et al. (2014) provide a review of the z-score models since 2000.

The research considered both costs and benefits and recommends changes in the governance structure.

Given the limited evidence of the sensitivity of accounting-based models to financial distress situations, periods, and industries that are not tested in the original models, Grice Jr and Dugan (2003) re-estimated the coefficients of the Zmijewski (1984) and Ohlson (1980) bankruptcy and financial distress prediction models. The findings indicated that the accuracy of the models increased when the coefficients were re-estimated for distressed and non-distressed firms over different periods, industries and financial conditions.

Shumway (2001) developed a hazard model, combining market variables. The market size, stock returns in previous years, and the idiosyncratic standard deviations of company stock returns are considered with accounting ratios. The model is consistent and efficient for out-of-sample forecasting. Hillegeist et al. (2004) established that the market-based model (covering options pricing) provides significantly better findings than accounting-based measures. The mixed model combines accounting and market variables to generate default probability and thereby provides greater predictive power than the accounting-based model itself. Agarwal and Taffler (2008) noted that market prices contain more information than the available accounting ratios. Therefore, market variables become appealing in risk prediction, reflecting future expected cash flows as opposed to the past performance of accounting ratios in the case of accounting models.

Three dimensions are considered in this study viz. profitability (a measure of performance), employment and R&D investment. These are the three major indicators for MNCs and have a significant influence on the economy during financial distress. Accordingly, our research consists of three hypotheses, described in the following section in conjunction with relevant conclusions from related literature.

2.1. Financial distress and performance

Financial distress can affect performance by changing the cost of stakeholder relationships, and the credit structure of the MNCs. This issue is particularly due to the objectives of managers, who aim to maximize the value of companies. Opler and Titman (1994) reported that the performance of firms in financial distress might be affected by the reluctance of customers to deal with distressed firms, the aggressive responses from strong competitors, and also due to the flexibility in downsizing the more leveraged firms. Jandik and Makhija (2005) examined the effects of debt and debt structure on corporate performance after unsuccessful takeover attempts and established a negative relationship between corporate performance and leverage. In contrast, Bergström, Eisenberg, and Sundgren (2002) reported no significant relationship between these two variables for Swedish firms.

The implications of financial distress on the various measures of performance are of significant importance to firm managers and researchers. Avramov et al. (2013) examined the profitability of anomaly-based strategies and the implications of financial distress thereon. Their findings suggest that hurdles in exploiting anomalies in real-time may be established in firms for which it is hard to sell short due to their poor liquidity condition. They found that the profitability of price momentum, credit risk, earnings momentum, asset growth, dispersion idiosyncratic volatility, and investments anomalies are concentrated in low-rated stocks under worsening credit conditions. In a model of corporate failure, following market and accounting-based measures Campbell, Hilscherc, and Szilagyid (2011) considered the pricing and measurement of distress risk in forecasting the likelihood of financial distress. They showed that high market betas and high return volatility characterise distressed stocks. In their analysis, considering the different size and value quintiles, they established the underperformance of firms facing distress.

During high-performance period, firms increase their trade receivables, however during the period of low cash flow, trade receivables decline. It is noted in Ak et al. (2013). Moreover they reported that stock returns and sales declined when firms have less trade receivables during financial distress. Firms with reduced trade receivables faced a greater decline in performance during financial distress.[4]

Hypothesis 1: Financial distress may have a negative influence on the performance of MNCs.

2.2. Financial distress and employment

In the presence of asymmetric information, managers' interests can deviate from the shareholders' interests. An increase of debt to net worth raises external finance premiums due to the associated increase in the probability of bankruptcy. In comparison to shareholders, managers are more responsible with the potential of bankruptcy during financial distress. Therefore, in an increasing debt environment, managers try to reduce the level of employment and investment to improve the efficiency of their MNCs. This disciplinary role has a negative effect on employment, i.e., resulting in the termination of employees.

Opler and Titman (1994) and Khurana and Lippincott (2000) argued that negative financial developments motivate firms to enter a restructuring process that involves, among other reactions, the termination of employees. Inekwe (2015) concluded that financial distress induces adverse effects on the employment level among small- and medium-sized enterprises in the United States.

Hypothesis 2: Financial distress may have negative effect on employment by MNCs

[4]See on Helwege (2010) declining asset values and financial firm bankruptcies.

2.3. Financial distress and R&D investment

To link financial distress with R&D activities, Brown, Fazzari, and Petersen (2009) examined a panel of publicly listed, high-tech US firms between 1990 to 2004. They showed that supply shifts in equity finance (both internal and external) had an aggregate positive effect on R&D, thus explaining most of the dramatic 1990s R&D boom in the US. They confirmed the relevance of innovative investment in the stock market which can be a contributing factor to economic growth. Li (2011) revisited the role of financial constraints in R&D investment. In particular, he argued that financially constrained, R&D-intensive firms are more likely to suspend or discontinue R&D projects, implying that the presence of financial constraints increases their risk profile. The empirical analysis presented the relationship between financial constraints and stock returns, primarily among R&D-intensive firms. The findings suggest that financial constraints may drive a positive R&D return even in the period of financial distress.

Du and Lai (2015) examined whether or not the two firm-specific characteristics of investment opportunity and financial distress moderate the contagion impact of low audit quality. They showed that the contagion effect of low audit quality is strengthened by investment opportunity, while financial distress reinforces the contagion effect. Koh et al. (2015) examined the strategies that firms adopt during the financial distress and reported that corporate lifecycle influences the choice made by these firms. Their findings established that reduced level of dividends and investment are associated with the recovery of the firms with little influence on their lifecycle.

Hypothesis 3: Financial distress may reduce R&D investment for MNCs

3. Financial distress: Definition, models, and data

3.1. Definition

An ex-post definition of financial distress risk considers distress to include any or high chances of bankruptcy, liquidity or loan default (Grice and Dugan 2001). Following Wruck (1990), financial distress is a situation in which current obligations are not met because of insufficient cash flow. These obligations range from unpaid debts to suppliers and employees, to potential or actual damages from litigation, to loan default. Asquith, Gertner, and Scharfstein (1994) define financial distress as the circumstance in which a firm's reported interest expenses are greater than its earnings before interest, taxes, depreciation, and amortization (EBITDA) for two consecutive years, or the firm's EBITDA are less than 80% of its interest expenses in any one year. Pindado, Rodrigues, and de la Torre (2008) classified a company as being financially distressed when its market value fell for two consecutive periods, and its financial expenses exceeded its EBITDA for two consecutive years.

These definitions are consistent with ex-ante financial distress in the sense that a firm is financially distressed not only when it files for bankruptcy or is liquidated, but when if any of the listed conditions exist. Therefore, the first proxy for financial distress (FD1) for this study reflects the conditions under which a firm's market value declines for two consecutive periods and its accrued expenses are greater than its EBITDA for two consecutive years. The second proxy for financial distress (FD2) for this study represents the condition of EBITDA less than 80% of a firm's financial (accrued) expenses in any three consecutive

years. Table 1 presents the summary of distressed and non-distressed firms in the study sample.[5]

*Insert Table 1********

3.2. Empirical models

Nam et al. (2008) specified a duration model incorporating multi-period financial statements and the macroeconomic dependencies within firms. The time of failure of a firm is denoted by survival time, T. Being a continuous random variable, T has a probability density function$f(t)$, and a cumulative density function $F(t)$. The probability that a firm survives over the time period can therefore be determined. The conditional probability of failure at time t provides a measure of the instantaneous risk of default (the hazard function) provided a firm survives until time t. Multi-period logit models were employed in estimating the continuous proportional hazard model.

The likelihood function of the discrete time hazard model is equivalent to the likelihood function of a multi-period logit model (Shumway 2001). Therefore, estimation of the hazard model with time-varying covariates can be achieved using the multi-period logit functions.[6] The unspecified term (i.e., the baseline hazard rate) may be considered in various forms. The model is duration-independent when a time-invariant constant term is used, while duration-dependent when we incorporate time-varying factors.

Nam et al. (2008) employed macroeconomic variables with duration dependent models. It was argued that the indirect measures, such as time dummies, might not have effectively

[5] The descriptive statistics of all variables are presented in Table A1 (On-line Appendix).
[6] The conditional logit models allow the use of the non-linear maximum likelihood to determine the failure rate conditioned on firm characteristics. Here, normality in the distribution of variables is not required.

captured economy-wide common effects and that their correlations cannot be completely captured by the historical survival period of firms. This study, therefore, considered both the hazard and conditional logit models for the preliminary empirical analysis. To estimate the relationship between financial distress and the operation of MNCs, the CMP model developed by Roodman (2011) was used. This model generates consistent and efficient estimates using the maximum likelihood of the seemingly unrelated regression (SUR) model. Being able to fit continuous and dichotomous dependent variables, the CMP model bridges the dichotomy between linear and non-linear models. The econometric model yields:

$$p_{it} = \propto_1 + \gamma z_{it} + \delta f_{it}^* + \mu_{it} \quad (1)$$

$$f_{it}^* = \propto_2 + \beta d_{it} + \varepsilon_{it} \quad (2)$$

$$f = g(f^*) = \begin{cases} 0 \text{ if } f^* \leq 0 \\ 1 \text{ if } f^* > 0 \end{cases}$$

where p can be any of the three performance indicators (i.e., profitability, employment, R&D investments), we consider. $\propto$ is the constant term, f is the financial distress variable (a dichotomous dependent variable, which takes the value of 1 for financially distressed firms, and 0 otherwise), μ_{it} is the error term and d is a vector of the determinants of financial distress. β, γ and δ are vectors of coefficients, while z is a vector of determinants for a firm's profitability, R&D investments or employment. i is the index of firms and t is the time index $\epsilon = (\varepsilon, \mu)' \backsim \mathrm{N}(0, \Sigma)$, $\Sigma = \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}$, while the endogeneity of f_{it} in the p_{it} equation is measured by ρ. Unobserved factors that influence the dependent variables are captured by ρ. For robustness checks, heteroskedastic consistent standard errors are reported. In addition, following the literature, a general recursive multi-equation probit

model was identified and used in this study as long as one varying predetermined variable appears in each equation (Wilde 2000).[7]

3.3. Measurement of variables and sample selection criteria

To obtain models with a high accuracy of financial distress risk prediction, the analysis employs two versions of the accounting model (Model 1 and 2) and two versions of the mixed model (Model 3 and 4) (the online appendix discusses the performance of the models). The preference for the mixed model is anchored in its performance in the extant literature.[8] Following an accounting approach, Model 1 includes earnings before interest and taxes/total assets (EBT), current assets/current liabilities (CACL), and total debts/total assets (TDTA). Model 2 includes earnings before interest and taxes/total assets (EBT), current assets/current liabilities (CACL), a dummy variable that takes the value of 1 if total liabilities exceed total asset, and zero otherwise, (TLTAD), and total debts/total assets (TDTA).

Models 3 and 4 represent the mixed approach. Model 3 includes all accounting ratios employed in Model 2, we have added a variable stock return (STKR) to capture the market. Model 4 includes accounting ratios employed in Model 2, plus realised volatility (VRT). Variables are with one-year lag for our prediction models. Therefore, a financial distress event is observed one year before its occurrence.

The return on assets is negative for firms that are near to default. As smaller firms may have a higher probability of default, adjustment for size can be a significant factor for default purposes. Stock returns and the EBT ratio are expected to decrease the probability of default. A measure of total liabilities/total asset captures the degree of indebtedness of a firm.

[7]Following Roodman (2011), the imposition of exclusion restrictions to satisfy the order condition of the simultaneous equation framework may yield robust identification.

[8] For a recent review of different estimation techniques, see (Sun et al. 2014).

Therefore, the dummy TLTAD is expected to increase the likelihood of financial distress. CACL is a measure of liquidity, while the indebtedness of a firm is indicated by TDTA. The CACL and TDTA variables can have mixed effects in the models.

Other firm-level variables employed include employment (EMP), research and development expenditures (R&D), sales (SAL), investment (INV), capital (CAP- common/ordinary equity to invested capital ratio), cash-flow hedges (HED), and total revenues (TRV). The variable HED includes the after-tax amount of unrealised gain/loss on derivative transactions or cash flow hedges.[9] Among market variables, stock market returns (STKR) include the market price of equity for sampled firms, while the volatility (VRT) is measured as the square of stock returns. Stock returns are computed as the log difference of stock prices. Following Tinoco and Wilson (2013), the hyperbolic tangent transformation is used for firm-level variables. This adjustment compensates for outlier issues while reducing the values that fall outside the expected range, and a linear transformation of input values located near the expected values can, therefore, be generated (Godfrey 2009). The use of four prediction models, along with two financial distress conditions proxied by FD1 and FD2, serves as an inbuilt robustness check in the full sample analysis. Also, the real interest rate (RER) is added as a control in capturing the macroeconomic effects for the financial distress model (Tirapat and Nittayagasetwat 1999).

The specification provided by De Loecker and Goldberg (2014) is taken as the measure of firm performance (i.e., profitability). From a regression of sales (S_{it}) of firm i at time t on expenditures (E_{it}), profitability (PRO_{it}) is determined as the independently and identically distributed residual of the fixed effect model:

[9] Data source: The Centre for Research in Security Prices (CRSP) and Compustat merged file.

$$\log(S_{it}) = \delta\log(E_{it}) + PRO_{it} + \vartheta_i \quad (4)$$

where δ represents a vector of the coefficient, ϑ_i denotes the constituent-specific fixed effects, and PRO_{it} is the residual component. The log-linear version is considered, while the profitability is denoted by PRO.

The study employs a panel of MNCs domiciled in eleven countries, i.e., Australia, Canada, France, Germany, Ireland, Israel, Japan, Mexico, the Netherlands, the U.K., and the U.S. The MNCs from 11 countries were selected, so that the effects of financial distress on their performance could be analysed (measured through profitability, employment, R&D, and hedging strategies). The data from these countries constitute 95% of MNCs in the entire data set. The selection process was based on the maximum available number of firms in the sample for all variables under consideration. The firms classified as multinationals within the domicile of the selected countries were considered. The data for the variables under scrutiny were obtained from the Compustat database, which covers 16,043 firms with varying data for each variable. RER data were obtained from the World Development Indicator (WDI) maintained by the World Bank. The study covers the period between 1987 and 2013.

4. Empirical analysis

4.1. Financial distress: performance, employment, and R&D investments

The following two sub-sections illustrate the findings from full sample and cross-country analysis for the current panel. Also, the significance of hedging in R&D investment for financially distressed MNCs is discussed.

4.1.1. Full sample analysis

This section relates financial distress to the four indicators, i.e., profitability (a measure of performance), employment, R&D, and hedging strategies. Using the CMP model, the effects of accounting ratios and market variables on ex-ante financial distress and the effects of financial distress on the three selected variables of MNCs are examined simultaneously. Only the estimates from the robust standard errors are reported. Robustness checks were performed by measuring distress in two forms and employing two accounting and two mixed models. The coefficients are reported for the binary models (Equation 2), while the marginal effects for the continuous dependent variables, i.e., profitability, employment and R&D equations, were obtained directly from the CMP specification (Equation 1). To incorporate the heterogeneity of the effects of financial distress across regions, regional dummies were used, where these dummies are classified as Asia and Pacific (Region 1), Europe (Region 2), and North America (Region 3).

Financial distress and performance

Research on the performance of MNCs has generated considerable interest in the international business sector. Table 2 illustrates that earnings before interest and taxes/total assets (EBT) ratio, total debts/total assets (TDTA) ratio, current assets/current liabilities (CACL), and firm's stock returns (STKR) decrease the likelihood of financial distress, while the total liability dummy (TLTAD) has the inverse effect. The coefficients are statistically significant and concur with theoretical expectations. An increment in equity returns is expected to lower default risk. Apart from the generation of superior predictive models through the inclusion of equity prices, the improvement of the timeliness is another advantage (Keasey and Watson 1991).

*Insert Table 2********

In the upper panel of Table 2, the effects of financial distress on the profitability of MNCs are presented for the panel of countries. Financial distress decreases profitability. The economic significance of financial distress is reflected by the magnitude of the coefficients. The two forms of financial distress show detrimental effects (0.15% under FD2 and 0.21% under FD1) on the profitability of these firms. Among the control variables, both investments and returns are positively correlated with profitability, while the real interest rate is statistically insignificant.

Significant profitability is beneficial to the organisation and will, therefore, have a direct influence on other major activities. This assumption relies on a variety of factors, such as potential arbitrage opportunities in factor cost differentials across multiple locations (Kogut 1985). Given that venturing overseas comes with numerous benefits, Gomes and Ramaswamy (1999) argued that, beyond some optimal levels of multinational expansion, negative marginal returns and decelerating profitability growth could both accompany continued foreign operations. They argue that the relationship between performance and multi-nationality is non-linear, which comprises periods of recession and expansionary phases. Their argument is based on the costs associated with the operation of MNCs.

Financial distress and employment

Table 3 reports the response of employment to financial distress in MNCs. The findings show the detrimental effects of financial distress on employment. These effects are statistically significant, with a decrease in employment in the wake of financial distress. The effect is significant regarding the magnitude of the coefficient. From the eight specifications, a 0.49% to 1% decline in employment can be observed. This result conforms with the theory

of underemployment and financial distress developed by Nosal (1998). A firm may face bankruptcy in a very low state of the world (where either the demand of the firms' product or the productivity of the firm represents the state of the world). To cope with this situation, a firm may embark on a cost-saving measures by implementing terminations. Thus, financial distress may have an adverse effect on employment in the low state.

A look at the control shows that investments and revenues are positively correlated with employment, while volatility is significant in contracting R&D investments. From the financial perspective, the risk associated with an enterprise, its subsidiary, or a project is measurable via the volatility in returns, cash flows or other financial elements. Being observable, these financial risks maintain a pivotal position in enterprise management.

*Insert Table 3********

Financial distress and R&D investment

Foreign corporate affiliates conduct R&D to support sales activities, enhance foreign local manufacturing, adapt home-developed technologies to foreign markets, create new technologies for world markets, and access local technological and scientific expertise abroad (Ambos 2005). Table 4 shows the indirect cost of financial distress through investment activities in research and development across MNCs. This specification is essential in assessing the indirect cost of financial distress. The findings indicate that financial distress contracts investment in R&D, as it induces a fall in R&D expenditures from 0.08 percent to 0.70 percent. Therefore, financial distress is economically and statistically significant in determining R&D activity. As control variables, capital is

positively associated with R&D, while sales and the real interest rate have negative effects on R&D.

*Insert Table 4********

4.1.2. Cross-country comparisons

To address the possibility of heterogeneity across countries, the analysis considers the effects of financial distress on profitability, employment and R&D investments on a country level.[10] The first measure of financial distress vs. FD1 was employed for this purpose.

Table 5 presents the effects of financial distress on the profitability of firms in the individual country, reporting only the countries for which significant findings were obtained. The findings indicate that financial distress lowers profitability across all countries, with the magnitude of the decline ranging from 0.21% to 0.57%.

Both investments and sales are positively correlated with performance for most of the countries, while the real interest rate lowers the firms' performance in Canada and the U.S. These findings confirm theoretical expectations of the effects of investments on the performance of firms and economies. These findings further show that MNC in Canada and the U.S. are sensitive to changes in the real interest rate over the financially distressed period.

Table 6 presents the effect of financial distress on employment for the countries for which significant findings were identified. The findings indicate that ex-ante financial distress is detrimental to employment and the findings are statistically significant only for Canada, the U.K., the Netherlands and the U.S.A. In contrast, employment in Australia and Japan

[10] For country code, we use the FIC classification from the Compustat database.

increases under ex-ante financial distress. These findings concur with the fact that ex-ante financial distress represents a low state, where a firm may either recover or become insolvent. Following Nosal (1998), low levels of workers' welfare represent low states of the world until a positive change in the state of the world occurs to reverse the workers' conditions. Signs for the control variables, i.e., sales and investments, are positive, while the real interest rate is negative. All coefficients are statistically significant.

Previous studies have shown that financially distressed firms may reduce employment and investments, and they can be forced to sell assets to recover. These actions contribute to management-driven losses in sales (Opler and Titman 1994). Firms under financial distress can also suffer from a fundamental reduction in business arising from an economic downturn or bad management. However, ascribing the actions of firms in financial distress to their distressed conditions is difficult. There is an insignificant effect of financial distress on the sale of assets (Opler and Titman 1994). In contrast, Asquith, Gertner, and Scharfstein (1994) reported that under distress conditions, firms with lower book-to-market equity ratios, higher operating incomes, and higher cash flow coverage ratios are likely to cut capital expenditures, sell assets or go bankrupt. The study documented large reductions in capital expenditures of financially distress firms, with 83% of the firms lowering their capital expenditures in the year before the occurrence of the distress event.

Table 7 presents the country-specific findings of the effect of financial distress on R&D expenditures. The findings reveal that the accounting variables are significant in predicting financial distress. These findings confirm the full sample findings, which indicate that financial distress lowers investments in R&D. However, the findings are significant only for Israel and Japan. In contrast, investments in R&D for the U.K. and the U.S. remain positive under financial distress.

*Insert Table 5********

*Insert Table 6********

*Insert Table 7********

The role of MNCs in the generation of technology and its transmission cannot be overlooked. In the contemporary policy debate on the contribution of foreign direct investment, the central focus is on the innovative capability of the host economy, which is attributable to the operations of affiliates of MNCs. Athukorala and Kohpaiboon (2010) argued that R&D undertaken with the host economy is expected to generate important externalities for local technological and scientific capabilities, encouraging the government of the host-economy to view technology generation as preferable to technology transmissions. Extending the previous studies on the determinants of multinational R&D activities reveals that the overall R&D capability, the domestic market size, and the cost of hiring R&D personnel are all primary determinants of the R&D intensity of operation of affiliates for the U.S. multinationals. Therefore, financial distress is expected to affect the cost of operation.

4.2. The effect of financial distress on R&D investment with hedging

In this sub-section, the hedging cash flows are compared to the financial distress indicator and their combined effect on R&D is examined. Specifically, the effect of financial distress on R&D investments both for the case of individual countries and for the full panel is scrutinized. The findings in Table 8 reflect that financial distress correlates positively with R&D in the presence of hedged cash flows. Similar findings were obtained for the cases of Canada, Israel, the Netherlands and the U.S.

The interaction term is positive and significant. The significance of hedging in major investment strategies for financially distressed firms is thus established (see DeMarzo and Duffie 1995; Song, Lee, and Makhija 2015).

Given that no alternative methodologies can be used to establish the relationship in the joint estimation of continuous and dichotomous dependent variables, the analysis undertakes a robustness check by using a single equation method. This is estimated using the instrumental variable (IV) technique; viz, the Generalised Method of Moments (GMM) (Baum, Schaffer, and Stillman 2007). The first lag of the financial distress (FD1) is used as an instrument, and each equation is exactly identified. The last set of findings is reported, and the outputs are labeled as G1(IV-model) and G2 (IV model with a lag of R&D) in Table 9. Similar to the findings with the CMP model, the interaction term remains positive and significant. Therefore, hedging strategies are established as being significant in financially distressed MNCs for R&D investment purposes.

*Insert Table 8********

4. Conclusion and policy implications

In the literature, most distress risk models have concentrated on firms or industries in specific sectors. Therefore, the modeling of insolvency or financial distress for MNCs is imperative to empirical research. Also, the examination of financial conditions other than bankruptcy and liquidation is also desirable. This study has shown the influence of financial distress in MNCs on their performance, employment, and R&D activities. The main conclusion was that MNCs experiencing financial distress were liable to reduce R&D investments and lower employment levels. These indicating factors were invariably

reflected in the performance of these firms, and hedging against risk could mitigate the adverse effect of financial distress.

Given that previous bankruptcy prediction models have relied exclusively on cross-sectional data for prediction purposes, the use of panel setting is warranted to capture the dynamics of the interdependence among variables. In a panel specification, conditional mixed process models were used to address the endogeneity issue. An efficiency gain is achieved with the simultaneous equation framework by incorporating cross-equation covariance among the models. Alternative measures of ex-ante financial distress were also computed, and distress risk was predicted a year before its realisation. In the preliminary analysis and for prediction purposes, we use the AUC in checking the suitability of both conditional logit and hazard models

The findings establish a good predictive power both for the accounting and the mixed models. In the pool estimates, the findings revealed that earnings before interest and taxes/total assets, current assets/current liabilities, total liability dummy, total debts/total assets and firms' stock return could predict financial distress in the case of MNCs. The findings of the main analysis indicated that financial distress was capable of influencing the operation of these MNCs, and significant contractions in employment and investment in research and development were also established. Also, financial distress was found to be detrimental to the profitability of MNCs. Over the period under investigation, the robust estimates remained statistically significant in establishing the dynamic link between financial distress and the major activities considered for these MNCs. These effects differ across countries, and the findings did not hold for those firms that hedged against risk.

In anchoring the policy implications of our findings on MNCs, the acknowledgment of its limitations is essential. It may be said that different sectors of the MNCs would not be

affected in a similar manner. In that case, the treatment of all units as identical might generate bias in the interpretation of the findings. A comprehensive analysis of the causes of bankruptcy, liquidation and corporate default (where applicable) to MNCs from different host countries relating market variables is therefore warranted. An in-depth analysis of cross-country study requires the availability of detailed data set. Nevertheless, our findings support that different countries have different adjustment paths on performance, employment and R&D investment strategies. This message is helpful for the policy advisers, management practitioner, and foreign investors.

Also, our findings have implications for tax purposes, particularly to host countries. In the presence of financial distress, countries should impose favorable tax rates where MNCs may finance investments through debt to improve the allocation of resources. Alternatively, a tax relief can be imposed on investment financed with retained earnings. The misallocation of resources occurs because higher levels of leverage increase the perceived uncertainty of the firm's ability to pay interest and equity obligations. This may cause further financial distress, which can be indirect costs to the firms.

Future research may include analysis of the financially distressed MNCs in specific sectors while exploring the robustness of the findings sourced from the banking sector. This research endeavor could determine whether or not increased economic activity due to the presence of MNCs in crisis period helps in supporting local firms through spill over effects. These effects may occur from increased demand from imported input/technology, improved access to trade credit, or increasing the level of employment. A cross-country comparison would be beneficial for these purposes.

References

Agarwal, V., and R. Taffler. 2008. "Comparing the performance of market-based and accounting-based bankruptcy prediction models." *Journal of Banking & Finance* 32 (8):1541-51.

Ak, B. K., P. M. Dechow, Y. Sun, and A. Y. Wang. 2013. "The use of financial ratio models to help investors predict and interpret significant corporate events." *Australian Journal of Management* 38 (3):553-98.

Altman, E. I. 1968. "Financial ratios, discriminant analysis and the prediction of corporate bankruptcy." *The Journal of Finance* 23 (4):589-609.

Altman, E. I., M. Iwanicz-Drozdowska, E. K. Laitinen, and A. Suvas. 2014. "Distressed firm and bankruptcy prediction in an international context: A review and empirical analysis of Altman's Z-score model." *Available at SSRN 2536340*.

Ambos, B. 2005. "Foreign direct investment in industrial research and development: A study of German MNCs." *Research Policy* 34 (4):395-410.

Asquith, P., R. Gertner, and D. Scharfstein. 1994. "Anatomy of financial distress: An examination of junk-bond issuers." *The Quarterly Journal of Economics* 109 (3):625-58.

Athukorala, P.-c., and A. Kohpaiboon. 2010. "Globalization of R&D by us-based multinational enterprises." *Research Policy* 39 (10):1335-47.

Avramov, D., T. Chordia, G. Jostova, and A. Philipov. 2013. "Anomalies and financial distress." *Journal of Financial Economics* 108 (1):139-59.

Baum, C. F., M. E. Schaffer, and S. Stillman. 2007. "Ivreg2: Stata module for extended instrumental variables/2SLS, GMM and AC/HAC, LIMl, and K-class regression." *Stata Journal* 7 (4):465–506.

Beaver, W. H. 1966. "Financial ratios as predictors of failure." *Journal of Accounting Research*:71-111.

Beaver, W. H. 1968. "The information content of annual earnings announcements." *Journal of Accounting Research*:67-92.

Bergström, C., T. Eisenberg, and S. Sundgren. 2002. "Secured debt and the likelihood of reorganization." *International Review of Law and Economics* 21 (4):359-72.

Bhattacharya, M., and H. Bloch. 2004. "Determinants of innovation." *Small Business Economics* 22 (2):155-62.

Brown, J. R., S. M. Fazzari, and B. C. Petersen. 2009. "Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom." *The Journal of Finance* 64 (1):151-85.

Campbell, J. Y., J. Hilscher, and J. Szilagyi. 2008. "In search of distress risk." *Journal of Finance* 63 (6):2899-939.

Campbell, J. Y., J. Hilscherc, and J. Szilagyid. 2011. "Predicting financial distress and the performance of distressed stocks." *Journal of Investment Management* 9 (2):1-21.

De Loecker, J., and P. K. Goldberg. 2014. "Firm performance in a global market." *Annual Review of Economics* 6 (1):null.

DeMarzo, P. M., and D. Duffie. 1995. "Corporate incentives for hedging and hedge accounting." *Review of Financial Studies* 8 (3):743-71.

Du, X., and S. Lai. 2015. "Financial distress, investment opportunity, and the contagion effect of low audit quality: Evidence from China." *Journal of Business Ethics*:1-29.

Fitzpatrick, J., and J. P. Ogden. 2011. "The detection and dynamics of financial distress*." *International Review of Finance* 11 (1):87-121.

Godfrey, M. D. 2009. "The TANH transformation." *Information Systems Laboratory, Electrical Engineering Department, Stanford University, Tech. Rep* (Information Systems Laboratory Stanford University).

Gomes, L., and K. Ramaswamy. 1999. "An empirical examination of the form of the relationship between multinationality and performance." *Journal of International Business Studies* 30 (1):173-87.

Grice, J., and M. Dugan. 2001. "The limitations of bankruptcy prediction models: Some cautions for the researcher." *Review of Quantitative Finance and Accounting* 17 (2):151-66.

Grice Jr, J. S., and M. T. Dugan. 2003. "Re-estimations of the Zmijewski and Ohlson bankruptcy prediction models." *Advances in Accounting* 20 (0):77-93.

Helwege, J. 2010. "Financial firm bankruptcy and systemic risk." *Journal of International Financial Markets, Institutions and Money* 20 (1):1-12.

Hillegeist, S., E. Keating, D. Cram, and K. Lundstedt. 2004. "Assessing the probability of bankruptcy." *Review of Accounting Studies* 9 (1):5-34.

Inekwe, J. N. 2015. "Financial distress, employees' welfare and entrepreneurship among SMEs." *Social Indicators Research* 129 (3):1135-53.

Jandik, T., and A. K. Makhija. 2005. "Can diversification create value? Evidence from the electric utility industry." *Financial Management* 34 (1):61-93.

Keasey, K., and R. Watson. 1991. "Financial distress prediction models: A review of their usefulness1." *British Journal of Management* 2 (2):89-102.

Khurana, I. K., and B. Lippincott. 2000. "Restructuring and firm value: The effects of profitability and restructuring purpose." *Journal of Business Finance & Accounting* 27 (9‐10):1085-106.

Kogut, B. 1985. "{designing global strategies: Profiting from operational flexibility}." *Sloan Management Review* 27 (1):27-38.

Koh, S., R. B. Durand, L. Dai, and M. Chang. 2015. "Financial distress: Lifecycle and corporate restructuring." *Journal of Corporate Finance* 33:19-33.

Li, D. 2011. "Financial constraints, R&D investment, and stock returns." *Review of Financial Studies*:hhr043.

Nam, C. W., T. S. Kim, N. J. Park, and H. K. Lee. 2008. "Bankruptcy prediction using a discrete-time duration model incorporating temporal and macroeconomic dependencies." *Journal of Forecasting* 27 (6):493-506.

Nosal, E. 1998. "Financial distress and underemployment." *The Review of Economic Studies* 65 (4):817-45.

Ohlson, J. A. 1980. "Financial ratios and the probabilistic prediction of bankruptcy." *Journal of Accounting Research* 18 (1):109-31.

Opler, T. C., and S. Titman. 1994. "Financial distress and corporate performance." *The Journal of Finance* 49 (3):1015-40.

Pindado, J., L. Rodrigues, and C. de la Torre. 2008. "Estimating financial distress likelihood." *Journal of Business Research* 61 (9):995-1003.

Powell, R., and A. Yawson. 2012. "Internal restructuring and firm survival." *International Review of Finance* 12 (4):435-67.

Roodman, D. 2011. "Fitting fully observed recursive mixed-process models with CMP." *Stata Journal* 11 (2):159-206.

Shumway, T. 2001. "Forecasting bankruptcy more accurately: A simple hazard model." *Journal of Business* 74 (1):101-24.

Song, S., S.-H. Lee, and M. Makhija. 2015. "Operational hedging in foreign direct investments under volatile and divergent exchange rates across countries." *Journal of World Business* 50 (3):548-57.

Sun, J., H. Li, Q.-H. Huang, and K.-Y. He. 2014. "Predicting financial distress and corporate failure: A review from the state-of-the-art definitions, modeling, sampling, and featuring approaches." *Knowledge-Based Systems* 57:41-56.

Tinoco, M. H., and N. Wilson. 2013. "Financial distress and bankruptcy prediction among listed companies using accounting, market and macroeconomic variables." *International Review of Financial Analysis* 30:394-419.

Tirapat, S., and A. Nittayagasetwat. 1999. "An investigation of Thai listed firms' financial distress using macro and micro variables." *Multinational Finance Journal* 3 (2):103-25.

UNCTAD. 2009. "World investment report: Transnational corporations, agricultural production and development."

Wanke, P., C. P. Barros, and J. R. Faria. 2015. "Financial distress drivers in Brazilian banks: A dynamic slacks approach." *European Journal of Operational Research* 240 (1):258-68.

Wilde, J. 2000. "Identification of multiple equation probit models with endogenous dummy regressors." *Economics Letters* 69 (3):309-12.

Wruck, K. H. 1990. "Financial distress, reorganization, and organizational efficiency." *Journal of Financial Economics* 27 (2):419-44.

Zmijewski, M. E. 1984. "Methodological issues related to the estimation of financial distress prediction models." *Journal of Accounting Research* 22:59-82.

Table 1: Financial distress identification

Distress	FD	ND	Total	%FD
FD1	4,885	122,278	127,163	3.8
FD2	16,214	90,812	107,026	15.2

FD and ND denote firms with and without financial distress. % FD is the percentage of financially distressed firms in the sample. Total is the number of observations under $FD1$ and $FD2$. FD1 and FD2 represent two proxies of financial distress described in Section 3.

Table 2: The effect of financial distress on profitability: Full sample

	Profitability							
FD1	-0.208***		-0.206***		-0.204***		-0.180***	
	(0.017)		(0.016)		(0.015)		(0.017)	
FD2		-0.151***		-0.151***		-0.153***		-0.143***
		(0.011)		(0.011)		(0.011)		(0.011)
RER	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
INV	0.146***	0.119***	0.145***	0.118***	0.145***	0.117***	0.146***	0.119***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
STKR	0.046***	0.038***	0.046***	0.038***	0.046***	0.037***	0.046***	0.038***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Region1	0.001	0.011	0.001	0.011	0.002	0.011	0.002	0.011
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Region2	-0.002	-0.004	-0.002	-0.004	-0.002	-0.004	-0.002	-0.004
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
	Financial Distress							
Model	1	1’	2	2’	3	3’	4	4’
EBT	-0.842***	-3.049***	-0.745***	-3.017***	-0.909***	-4.721***	-1.026***	-4.728***
	(0.022)	(0.034)	(0.022)	(0.034)	(0.027)	(0.074)	(0.030)	(0.084)
CACL	-0.294***	-0.268***	-0.097**	-0.167***	0.061	-0.253***	0.081	-0.243***
	(0.041)	(0.041)	(0.042)	(0.041)	(0.051)	(0.055)	(0.053)	(0.059)
TLTAD			0.428***	0.289***	0.443***	0.389***	0.427***	0.356***
			(0.029)	(0.031)	(0.037)	(0.046)	(0.039)	(0.048)
TDTA	-0.414***	-0.890***	-0.602***	-1.052***	-0.602***	-1.028***	-0.581***	-1.020***
	(0.039)	(0.036)	(0.039)	(0.037)	(0.047)	(0.049)	(0.049)	(0.053)
STKR					-0.107***	0.052***		
					(0.017)	(0.017)		
VRT							0.087**	0.466***
							(0.038)	(0.036)
Observations	101,751	86,937	106,113	90,656	81,095	67,972	79,223	67,842

Note: FD1 and FD2 are proxies for financial distress. Model(s) 1, 1’, 2 and 2’ are based on accounting approach while model (s) 3, 3’ and 4, 4’ are based on mixed approach. 1-4 are models used to predict FD1 while 1'-4' are models used to predict FD2Variables are denoted here as RER: Real interest rate; INV: investment; STKR: stock return; SAL: sales; CAP: capital; VRT: realised volatility; EBT: earnings before interest and taxes/total assets; CACL: current assets/current liabilities; TLTAD: dummy=1 if total liabilities exceed total assets otherwise 0; TDTA: total debts/total assets; RET: firms’ stock return. Region1 and Region 2 are Asia and Pacific and European regions respectively. Region 3 is used as a reference. Robust standard errors are in parenthesis. ***, **, indicate significance at 1%, and 5% respectively. Region 3 is used as a reference. Country dummy is included in model 1 and model 1’.

Table 3: Effect of financial distress on employment: Full sample

	Employment							
FD1	-0.807***		-0.802***		-0.824***		-0.973***	
	(0.011)		(0.011)		(0.020)		(0.008)	
FD2		-0.989***		-0.989***		-0.574***		-0.492***
		(0.004)		(0.005)		(0.008)		(0.006)
INV	0.087***	0.006***	0.083***	0.005***	0.074***	0.039***	0.030***	0.053***
	(0.005)	(0.002)	(0.005)	(0.002)	(0.005)	(0.004)	(0.006)	(0.004)
REV	0.540***	0.098***	0.543***	0.102***	0.512***	0.380***	0.432***	0.416***
	(0.008)	(0.029)	(0.008)	(0.033)	(0.008)	(0.008)	(0.021)	(0.007)
VRT	-0.297***		-0.298***		-0.273***		-0.320***	
	(0.007)		(0.007)		(0.010)		(0.008)	
Region1	0.044***	0.013**	0.043***	0.013**	0.042***	0.057***	0.020***	0.059***
	(0.009)	(0.006)	(0.009)	(0.006)	(0.009)	(0.008)	(0.006)	(0.009)
Region2	0.251***	0.036*	0.251***	0.038*	0.246***	0.227***	0.208***	0.238***
	(0.005)	(0.019)	(0.005)	(0.021)	(0.006)	(0.005)	(0.014)	(0.005)
	Financial Distress							
Model	1	1'	2	2'	3	3'	4	4'
EBT	-1.192***	-0.246**	-1.158***	-0.258**	-1.483***	-4.591***	-0.774***	-4.866***
	(0.020)	(0.102)	(0.021)	(0.120)	(0.035)	(0.085)	(0.135)	(0.084)
CACL	0.024	-0.039***	0.088**	-0.039***	0.230***	-0.203***	0.079**	-0.178***
	(0.038)	(0.010)	(0.039)	(0.011)	(0.045)	(0.045)	(0.031)	(0.053)
TLTAD			0.179***	0.007	0.057*	0.201***	-0.039*	0.188***
			(0.027)	(0.006)	(0.035)	(0.039)	(0.022)	(0.044)
TDTA	-0.539***	-0.039***	-0.621***	-0.043**	-0.570***	-1.099***	-0.127***	-1.176***
	(0.033)	(0.014)	(0.034)	(0.018)	(0.044)	(0.042)	(0.034)	(0.048)
SKRT					-0.025*	0.079***		
					(0.013)	(0.014)		
VRT							-0.725***	0.576***
							(0.025)	(0.031)
Observations	109,465	92,869	109,465	92,869	84,941	87,493	74,012	86,990

Note: Variable notations are from Table 2. Robust standard errors are in parenthesis. ***, **, indicate significance at 1%, and 5% respectively. Model(s) 1, 1', 2 and 2' are based on accounting approach while model (s) 3, 3' and 4, 4' are based on mixed approach. 1-4 are models used to predict FD1 while 1'-4' are models used to predict FD2.

Table 4: The effect of financial distress on R&D investment: Full sample

	R&D							
FD1	0.019		0.051		-0.701***		-0.004	
	(0.058)		(0.035)		(0.007)		(0.034)	
FD2		-0.211***		-0.235***		-0.090***		-0.078***
		(0.021)		(0.023)		(0.009)		(0.008)
RER	-0.009***	-0.009***	-0.005***	-0.007***	-0.008***	-0.009***	-0.008***	-0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
SAL	-0.071***	-0.282***	-0.082***	-0.301***	-0.102***	-0.241***	-0.072***	-0.238***
	(0.007)	(0.011)	(0.007)	(0.011)	(0.007)	(0.009)	(0.007)	(0.009)
CAP	0.059***	0.040***	0.062***	0.041***	0.060***	0.047***	0.059***	0.046***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Region1	0.220***	0.164***			0.201***	0.171***	0.219***	0.172***
	(0.006)	(0.007)			(0.006)	(0.007)	(0.006)	(0.007)
Region2	0.260***	0.211***			0.240***	0.219***	0.260***	0.220***
	(0.004)	(0.005)			(0.004)	(0.005)	(0.004)	(0.005)
	Financial Distress							
Model	1	1'	2	2'	3	3'	4	4'
EBT	-0.831***	-2.990***	-0.726***	-2.926***	-0.760***	-4.708***	-1.008***	-4.712***
	(0.021)	(0.042)	(0.022)	(0.045)	(0.022)	(0.074)	(0.030)	(0.084)
CACL	-0.185***	-0.441***	0.006	-0.374***	-0.260***	-0.359***	0.153**	-0.346***
	(0.068)	(0.046)	(0.057)	(0.047)	(0.050)	(0.057)	(0.066)	(0.061)

TLTAD			0.446***	0.232***	0.249***	0.352***	0.442***	0.327***
			(0.030)	(0.031)	(0.032)	(0.046)	(0.039)	(0.048)
TDTA	-0.403***	-0.819***	-0.638***	-0.924***	-0.363***	-0.966***	-0.607***	-0.967***
	(0.042)	(0.038)	(0.042)	(0.041)	(0.041)	(0.050)	(0.051)	(0.054)
STKR					-0.078***	0.047***		
					(0.014)	(0.016)		
VRT							0.080**	0.477***
							(0.038)	(0.036)
Observations	105,986	89,262	105,986	89,262	94,316	79,021	89,769	75,497

Note: Variable notations are from Table 2. Robust standard errors are in parenthesis. ***, **, indicate significance at 1%, and 5% respectively. Model(s) 1, 1', 2 and 2' are based on accounting approach while model (s) 3, 3' and 4, 4' are based on mixed approach. 1-4 are models used to predict FD1 while 1'-4' are models used to predict FD2.

Table 5: The effect of financial distress on profitability: Cross country comparison

Country	Canada	Germany	UK	Israel	Japan	Netherlands	USA
FD1	-0.320***	-0.478***	-0.574*	-0.532***	-0.499***	-0.380***	-0.214***
	(0.115)	(0.112)	(0.317)	(0.203)	(0.051)	(0.103)	(0.015)
RER	-0.010*	0.042	0.003	0.001	-0.002	0.005	-0.003***
	(0.005)	(0.040)	(0.007)	(0.002)	(0.013)	(0.004)	(0.001)
SAL	0.128*	-0.342	0.252**	0.319***	0.257***	0.059	0.142***
	(0.072)	(0.223)	(0.101)	(0.106)	(0.086)	(0.085)	(0.011)
INV	0.266***	14.728***	0.318**	0.201***		0.121***	0.144***
	(0.066)	(1.183)	(0.142)	(0.054)		(0.038)	(0.009)
				Financial Distress			
EBT	-0.320*	-0.853*	-1.037***	-0.742***	-9.308***	-1.568**	-0.863***
	(0.194)	(0.468)	(0.269)	(0.204)	(2.174)	(0.723)	(0.022)
CACL	-0.526**	-0.436	-0.685	-0.626	1.616	-0.189	-0.297***
	(0.229)	(3.311)	(0.458)	(0.405)	(2.045)	(0.784)	(0.042)
TDTA	-0.957**	-0.502	0.466	-0.780**	-2.291**	-0.528	-0.418***
	(0.413)	(2.690)	(0.481)	(0.314)	(0.904)	(0.763)	(0.039)
Observations	5,238	316	1,470	1,461	699	661	95,581

Note: Variable notations are from Table 2. Robust standard errors are in parenthesis. ***, **, indicate significance at 1%, and 5% respectively.

Table 6: Effect of financial distress on employment: Cross country comparison

Country	Australia	Canada	UK	Japan	Netherlands	USA
FD1	0.566**	-0.986***	-0.857***	0.018**	-0.270***	-0.944***
	(0.253)	(0.094)	(0.098)	(0.008)	(0.040)	(0.018)
RER	-0.011	-0.004	-0.001	-0.000	-0.000	-0.006***
	(0.007)	(0.003)	(0.004)	(0.001)	(0.002)	(0.001)
SAL	0.287***	0.257***	0.108***	-0.020	0.157***	0.280***
	(0.062)	(0.026)	(0.030)	(0.014)	(0.040)	(0.010)
INV	0.850***	0.487***	0.361***		0.020	0.128***
	(0.067)	(0.022)	(0.036)		(0.020)	(0.008)
			Financial Distress			
EBT	1.034***	-0.477**	-1.929***	-11.703***	-2.106***	-1.379***
	(0.273)	(0.199)	(0.235)	(2.697)	(0.767)	(0.079)
CACL	-1.955**	-0.326	0.300	0.530	0.383	0.084***
	(0.906)	(0.226)	(0.342)	(1.368)	(0.594)	(0.027)
TDTA	-1.026	-1.298***	0.319	-1.596	-1.656***	-0.473***
	(1.091)	(0.410)	(0.371)	(1.012)	(0.585)	(0.046)
Observations	359	5,342	1,513	703	678	100,436

Note: Variable notations are from Table 2. Robust standard errors are in parenthesis. ***, **, indicate significance at 1%, and 5% respectively.

Table 7: Effect of financial distress on R&D investment: Cross-country comparison

Country	UK	Israel	Japan	USA
FD1	0.115**	-0.431***	-0.359***	0.224***
	(0.056)	(0.069)	(0.053)	(0.017)
RER	0.002**	-0.000	0.011	-0.017***
	(0.001)	(0.003)	(0.011)	(0.001)
INV	0.064***	0.046**		0.166***
	(0.020)	(0.021)		(0.005)
		Financial Distress		
EBT	-0.770***	-0.895***	-9.811**	-0.900***
	(0.197)	(0.235)	(4.723)	(0.022)
CACL	-0.303	-0.614	-0.002	-0.118***
	(0.443)	(0.389)	(0.713)	(0.044)
TDTA	-0.968***	0.256	-1.593**	-0.484***
	(0.348)	(0.425)	(0.630)	(0.040)
Observations	1,556	1,534	706	101,467

Note: Variable notations are from Table 2. Robust standard errors are in parenthesis. ***, **, indicate significance at 1%, and 5% respectively.

Table 8: Effect of financial distress on R&D under hedging: Cross country comparison

Method			CMP			G1	G2
Country	Canada	Israel	Netherlands	USA	Full sample	Full sample	Full sample
FD1	0.357***	0.033	0.086*	0.117***	0.107***	0.039**	-0.007
	(0.074)	(0.065)	(0.046)	(0.013)	(0.013)	(0.016)	(0.005)
STKR	-0.003	-0.020		-0.013**	-0.011**	-0.011**	0.007***
	(0.031)	(0.017)		(0.005)	(0.005)	(0.005)	(0.001)
HED	-0.000	-0.000***	-0.000*	-0.000***	-0.000***	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
HED*FD1	0.635***	0.115**	0.000	0.000**	0.000*	0.000***	0.000*
	(0.011)	(0.057)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Lag R&D							0.976***
							(0.003)
EBT	-0.330*	-0.758***	-1.455**	-0.865***	-0.841***		
	(0.195)	(0.202)	(0.720)	(0.022)	(0.021)		
CACL	-0.517**	-0.442	0.199	-0.281***	-0.241***		
	(0.226)	(0.432)	(0.773)	(0.041)	(0.040)		
TDTA	-0.968**	-0.927***	-0.472	-0.420***	-0.385***		
	(0.411)	(0.347)	(0.753)	(0.039)	(0.038)		
Observations	5,190	1,459	612	92,632	103,836	16,437	16,278

Note: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. HED is hedging and for other notations see Table 2. G1 is an IV-model) and G2 is an IV model with a lag of R&D.

Online Appendix

Figure 1 depicts an overview of a conceptual framework for our analysis. The arrows indicate that a potential bi-directorial causality may exist between the two variables. The role of hedging is incorporated to allow the MNCs in minimising the effects of financial distress on R&D investments. In that sense, hedging strategy plays a significant role in R&D investment decision.

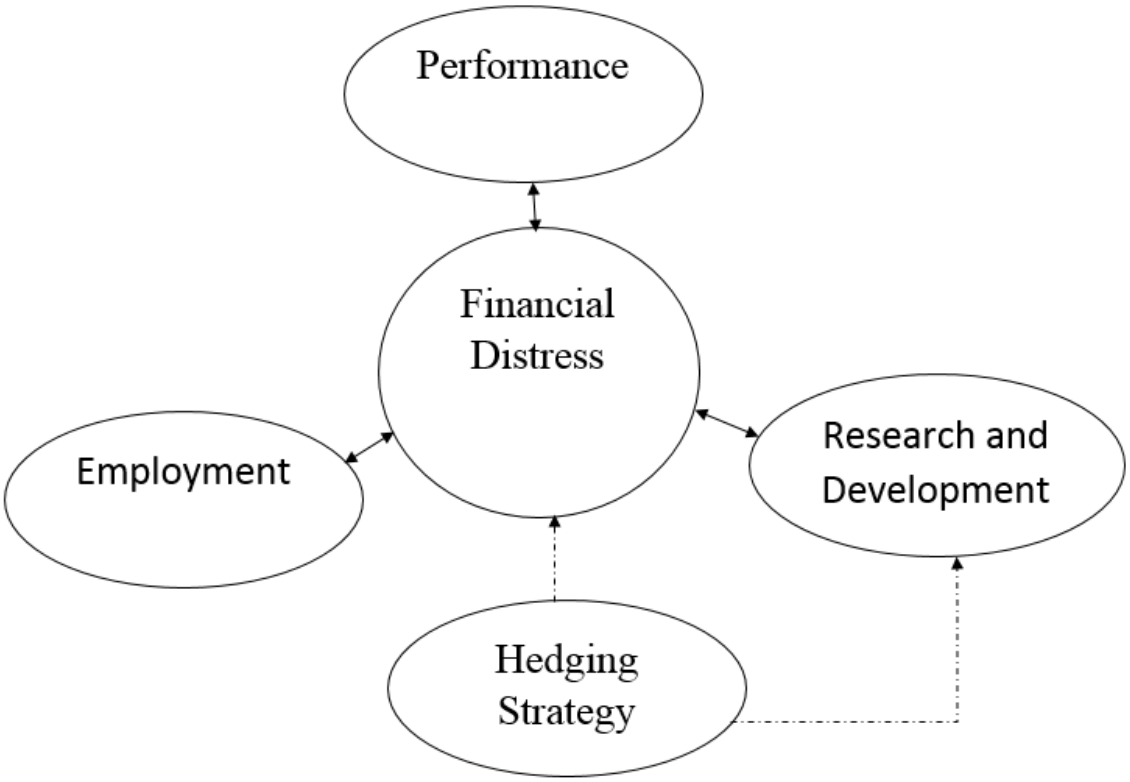

Figure A1: A schematic framework of financial distress with hedging as a policy suggestion for R&D investment.

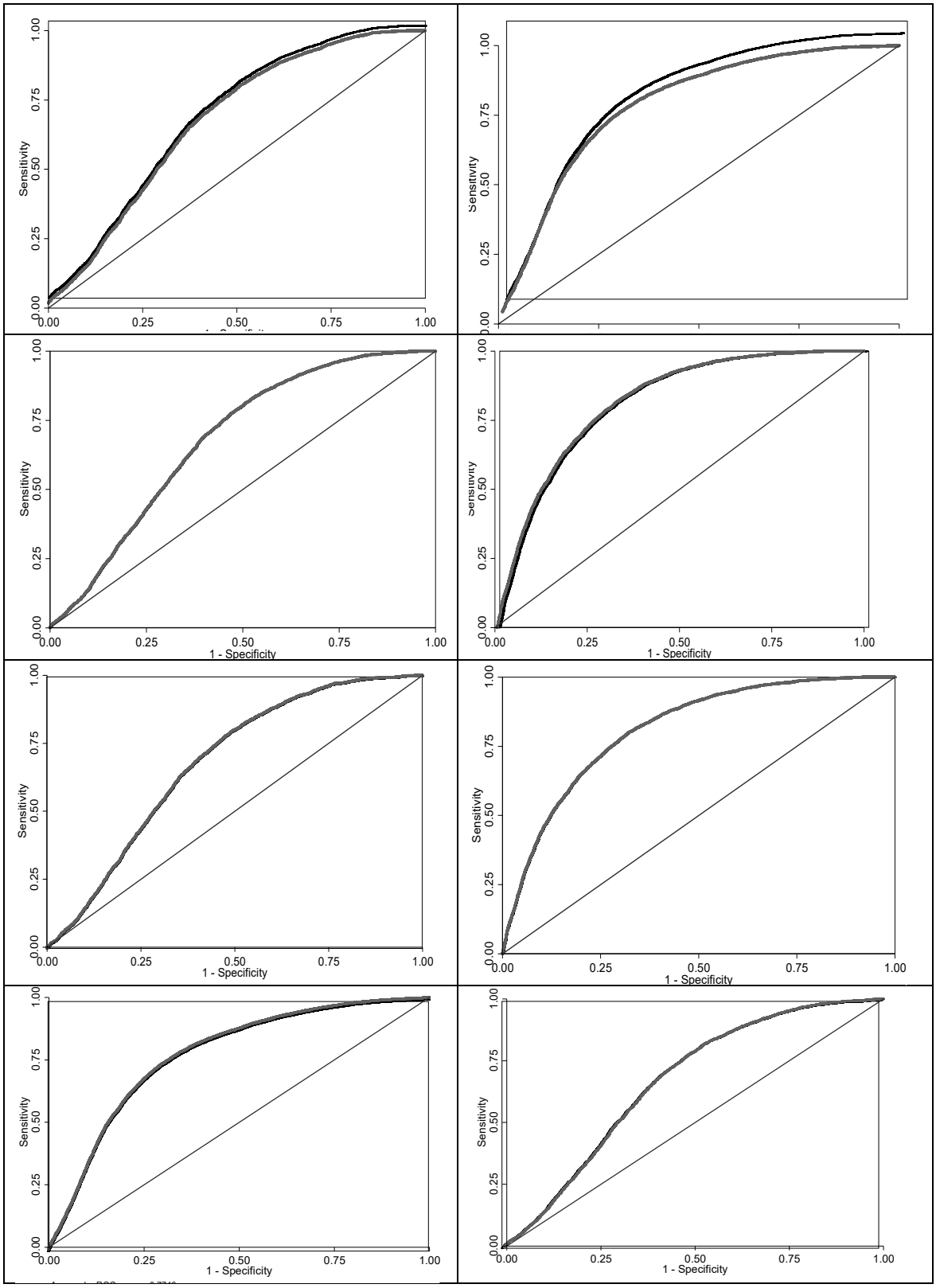

Figure A2: The figures represent the areas under the ROC curve. The left wing (top-bottom) contains the graphs from model $1-4$. Similarly, the graphs from model $1'-4'$ are in the right wing. The graphs are from the conditional logit predictions.

The panel descriptive statistics are presented in Table A1 while the descriptive statistics of financial distress and other controls for the eleven countries are presented in Table A2. Following descriptive statistics under FD1 measurements, the MNCs domiciled in Israel and U.S. have the highest financial distress values in the current sample. Table A3 presents the correlation matrix of the variables for prediction models, with the findings indicating the absence of multicollinearity.

Table A1: Descriptive Statistics (Panel)

Variable	Observation	Mean	Standard Deviation
FD1	127,163	0.03	0.19
FD2	107,026	0.15	0.35
EBT	117,606	0.00	0.22
VRT	75,463	0.18	0.21
SAL	118,336	0.64	0.29
STKR	87,316	-0.02	0.45
EMP	107,239	0.56	0.40
REV	135,532	0.94	0.21
INV	135,769	0.90	0.35
CACL	108,102	0.87	0.19
TLTAD	136,383	0.06	0.24
TDTA	118,237	0.24	0.21
RER	130,868	4.66	2.03
PRO	101,094	4.94e-11	0.51
R&D	74,784	0.69	0.41
CAP	118,541	0.54	0.32
HED	27,241	-3.26	106.98

Note: Variable notations are from Table 2.

Table A2: Descriptive Statistics by Country

Variable	N	Mean	Min	Max	N	Mean	Min	Max
Australia					**Canada**			
FD1	402	0.01	0	1	5819	0.01	0	1
FD2	278	0.18	0	1	3017	0.20	0	1
EMP	325	19.07	0	182.33	4285	5.26	0	125.15
R&D	252	16.12	0	244	2359	52.68	-0.26	5496
PRO	198	-4.35e-10	-3.64	4.36	2204	2.67e-10	-7.41	4.76
HED	65	-7.24	-417	127	1405	0-.49	-317	598
France					**Germany**			
FD1	506	0.01	0	1	366	0.013	0	1
FD2	328	0.12	0	1	330	0.09	0	1
EMP	512	67.32	0.04	427.92	369	108.89	0.01	572.8
R&D	399	622.03	0.84	10092.58	333	1569.54	1.70	14035.29
PRO	282	2.32e-10	-1.75	3.64	296	-5.15e-10	-2.12	1.34
HED	83	56.98	-174.99	1280.66	72	184.15	-299.96	2805.35
Ireland					**Israel**			
FD1	526	0.01	0	1	1583	0.051	0	1
FD2	420	.1	0	1	1211	0.30	0	1
EMP	532	25.13	0.00	275	1275	1.38	0	45.94
R&D	432	171.78	0.03	1976	1534	21.30	-0.1	2188
PRO	411	0.00	-8.22	1.90	1197	-2.17e-10	-4.02	2.39
HED	227	-4.10	-265	365.07	640	-0.80	-197	14.77
Japan					**Mexico**			
FD1	754	0.012	0	1	368	0.00	0	1
FD2	640	0.01	0	1	228	0.01	0	1
EMP	692	90.88	0.152	384.58	342	25.83	.2	248.24
R&D	653	1526.17	0	10924	65	1.41	0	11.03
PRO	607	3.65e-10	-1.09	1.32	196	4.75e-12	-2.15	2.27
HED	155	-7.55	-316.24	75.96	62	-10.67	-94.46	3.82
Netherlands					**United Kingdom**			
FD1	739	0.02	0	1	1674	0.010	0	1
FD2	606	0.10	0	1	1324	0.09	0	1
EMP	725	50.846	0.06	341.90	1670	27.74	.001	245.66
R&D	500	460.36	0	3430.52	1018	318.47	0	6860.21
PRO	605	2.33e-10	-1.70	1.52	1268	-0.01	-6.53	3.15
HED	171	85.63	-458.28	3545.71	230	-37.61	-1246	1090
USA								
FD1	114426	0.04	0	1				
FD2	98644	0.150	0	1				
EMP	112166	6.93	0	2200				
R&D	67239	60.83	-0.51	12183				
PRO	93830	4.25e-11	-7.15	4.89				
HED	24131	-4.49	-5300	2009				

Note: Variables are measured in millions, with the exception of employment that is measured in thousands, PRO is a residual, represents profitability. N=the number of observations.

Predictions of financial distress

This section focuses on the financial distress prediction models and applies the hazard, and the conditional logit estimation approaches to predict the likelihood of financial distress across MNCs. The predictive strength of the accounting-based model is described in Models 1 and 2, while Models 3 and 4 are mixed. These models are repeated with the second proxy (FD2) of financial distress in specifications 1' to 4', respectively. Table A3 presents the findings from the panel conditional logit (columns 1-4), and the findings from hazard models in columns 5 -8.

Table A3: Area under the receiver operating characteristics (ROC) curve

	Conditional Logit				Hazard			
Model	N	AUC	SE	AR	N	AUC	SE	AR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	18,549	0.67	0.00	0.34	7,480	0.72	0.03	0.44
2	13,760	0.68	0.00	0.36	6,485	0.73	0.03	0.46
3	11,696	0.68	0.00	0.36	6,065	0.75	0.02	0.50
4	18,549	0.67	0.00	0.34	7480	0.72	0.03	0.44
1’	31,539	0.77	0.00	0.54	5,207	0.90	0.01	0.80
2’	18,437	0.82	0.00	0.64	4,340	0.93	0.01	0.86
3’	15,189	0.81	0.00	0.62	4,053	0.90	0.02	0.80
4’	31,539	0.77	0.00	0.54	6361	0.75	0.02	0.50

$1-4$ are models used to predict $FD1$ while $1'-4'$ are models used to predict $FD2$. N represents the number of observations. AUC is the area under the ROC curve estimated as the Wilcoxon statistic. AR is the accuracy ratio, which is computed as 2*(AUC-0.5). SE represents standard error. The conditional logit models are used to predict FD for years prior to 2008 while the Hazard model are used to predict distress for years after 2009. The subdivision is due to large sample size, which facilitates the computation of the values and only e(sample) is used.

To ascertain the overall performance, the receiver operating characteristics (ROC) curve is used. A direct and an appropriate measure of the predictive power of models developed from a logit method are represented by the area under the ROC curve, denoted by AUC. The accuracy ratio (i.e., 2*[AUC-0.5]) underpins the discriminating power of this model. By examining the AUC, as well as the overall classification accuracy, the strength of these models can be predicted. Also, the graphical representation of the result of the AUC

obtained through the conditional logit approach is presented in Figure 2.[11] The findings highlight that Model 2 has the highest accuracy ratio, while the areas under the ROC curve are 0.82 and 0.93 under the conditional and hazard models, respectively. The corresponding accuracy ratios are given in Table 2, and Figure A2(Online Appendix) presents the graphs under the conditional logit model. The findings of the conditional fixed effects specification partially favor the mixed model.

[11] The AUC is a measure of a performance metric for a logistic regression, commonly used for binary classification problems (in our case predicting financial distress).