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Monitoring Mechanisms, Managerial Incentives, Investment Distortion Costs, and Derivatives Usage*

Jingjing Huang[a], Chen Su[b], Nathan Lael Joseph[a], Dudley Gilder[a]

[a] Aston Business School, Aston University, Aston Triangle, Birmingham B4 7ET, UK

[b] Newcastle University Business School, 5 Barrack Road, Newcastle upon Tyne NE1 4SE, UK

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Abstract

We relate derivatives usage to the level of corporate governance/monitoring mechanisms, managerial incentives and investment decisions of UK firms. We find evidence to suggest that the monitoring environment, e.g., board size, influences the use of both currency and interest rate derivatives usage. Managerial compensation also influences derivatives usage. Investment decisions are affected by the governance and managerial compensation of firms, which in turn impact on derivatives usage. We find a strong tendency for UK firms to reduce derivatives usage in situations where derivatives usage should be increased. There is limited evidence that firms use hedging substitutes to avoid monitoring from external capital markets.

Key words: Corporate hedging; corporate governance (CG); agency problem; under/overinvestment; logistic regression

JEL Classification: G32; G33; G34; C12; C35

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* E-mails: Huangj5@aston.ac.uk (J. Huang; corresponding author); chen.su@ncl.ac.uk (C. Su); n.l.joseph@aston.ac.uk (N.L. Joseph); d.gilder@aston.ac.uk (D. Gilder).

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1. Introduction

The corporate governance (CG) arrangements of firms and their level of executive remuneration are important areas of public interest and academic research.[1] Firm performance has been attributed to the strength of their CG and monitoring arrangements as well as the degree of alignment between managerial and shareholder interests (Gompers et al., 2003; Cremers and Nair, 2005).[2] Theoretical work relates investment decisions to executive remuneration (see Jensen and Meckling, 1976; Myers, 1984), such that, depending on the types of managerial incentives, managers can maximise their personal wealth at the expense of shareholders. The more convex the pay structure of managers, the less incentive managers have to manage risk (Smith and Stulz, 1985). Thus, both the extent of monitoring mechanisms and the types of managerial incentives can cause managers to take on more risk when they stand to benefit more than shareholders from investment decisions. Tufano (1996), for example, reports that managers holding stock options, manage a smaller proportion of the firm's risk, whereas those holding common stocks manage more risk. In situations of manager-shareholder conflicts, investment distortions occur, such that managers reject positive net present value (NPV) projects (underinvestment distortion) and undertake value destroying investment projects (overinvestment distortion). Risk management theories provide a role for the use of derivatives to manage managerial incentives and to reduce investment distortion and agency costs (Smith and Stulz, 1985; Froot et al., 1993; Tufano, 1998). The UK Financial Reporting Council (2014) indicates that the board of directors is ultimately responsible for risk management and internal control.[3] However, the effectiveness of the monitoring mechanisms within firms may reflect the desire of internal directors to limit the moderating effects of monitoring mechanisms in order to enhance managerial wealth.[4] In this case, the use of derivatives will depend on the strength of the monitoring mechanisms in place as well as the desire of managers to gain an advantage from investment decisions. Investment distortion costs can also occur if firms use hedging substitutes rather than financial derivatives to manage their risk (see Tufano, 1998).

This paper, therefore, examines the linkages between derivatives usage and monitoring mechanisms and how they relate to managerial incentives and investment decisions. We use a sample of UK listed non-financial firms for this purpose. If firms with higher monitoring mechanisms and managerial incentives also make greater use of derivatives, this finding would be consistent with the view that firms establish monitoring mechanisms to protect the interests of both managers and shareholders. A negative relation is indicative of risk

[1] The voluntary code of conduct on CG and executive remuneration for UK listed firms are contained in a series of reports for practitioners (The Cadbury Report, 1992; The Hampel Report, 1998; The Walker Review, 2009; The UK Financial Reporting Council, 2010). Regulatory changes have been especially pronounced for US firms in the form of legally enforceable rules of the Sarbanes–Oxley Act of 2002 and the Dodd–Frank Act 2010.

[2] Hereafter, we use the expressions of CG and monitoring mechanisms interchangeably.

[3] The UK code of conduct requires that directors of listed firms comply or explain their approach to monitoring risk (Cadbury Report, 1992). The UK Financial Reporting Council (2014, p. 3) gives the board of directors "ultimate responsibility for risk management and internal control, including for the determination of the nature and extent of the principal risks it is willing to take to achieve its strategic objectives and for ensuring that an appropriate culture has been embedded throughout the organization".

[4] The UK government has made several attempts to provide a legislative framework to ensure that shareholders control and vote on the level of directors' remuneration. These attempts have failed to varying degrees (Available at: https://goo.gl/cM8abQ).

taking to benefit managers more than shareholders. Also, if inside dominated boards make greater use of derivatives, this would suggest that derivatives are used to enhance both shareholder and managerial interests. Depending on the circumstances that firms are facing, the extent of monitoring may be influenced by regulatory changes that require greater oversight by both external and internal directors.[5] We focus on situations where firms use either currency or interest rate (IR) derivatives in the presence of investment decisions. Our approach is in line with agency costs, where investment decisions are not always aligned with shareholders' interest (Tufano, 1998).

The use of derivatives therefore provides a useful setting to carry out our tests, since firms use currency and IR derivatives for different reasons.[6] Specifically, currency derivatives are used to manage the exposure of foreign cash flows, whereas IR derivatives are used to manage exposure to IR changes and increase leverage (El-Masry, 2006; Bodnar et al., 2013). Since the UK bankruptcy codes favour creditors more than shareholders (Franks et al., 1996), UK firms might have more concerns over expected liquidity and financial distress costs, compared to the effects of currency fluctuations on foreign cash flows. Of course, some firms use both currency and IR derivatives and we deal with this aspect separately. Whether firms use currency or IR derivatives depends on their circumstances. Currency derivatives users are more likely to be global firms. IR derivatives users are likely to be more national in their orientation although IR derivatives can also be used to manage the risk associated with foreign debts. The use of IR derivatives is an important element of capital structure decisions (Borokhovich et al., 2004; Visvanathan, 1998), with IR derivatives being used to support credit rating upgrades (Simkins and Rogers, 2006).

Our paper focuses on four main issues: (i) the extent to which monitoring mechanisms relate separately to currency and IR derivatives usage; (ii) the relation between managerial incentives/compensation and derivatives usage; (iii) the link between derivatives usage and investment distortion costs; and (iv) the relation between the use of hedging substitutes and derivatives usage. In the latter case, firms may use hedging substitutes rather than derivatives to avoid external monitoring by external markets. An important setting for these issues is with respect to investment distortion costs. Tufano (1998) shows that firms can implement risk management programmes to manage internal cash surpluses and shortages and, in turn, reduce investment distortion costs.

To undertake our study, we analyse separate sub-samples of currency and IR derivatives users and contrast their attributes with those of non-users. This approach allows us to link the explanations for derivatives usage more tightly with the theory, since firms use currency and IR derivatives for different reasons. We measure

[5] Firms have also incurred substantial losses through misuse of derivatives. Examples of large derivatives related losses are: (i) US$1.3 billion by Metallgesellschaft due to the use of energy derivatives and swaps; and (ii) US$1.7 billion loss by Orange County, California (Available at: https://goo.gl/A1x3rx).

[6] Our currency derivatives users are firms that use only currency forwards, currency rate swaps and futures, currency options and/or other currency derivatives and combinations. IR derivatives users are firms that use only IR swaps, IR options, IR futures, forward rate agreements, and/or other types of IR derivatives. This categorisation is standard in empirical work (see Borokhovich et al., 2004; Nelson et al., 2005; Panaretou, 2014). Using a broad grouping allows for easier explanations of relation between derivatives usage and monitoring mechanisms and managerial incentives (see Lel, 2012). Collectively, we refer to currency and IR users as derivatives users.

monitoring mechanisms using: (i) the natural logarithm of one plus the value of our own constituted CG index (*LnCG_Index*); (ii) the natural logarithm of board size (*LnBoard_Size*); and (iii) the percentage of non-executive directors on the board (*NED*). Similar to *LnBoard_Size* and *NED*, we view the *LnCG_Index* as a proxy for the monitoring environment. Managerial incentives are measured using the book value of stock compensation divided by market value (*Stock_CompMV*), and the book value of executive compensation divided by market value (*Executive_CompMV*).

Each set of derivatives users is benchmarked against a set of non-users that has either currency and/or IR exposure, but does not hedge. Indeed, our non-users specifically indicate in their financial reports that they do not use derivatives, despite having exposures to exchange rate and/or IR changes. The distinction between the types of derivatives users and non-users, and their monitoring environments is economically important in three respects. First, more firms use currency derivatives than IR derivatives and more large firms use derivatives than small firms (Bodnar et al., 1996; Panaretou, 2014). Second, the use of derivatives carries substantial financial risks. Indeed, UK treasury functions require authorisation from the board of directors about the type and amount of derivatives to use and the level of counterparty risk to accept (Grant and Marshall, 1997). The financial reports of many of our derivatives users indicate that their chief executive officers (CEOs) and internal directors actively participate in risk management decisions. This level of participation by executives provides ample opportunity to create an internal control environment that favours their interests. Firms that use derivatives are likely to have stronger monitoring mechanisms because of the additional risk associated with using derivatives. While non-users would also likely have monitoring mechanisms in place, we predict that their monitoring mechanisms will not be as strong as those of derivatives users. Finally, decisions regarding derivatives usage are determined endogenously, based on attributes, such as board size, board structure, and compensation plans. Adams et al. (2010, p. 59) make related arguments that are not associated with derivatives usage.[7] While we contrast the attributes of users and non-users and test them against theoretical predictions, the endogeneity problem does not go away for either set of firms, since managers can control both monitoring mechanisms and derivatives usage to achieve the desired effects. It is hard to see how this endogeneity problem can go away entirely (see Géczy et al., 1997), even if we use the predicted values of our monitoring and managerial compensation variables from instrumental variables–generalised method of moments (IV–GMM) estimations. We also estimate a set of IV–probit regressions.

Using two-stage logistic regressions, we do not find a significant relation between currency derivatives usage and our *LnCG_Index*^{P} (baseline and interaction models).[8] However, IR derivatives usage is positively related to *LnCG_Index*^{P} (p-value ≤ 0.01). Currency (IR) derivatives usage is also positively (negatively) related to *LnBoard_Size*^{P} (p-value ≤ 0.10), whereas the use of currency and IR derivatives is negatively related with *NED*^{P}. The negative coefficients for some of the monitoring mechanism variables are not in line with the theory. Since we find positive coefficients for these variables using the IV–probit regressions, we believe that some

[7] We thank an anonymous reviewer for pointing this out to us.

[8] We use the superscript ^{P} to denote the coefficient that is associated with the predicted values from the IV–GMM estimations.

of the contradictions in our results might be because the predicted values from our IV–GMM are not too reliable. Interacting each monitoring variable with free cash flow, *Q*, and *Z*-score typically generates negative coefficients across our estimation methods.[9] Generally, firms with low values on these interaction terms have negative coefficients, although there is a small tendency for the relation to be *U*-shaped in high and low values. For IR derivatives usage, the relation between usage and these measures is also negative, suggesting risk-shifting. In general, the monitoring mechanism variables multiplied by high and low values of variables that proxy for investment opportunities, e.g., free cash flow, have reducing effects on derivatives usage. Firms with low *Q*, low *Z*-score, and low free cash flows have poorer economic prospects than firms with high values on these measures. Derivatives usage tends to be negatively related with high and low values of these measures.

The choice of compensation contracts can depend on the expected level of financial distress (Gilson and Vetsuypens, 1993). Smith and Stulz (1985) predict a positive relation between managerial wealth and the variability of firms' expected profits. For all our estimates, the use of currency and IR derivatives is positively related to $Stock\_CompMV^P$ and $Executive\_CompMV^P$ (p-value ≤ 0.10), although currency derivatives usage has mixed coefficient signs in our two-stage logistic regressions. Prior studies suggest that managerial compensation and investment decisions are linked, causing managers to take on more risk (Tufano, 1996). We corroborate prior results, but only for high and low values of investment decision variables. Our results for the use of hedging substitutes are generally weak.

The papers by Judge (2006), Belghitar et al. (2008), and Panaretou (2014) are the closest to ours in a UK context. However, these papers differ from ours in several important respects.[10] While Judge (2006) and Belghitar et al. (2008) use three-year averages of financial data. We use up to 11 firm-year observations. Our approach permits more variation across firms. Similar to our study, Belghitar et al. (2008) appear to separately analyse currency and IR derivatives users. Panaretou (2014, p. 1,180) uses the ratio of "… the top-five insider holdings of common stocks to total shares …" and institutional shareholdings as CG measures. We use a 14-binary component CG-index. We take a country-specific approach as this allows us to directly capture the specific attributes associated with managerial compensation plans and monitoring mechanisms.

Theoretically, firms use currency derivatives to: (i) reduce expected tax liabilities associated with pre-tax profit volatility (Smith and Stulz, 1985); (ii) reduce expected investment distortion costs (Bessembinder, 1991; Froot et al., 1993); and (iii) reduce managerial risk aversion and enhance managerial compensation plans (Smith and Stulz, 1985). Similarly, firms use IR derivatives to: (i) reduce the risk of financial distress and bankruptcy

[9] *Low* (*High*) denotes the bottom third (top third) of observations for a variable, in each sample of currency, IR, and combined derivatives users and non-users.

[10] Other studies that differ from ours include Bartram et al. (2009). They undertake a cross-country study that includes UK firms. Their paper employs financial variables for derivatives users and non-users and variables concerned with ownership concentration and (external) investor protection. They do not consider internal governance and board structure. Also, Borokhovich et al. (2004) examine IR derivatives usage for US firms. They include variables, such as board composition and structure as well as ownership structure, but do not consider non-users and currency derivatives users.

costs (Smith and Stulz, 1985; Stulz, 1996); and (ii) increase leverage and protect expected interest tax shields (Leland, 1998; Graham and Rogers, 2002). Our hypotheses relate to some of these theoretical predictions.

The next section presents a brief overview of theoretical and empirical work from which we develop our hypotheses. Section 3 presents the methodology and the data sets. Our empirical results are presented in Sections 4 and 5, and we conclude in Section 6.

2. Background and Hypotheses

This section presents our hypotheses. We link the hypotheses for monitoring mechanisms and managerial incentives with derivatives usage and explain the importance of using derivatives in investment decisions.[11] Our hypotheses are set in general terms.

2.1. Derivatives usage and monitoring mechanisms

Firm value, agency conflicts, and corporate performance differ between poorly and well-governed firms (see Chhaochharia and Grinstein, 2007; Hoechle et al., 2012). Relative to inside directors, outside directors have incentives to act and make decisions that are in the best interests of shareholders (Fama and Jensen, 1983). A larger number of NEDs does not imply greater internal control and more effective monitoring (Jensen, 1993; Guest, 2009), if also, the CEO's power base increases and NEDs engage in free-riding (Adams et al., 2005; Faleye, 2015). Géczy et al. (2007) find that weaker firm-wide governed firms use derivatives more for speculative reasons than to reduce firm level risk. However, such firms have more internal monitoring and internal control in place to avoid potential abuses. Monitoring mechanisms can benefit directors more than shareholders, even in the absence of speculation. One approach is to bias the board size towards internal rather than external directors; another approach is to maintain CEO-chair duality. This way, internal directors and CEOs have more control over the extent of monitoring and the way derivatives are used to enhance their own interests. If monitoring mechanisms are weak, managers are more likely to use derivatives for their own benefit (Bartram et al., 2009; Lel, 2012). However, Borokhovich et al. (2004) find a positive relation between the proportion of outside directors and IR derivatives usage, indicating that outside directors actively participate in decisions about derivatives usage to protect shareholders' interests. Collectively, these findings suggest that risk management strategies might be influenced by the monitoring mechanisms in place. Thus we hypothesise that:

> ***H_1*: *Derivatives usage is positively related to the monitoring mechanisms within firms.***

We measure monitoring mechanisms using: (i) the natural logarithm of one plus our CG-index (*LnCG_Index*); (ii) the natural logarithm of total board membership (*LnBoard_Size*); and (iii) the percentage of non-executive directors and total number of directors (*NED*). Our CG-index is based on zero/one dummy variables comprising 14 components such as CEO-chair separation, presence/absence of a remuneration committee, and

[11] We do not specifically establish a hypothesis for taxation. However, we use the ratio of total tax payments divided by total pre-tax income (*TXR*) to test for a negative relation between *TXR* and derivatives usage. Theoretically, firms use derivatives to minimisation tax payable (Smith and Stulz, 1985).

so on (see Appendix II). The components of our CG-index are primarily concerned with internal monitoring.[12] This is because the UK Financial Reporting Council (2014) makes directors directly responsible for risk management.

There is widespread agreement that a good set of monitoring mechanisms contains attributes that enhance board effectiveness. However, the choice of the particular set of monitoring mechanisms is not straightforward. For example, agency theory favours CEO-chair separation to control managerial self-interest and to reduce agency costs. The stewardship perspective supports CEO-chair duality as a way of preserving good stewardship and ensuring managerial control. Goyal and Park (2002) find that poorly performing CEOs are less likely to be dismissed if they have both CEO and Chair roles. However, high-ability CEOs may be awarded a combined title for good performance, meaning that CEO power is determined endogenously.[13] Board independence is not directly measurable since it depends on the balance of power between the CEO and the board. We see *LnBoard_Size* and *NED* as constraints on CEO power, even if they may not adequately proxy for the degree of CEO control. Up to a point, the benefits of large boards decrease, such that size outweighs the benefits of more expertise. Harris and Raviv (2008) show that shareholders benefit from insider-controlled boards if they are able to exploit internal information. Thus, either small or large boards are suitable, depending on board composition and firm characteristics (Coles et al., 2008; Han et al., 2016).

2.2. Managerial incentives and derivatives usage

Theoretically, corporate hedging increases firm value to benefit shareholders, bondholders, and managers (see Smith and Stulz, 1985; Froot et al., 1993; Leland, 1998). Hedging is positively related to managerial compensation plans if managers are risk-averse and compensation plans are a concave function of firm value (Smith and Stulz, 1985). The expected utility of risk-averse managers is significantly affected by the variability of the firm's expected profits (Smith and Stulz, 1985), causing managers to hedge to protect their own wealth in the firm. CEOs with more equity wealth in the firm diversify more risk (May, 1995). However, Tufano (1996) finds that managers holding more stock options (stocks) manage less (more) risk. Remuneration committees are expected to have a moderating effect on pay (The Greenbury Report, 1995) and, in turn, the extent of risk taking. Guthrie et al. (2012) find that total CEO pay increases even in the presence of independent remuneration committees. The CG environment is considered to be an important mechanism to mitigate the excesses of executive remuneration and to reduce managerial entrenchment and agency costs (Borokhovich et al., 1996; Florackis and Ozkan, 2009). Veprauskaitė and Adams (2013) find a negative relation between CEO

[12] Chernenko and Faulkender (2011) consider managerial compensation plans for IR derivatives users, but do not consider monitoring mechanisms. Géczy et al. (1997) use managerial wealth and share option ownership to proxy for managerial incentives of users and non-users. Their managerial incentive measures are not significant.

[13] One can reasonably argue that existing empirical evidence does not overwhelmingly support the view that the separation of the CEO and Chair roles enhances corporate performance. There is weak support for the view that the choice of roles affects corporate performance based on industry adjusted market and accounting returns (Brickley et al., 1997). The performance of firms may become less variable or more variable as CEOs become more powerful (see Bertrand and Mullainathan, 2003; Adams et al., 2005). Firms that split the role of CEO-chair following investor pressure have lower market returns and lower financial performance (Dey et al., 2011).

power and firm performance. However, Tan and Liu (2016) find that CEO power negatively relates to idiosyncratic volatility. There is limited evidence to suggest that well-governed firms use derivatives to pursue value-enhancing objectives rather than pursue managerial self-interest (see Huston and Stevenson, 2010; Allayannis et al., 2012).[14] Since our firms do not engage in speculation in derivatives markets, we hypothesise that:

H_2*: *Derivatives usage is positively related to the level of managerial incentives.

Managerial incentives are measured using: (i) stock-related compensation divided by market value (*Stock_CompMV*) multiplied by 100; (ii) executive compensation divided by market value (*Executive_CompMV*) multiplied by 100; and (iii) *Stock Price_Volatility* measured as the average stock price divided by the range of the stock's price over the year. We do not use the value of stock option compensation contracts due to the large number of missing observations in our data.

2.3. Investment distortion costs

Investment distortion costs arise either because of cash shortages for investments (underinvestment costs) or the excess availability of cash (overinvestment costs). The use of derivatives is argued to reduce the cost of both investment distortion costs, such that managers are incentivised to take on value-enhancing projects (Lessard, 1991; Froot et al., 1993). The expected costs of financial distress will increase if managers do not accept positive NPV projects. It is relatively straightforward to think of firms with high underinvestment costs as pertaining to underperforming firms, such that they are characterised by low free cash flow, low *Z*-score values, and low *Q* and liquidity levels. In this case, information asymmetry and agency costs increase, and managers seek private benefits from investment decisions (Morrellec and Smith, 2007). Neither the level of leverage nor growth opportunities alone can adequately proxy for underinvestment costs, since firms can rely on internal funds in the short term. However, the monitoring mechanisms of firms can ensure that derivatives are used to mitigate the need for costly external financing and for firms to meet their debt obligations. Thus, we hypothesise that:

H_{3A}*: *Derivatives usage is positively related to measures that proxy for underinvestment costs.

The over- and underinvestment problems reflect two extreme points on what we refer to as the *leverage continuum*. Morrellec and Smith (2007) suggest that the over- and underinvestment problems are resolved when firms have optimal leverage. It is difficult to determine empirically at which point this is achieved. Géczy, et al. (1997), Bartram et al. (2009), and others use firm leverage (*Leverage*) to proxy for underinvestment. We use both firm-specific leverage (*Leverage*) and the industry average leverage (*IND_Avg_LEV*), depending on our treatment for endogeneity (see Section 4). To capture the liquidity constraints imposed by underinvestment,

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[14] The UK recommended CG guidance aims to enhance the manner in which UK listed firms are governed (see The Cadbury Report, 1992; The Greenbury Report, 1995; The Hampel Report, 1998). UK listed firms have become more compliant in adhering to the UK Financial Reporting Council (2015) recommendations. They states: "… full compliance by the FTSE 350 now at 61.2% and 93.5% complying with all but 1 or 2 provisions" (Available at: https://goo.gl/GTbf15).

we use interest coverage ratio (*Interest_Cover*), average debt to maturity (*Debt_Maturity*), long-term debts to total debts (*LT Debts_Total Debts*), and low free cash flow to total assets (*Low_Free-Cash-Flow_Total Assets*). Since underinvestment costs adversely impact firm value, we also test H_{3A} using low Q (*Low_Q*) and low Z-score (*Low_Z-score*).

As stated before, the availability of excess free cash flow enables entrenched managers to avoid the scrutiny of external capital markets. This creates opportunities for managers to pursue overinvestment strategies (Froot et al., 1993; Tufano, 1998). Risk management can limit the available cash flows under the control of managers to reflect the trade-off between under- and overinvestment distortion costs (Froot et al., 1993; Tufano, 1998). Since risk management and the use of derivatives will reduce the availability of cash under managers' control, we hypothesise:

> ***H*₃B: *The use of derivatives is negatively related to measures of overinvestment costs.***

Firms with high overinvestment costs are expected to have high free cash flow, Z-score, Q, and so on. The high values on these measures will incentivise managers to accept projects that are not value-enhancing. Monitoring by external markets is likely to resolve this problem when derivatives are used, since information asymmetry will be reduced (Titman, 1992). Thus, to proxy for overinvestment costs, we use free cash flow to total assets (*Free-Cash-Flow_Total Assets*) and high free cash flow to total assets (*High_Free-Cash-Flow_Total Assets*). We also use capital expenditures to property, plant and equipment (*CAP_Exped_PPE*), capital expenditures to total sales (*CAP_Exped_Total Sales*), high Q (*High_Q*), and high Z-score (*High_Z-score*). Firms with overinvestment costs are also predicted to have high values on research and development (R&D) to total assets (*R&D_Total Assets*).

2.4. Hedging substitutes and derivatives usage

If firms have excess free cash flow, this condition temporarily takes away the need for them to hedge in external markets. Indeed, "[w]hile cash-flow hedging takes away the need to obtain 'expensive' financing, it does so by eliminating the discipline that the capital markets would impose on firms attempting to fund poor projects" (Tufano, 1998, p. 68). This means that firms experiencing overinvestment costs will hedge using internal resources to avoid hedging in external markets (Lessard, 1991; Froot, et al., 1993). Both the use of hedging substitutes and the overinvestment problem increase agency costs as managers undertake value destroying projects (Lessard, 1991; Froot, et al., 1993; Stulz, 1998). Thus, we hypothesise that:[15]

> **H_4:** *Derivatives usage is negatively related to measures associated with hedging substitutes.*

Hedging substitutes are measured using convertible debts divided by total debts (*Convertible Debts_Total Debts*), fixed assets divided by total assets (*Fixed Assets_Total Assets*), current ratio (*Current Ratio*), the

[15] Nance et al. (1993) predict a negative relation between derivatives usage and debt instruments. Géczy, et al. (1997, p. 1329) predict a positive relation between derivatives usage and convertible debts and preferred stocks. If measures, such as *Current Ratio* and *LnPre_Tax_Income*, capture the use of hedging substitutes, their levels will be lower since firms cannot use hedging substitutes indefinitely. Thus, the predicted direction will be negative.

natural logarithm of pre-tax income (*LnPre_Tax_Income*), total cash divided by total assets (*Cash_Total Assets*), and return on assets (*ROA*). These measures can be viewed as available resources under management's control for internally funded projects (see Nance et al., 1993; Géczy, et al., 1997). As such, H_4 relates to H_{3B}.[16]

3. Data and Methodology

All the firms in our sample are UK non-financial listed firms. The firms are manually identified as derivatives users or non-users, using the notes in their financial reports, year by year, over the 2005 to 2015 period. The financial reports are available on each firm's website and on http://www.northcote.co.uk. Key words, such as forwards, swaps, derivatives, and so on, are used to identify each firm's approach to risk management. Non-users specifically indicate that they have hedgeable exposures but do not use derivatives.[17] In most cases, the notes in the financial reports specifically stated the risk management policies of firms with explicit statements as to whether the use of derivatives is allowed or forbidden. A small minority of non-users indicate that they have no IR exposure as they have no foreign deposits or domestic loans. We treat them as non-users with exposures.[18] Graham and Rogers (2002, p. 824) take a similar view stating that "… we can interpret the absence of derivatives [in 10-K forms filed] as a choice not to use derivatives, rather than possibly indicating a lack of exposure to hedgeable risks." None of our firms use derivatives for speculative reasons (see also Grant and Marshall, 1997, p. 198).

There are 14 components in our CG-index (see Appendix II). These components are taken from Datastream. The presence or absence of each component is used to construct a broad unweighted governance index across each firm for each year. Since we are contrasting users and non-users, we cannot use the notional value of derivatives positions as in Borokhovich et al. (2004), Hentschel and Kothari (2001), and others, to characterise derivatives usage, as this variable does not exist for non-users.

Our multivariate regressions seek to identify the statistical features for each group of derivatives users and non-users. To deal with potential endogeneity, we estimate IV–GMM regressions for each group of derivatives users and non-users. We prefer the GMM method to the two-stage least squares (2SLS), since the predicted

[16] The similarity in the predicted coefficient signs of H_{3B} (overinvestment) and H_4 (hedging substitutes) needs clarification. Firms must have excess free cash flow, high *Q*, and so on, to have an overinvestment problem. Thus, an overinvestment problem would exist for more healthy firms with excess financial resources. Since the use of (financial) derivatives by definition exposes firms to scrutiny in external financial markets, they would use their excess cash flows for productive investments. As such, cash flow and liquidity will be lower, in line with H_{3B}. Indeed, using risk management programmes can reduce the availability of excess resources in the hands of managers (Tufano, 1996). The evidence indicates that firms use IR derivatives to reduce information asymmetry and enhance credit quality (Titman, 1992; Simkins and Rogers, 2006). Users of hedging substitutes would use internal resources to meet the cash flow shortfalls associated with the negative effects of currency and IR fluctuations on operating cash flows. Froot et al (1993) predict that firms cannot use hedging substitutes indefinitely, meaning that they will eventually fail if they do not hedge. Thus, the predicted coefficient sign for both H_{3B} and H_4 is negative.

[17] Bango Plc's Annual Report (2011, p. 14) states "… the Group's activities expose it to some financial risks. The Group monitors these risks but does not consider it necessary to use any derivative financial instruments to hedge these risks."

[18] Augean PLC Annual Report and Accounts (2015, p. 75) states, "… the Group's financial liabilities include trade payables, debt and finance liabilities. Trade payables are not interest bearing and are recognised initially at fair value and carried at amortised cost. Debt is initially recognised at fair value less transaction costs and carried at amortised cost. The Group's policy is that no trading in financial instruments or derivatives shall be undertaken."

values under 2SLS may not be efficient even if they are consistent (see Green, 1990, p. 603). The GMM provides reliable estimates for inferences from most types of data sets (Hansen, 1982).

We consider *LnCG_Index*, *LnBoard_Size*, *NED*, *StockCom_MV*, *ExecutiveCom_MV* and *Leverage* to be endogenous in our estimations. This is for the following reasons: (i) monitoring mechanisms, such as *LnCG_Index* and *LnBoard_Size*, are determined by managers; and (ii) managerial compensation plans that are a convex function of firm value incentivise managers to take more risk (see Smith and Stulz, 1985). We treat firm *Leverage* as endogenous since firms hedge to reduce the probability of financial distress and bankruptcy costs (Smith and Stulz, 1985), and Brockman et al. (2010) show that short-term debt users reduce the agency costs arising from the risk associated with executive compensation. Indeed, Cole et al. (2006) find a strong causal relation between the structure of CEO compensation, investment and debt polices, and firm risk. Finally, Morrellec and Smith (2007, p.3) make it clear that the over- and underinvestment problems are resolved when "… optimal leverage reflects a trade-off between under- and overinvestment costs." Therefore, our full IV–GMM equation for each set of derivatives users and non-users is:

$$\begin{aligned}
&(Monitoring\ mechanism\ or\ Remuneration\ variable)_{i,t} \\
&\quad = \mu_1 + \lambda_1(Stock\ Price_Volatility)_{i,t} + \lambda_2(Interest_Cover)_{i,t} \\
&\quad + \lambda_3(Z\text{-}score)_{i,t} + \lambda_4(Debt_Maturity)_{i,t} \\
&\quad + \lambda_5(Free\text{-}Cash\text{-}Flow_Total\ Assets)_{i,t} + \lambda_6(EBIT_Market\ Value)_{i,t} \\
&\quad + \lambda_7(CAP_Exped_PPE)_{i,t} + \lambda_8(CAP_Exped_Total\ Sales)_{i,t} \\
&\quad + \lambda_9(R\&D_Total\ Assets)_{i,t} + \lambda_{10}(Q)_{i,t} + \lambda_{11}(Current\ Ratio)_{i,t} \\
&\quad + \lambda_{12}(LnPreTaxIncome)_{i,t} + \lambda_{13}(ROA)_{i,t} + \lambda_{14}(Dividend\ per\ Share)_{i,t} \\
&\quad + \lambda_{15}(LnMarket\ Value)_{i,t} + \lambda_{16}(LnTotal\ Assets)_{i,t} + \lambda_{17}(LnTotal\ Sales)_{i,t} \\
&\quad + \lambda_{18}(TXR)_{i,t} + YEAR + INDUSTRY + ((Leverage)_{i,t} \\
&\quad = Instrumental\ variables) + \xi_{i,t}.
\end{aligned} \tag{1}$$

In Eq. (1), μ_1 and $\xi_{i,t}$ are, respectively, the intercept and error terms. *YEAR* and *INDUSTRY* are included to prevent the results being driven by time series and industry effects, respectively. The remaining variables are defined in Appendices I and III. Our IVs are based on yearly averages of financial variables over five broad industry sectors. We do not know a priori the exact number of IVs to use; so we choose from a list of 11 IVs. On average, five to seven IVs are needed. The chosen IVs are the ones that generate estimates that are free of model specification problems, e.g., endogeneity.

To deal with the problem of endogeneity in our logistic regressions, we estimate a reduced version of Eq. (1) as follows:

$$\begin{aligned}
&(Monitoring\ mechanism\ or\ Remuneration\ variable)_{i,t} \\
&\quad = a_1 + b_1(CAP_Exped_PPE)_{i,t} + b_2(CAP_Exped_\ Total\ Sales)_{i,t} \\
&\quad + b_3(Dividend\ per\ Share)_{i,t} + b_4(LnMarket\ Value)_{i,t} \\
&\quad + b_5(LnTotal\ Sales)_{i,t} + ((Leverage)_{i,t} = Instrumental\ variables) + \varepsilon_{i,t}.
\end{aligned} \tag{2}$$

In Eq. (2), $\varepsilon_{i,t}$ is the error term. The predicted values of each monitoring and compensation variable from Eq. (2) are incorporated into each logistic regression.[19] We use a reduced version of Eq. (1), since the full IV–GMM generated poor predicted values.[20] We prefer the logistic regression relative to the IV–probit regression since the logistic regression performs better by capturing observations in the tails of the empirical distribution. However, the IV–probit regression has the advantage that the endogeneity problem can be dealt with in one estimation.

An empirical model does not exist for the relation between derivatives usage and monitoring mechanisms, managerial compensation, and our explanatory variables.[21] So, we justify using Eq. (2) as follows. Following Dittmar and Mahrt-Smith (2007), Masulis et al. (2007), and others, firms with weaker CG undertake inefficient investment decisions that contribute to capital destruction. Furthermore, Chen et al. (2010) show that firms improve their governance structure before seeking external finance. Ryan and Wiggins (2002), for example, relate managerial remuneration to investment opportunities. Thus, measures such as *CAP_Exped_PPE*, *CAP_Exped_Total Sales*, and *Dividend per Share* (in Eq. (2)) are likely to proxy for investment opportunities. Related evidence links board size and NEDs to governance and financial performance (Chhaochharia and Grinstein, 2007; Faleye, 2015). Firms hedge to preserve growth options, dividends, and sales (Lessard, 1991; Froot et al., 1993). Finally, derivatives usage is related to size (Bodnar et al., 1996; Panaretou, 2014), which is measured using *LnMarket Value* and *LnTotal Sales*.

The logistic regression is specified as follows:

$$\begin{aligned} Usage^{*}_{i,t} = \alpha_1 &+ \beta_1(Monitoring\ mechanism\ or\ Remuneration\ variable)^{P}_{i,t} \\ &+ \beta_2(IND\_Avg\_LEV)_{i,t} + \beta_3(Stock\ Price\_Volatility)_{i,t} \\ &+ \beta_4(Interest\_Cover)_{i,t} + \beta_5(Z\text{-}score)_{i,t} + \beta_6(Debt\_Maturity)_{i,t} \\ &+ \beta_7(Free\text{-}Cash\text{-}Flow\_Assets)_{i,t} + \beta_8(EBIT\_Market\ Value)_{i,t} \\ &+ \beta_9(CAP\_Exped\_PPE)_{i,t} + \beta_{10}(CAP\_Exped\_Total\ Sales)_{i,t} \\ &+ \beta_{11}(R\&D\_Total\ Assets)_{i,t} + \beta_{12}(Q)_{i,t} + \beta_{13}(Current\ Ratio)_{i,t} \\ &+ \beta_{14}(LnPreTaxIncome)_{i,t} + \beta_{15}(ROA)_{i,t} + \beta_{16}(Dividend\ per\ Share)_{i,t} \\ &+ \beta_{17}(LnMarket\ Value)_{i,t} + \beta_{18}(LnTotal\ Assets)_{i,t} + \beta_{19}(LnTotal\ Sales)_{i,t} \\ &+ \beta_{20}(TXR)_{i,t} + YEAR + INDUSTRY + \varsigma_{i,t}. \end{aligned} \tag{3}$$

$Usage^{*}_{i,t}$ is an unobservable latent variable that captures the probability of a firm using/not using a particular set of derivatives. That is, $Usage^{*}_{i,t} = \begin{cases} 1, if\ Usage^{*}_{i,t} > 0 \\ 0, if\ Usage^{*}_{i,t} \le 0 \end{cases}$. $\zeta_{i,t}$ is the error term. The superscript ^{P} denotes the predicted values from Eq. (2).

[19] Wooldridge (2010) suggests the use of predicted values to deal with endogeneity. Géczy, et al. (1997) also use predicted values in their logistic regression.

[20] An anonymous reviewer suggested that the full model (inclusive of year and industry effects) would likely generate better predicted values. We run Eq. (1) and several of its reduced versions. The more complex the specification, the greater the tendency for the logistic regressions to generate excessively large coefficients and wrong coefficient signs. The inclusion of year and industry dummies in any version of Eq. (1) also created estimation problems for the two-stage logistic regressions. Evidence in the economics literature shows that complicated models generate poor forecasts relative to simple models (Meese and Rogoff, 1983; Liu et al., 1994). These arguments justify our use of Eq. (2) to generate the predicted values for the two-stage logistic regressions.

[21] Models of capital structure include some of the explanatory variable we use in Eq. (2). Mande et al. (2012) use a similar approach to generate predicted values for their CG indices.

Finally, the IV–probit regression is stated as follows:

$$\begin{aligned} Usage^{**}_{i,t} = {} & c_1 + c_2(IND\_Avg\_LEV)_{i,t} + c_3(Stock\ Price\_Volatility)_{i,t} \\ & + c_4(Interest\_Cover)_{i,t} + c_5(Z\text{-}score)_{i,t} + c_6(Debt\_Maturity)_{i,t} \\ & + c_7(Free\text{-}Cash\text{-}Flow\_Total\ Assets)_{i,t} + c_8(EBIT\_Market\ Value)_{i,t} \\ & + c_9(CAP\_Exped\_PPE)_{i,t} + c_{10}(CAP\_Exped\_Total\ Sales)_{i,t} \\ & + c_{11}(R\&D\_Total\ Assets)_{i,t} + c_{12}(Q)_{i,t} + c_{13}(Current\ Ratio)_{i,t} \\ & + c_{14}(LnPreTaxIncome)_{i,t} + c_{15}(ROA)_{i,t} + c_{16}(Dividend\ per\ Share)_{i,t} \\ & + c_{17}(LnMarket\ Value)_{i,t} + c_{18}(LnTotal\ Assets)_{i,t} + c_{19}(LnTotal\ Sales)_{i,t} \\ & + c_{20}TXR_{i,t} + YEAR + INDUSTRY \\ & + \big(Monitoring\ mechanism\ or\ Remuneration\ variable + (Leverage)_{i,t} \\ & = Instrumental\ variables\ \big) + v_{i,t}. \end{aligned} \tag{4}$$

In Eq. (4), $Usage^{**}_{i,t}$ is also an unobservable latent variable; c_1 and $v_{i,t}$ are, respectively, the intercept and error term. The probit model relies on the standard normal distribution since the probability of $Usage^{**}_{i,t}$ is computed using a cumulative normal probability function.[22] In Eqs. (3) and (4), *IND_Avg_LEV* proxies for firm leverage to reduce potential endogeneity problems. We use *IND_Avg_LEV* since individual firms are unlikely to influence this measure to give rise to an endogeneity problem. We trimming the top and bottom 1% of the observations for each variable to remove exceptionally large/small values for all our estimates, and use robust standard errors when estimating Eqs. (1) to (4).[23]

4. Empirical Results

4.1. Distribution of derivatives users and non-users

Panel A of Table 1 shows the distribution of users and non-users year by year. The sample of combined derivatives users (currency, IR, and commodity) increases from 105 in 2005 to 126 firms in 2015, reaching a peak of 136 firms in 2014; non-users peak in 2012 (81 firms). The majority of firms use several combinations of derivatives. For these firms, between 82.58% (109 out of 132 firms; in 2008) and 87.69% (114 out of 130; in 2010), mostly use currency derivatives with less regular use of IR and/or commodity derivatives. Also, between 54.39% (62 out of 114; in 2006) and 59.69% (77 out of 129; in 2012) of the firms, mostly use IR derivatives together with less regular use of currency and commodity derivatives. The table also shows the distributions for the clean samples of currency and IR derivative users on which we base our main results. Between 37.21% (48 out of 129; in 2012) and 42.11% (48 out of 114; in 2006) of derivatives users only use currency derivatives. Similarly, between 10.08% (13 out of 129; in 2012) and 13.64% (18 out of 132; in 2008) of derivatives users use only IR derivatives. Far fewer firms use commodity derivatives. Since we estimate logistic regressions, our sample size is unlikely to affect the reliability of our estimations.[24]

[22] The probit and logistic regressions have different specifications for the distribution of the disturbance term. The disturbance term of the logistic regression model follows the standard logistic distribution, whereas the disturbance term of the probit regression model follows the standard normal distribution. Both distributions are very close in the shape of their distribution functions, except at the tails. The logistic regression will always provide a better fit to non-normal distributions relative to the probit model since it captures the observations in the tails of non-normal distributions.

[23] All our estimations are performed in StataIC 15 and we specify our equations in a related way.

[24] Our sub-samples of derivatives users are unbalanced relative to non-users. However, the smaller sample size of IR derivatives users is unlikely to affect the reliability of the logistic regression estimates. Indeed, Owen (2007, p. 761) shows that "… under mild conditions,

[*Table 1, about here*]

Our users and non-users are from nine industry sectors (Panel B of Table 1). Industrials have the largest number of firm-year observations (498), followed by Consumer Services (292) and Consumer Goods (179). Our descriptive statistics show that derivatives users have larger average values for the monitoring mechanism and managerial incentive measures than non-users. Derivatives users also have larger average values for size and leverage measures compared with non-users. The Wilcoxon–Mann–Whitney statistic confirms that the two groups of users and non-users have different medians. The Spearman rank correlation coefficients for the explanatory variables for each set of firms give us no cause for concern. All results not fully presented are available from the authors**.**

4.2. IV–GMM estimates based on the full model

Table 2 shows the coefficient estimates using the full IV–GMM (Eq. 1). For each IV–GMM estimation, we rely on the following model specification tests for their validity: (i) the Hansen *J* statistic to test for over-identifying restrictions; (ii) the Hayashi *C* test for endogeneity; and (iii) the *F*-statistic to test the correlation between the IVs and the endogenous variables (weak instruments). The *C* and *J* statistics indicate no concern over endogeneity and over-identification, respectively. The *p*-values are larger than 0.10. The *F*-statistic has *p*-values of less than 0.10, indicating that the instruments are not weak (see Table 2). These specification tests give us confidence in our estimates.

[*Table 2, about here*]

Table 2 shows that the magnitude of estimated coefficients varies across users and non-users. *Leverage* is negatively related to *NED* for currency derivatives users (*p*-value ≤ 0.10). *Leverage* and *LnBoard Size* are negatively related to IR derivatives users (*p*-value ≤ 0.05). These measures are not significant for combined users and non-users. Thus, using combined users as a group neutralises the relation between *Leverage* and *LnBoard Size*. *Leverage* is also insignificant for all managerial compensation variables. This latter result contradicts the predicted relation between leverage and managerial compensation (see Calcagno and Renneboog, 2007).

Monitoring mechanisms (*LnCG_Index*, *LnBoard Size* and *NED*) have mixed coefficient signs for *EBIT_Market Value* (*p*-value ≤ 0.10). *Q* has positive coefficients for all users (*p*-value ≤ 0.10), but a negative coefficient for non-users in respect of *Stock_CompMV* (*p*-value ≤ 0.10). The coefficients for *LnMarket Value* are positive for all groups of derivatives users (*p*-value ≤ 0.01) in *LnCG_Index*; they are insignificant for non-users (*p*-value ≥ 0.01). *LnMarket Value* has positive coefficients in *LnBoard Size* for all groups of firms, except for currency derivatives users (*p*-value ≤ 0.10). The result for currency derivatives users is unexpected. Finance theory predicts a positive relation between managerial wealth and the variability of firms' expected profits (Smith and Stulz, 1985). However, managerial compensation (*Executive_CompMV* and *Stock_CompMV*) is

the intercept [in the logistic regression] diverges as expected, but the rest of the coefficient vector approaches a non-trivial and useful limit", such that the use of relatively small samples does not affect the coefficient estimates.

negatively related to *EBIT_Market Value* (p-value ≤ 0.01) in six out the eight estimates (p-value ≤ 0.10). Thus, managerial compensation has a negative impact for all groups of firms suggesting that managerial compensation increases when market value decreases, even for derivatives users. Hermalin (2005) argues that CEO pay positively relates to tighter CG, due to greater board diligence and the tendency to recruiting external CEOs. While the positive coefficients for *LnMarket Value* in *LnCG_Index* and *LnBoard Size* suggest that market value increases, the negative relation for *LnMarket Value* in *Executive_CompMV* seems to be counter-intuitive. It is possible that CEOs command a risk premium in the presence of declining market values.

4.3. Logistic regressions

Using Eq. (3), we estimate the two-stage logistic regressions for currency and IR derivatives usage. The predicted values for our endogenous variables are obtained from the IV–GMM estimates of Eq. (2). These IV–GMM estimates are not shown to save space. However, they satisfy specification conditions of no endogeneity and overriding restrictions (p-value ≥ 0.10) and no weak instruments (p-value ≤ 0.10). All our variables are defined in Appendices I and III.

[*Table 3, about here*]

Table 3 and 4 show that the goodness-of-fit of the logistic regressions are adequate based on Pearson χ^2 tests. The Wald χ^2 statistic is significant in all cases (p-value ≤ 0.01), indicating that all the variables in the models besides the constant, have explanatory power. Across all estimates, between 74.16% (Model 4A, Table 3) and 91.62% (Model 8B, Table 4) of the firm-year observations are correctly classified. The percentage correctly classified outperforms a naïve proportional chance model (see Joy and Tollefson, 1975) at a 1% level. The year dummies for 2007 and 2009 are always positive, but not necessarily significant (p-value ≥ 0.10). Indeed, the notes in the financial reports of some of our firms indicated that the use of derivatives increased during the crisis period. The industry dummy variables are significant only in a few cases (p-value ≤ 0.10). For the results that follow, we denote our baseline models as Model 1A, Model 2A, and so on. Models with interaction terms are designated, Model 1B, Model 2B, and so on.

4.3.1. Monitoring mechanisms and currency derivatives usage

Models 1A to 3B (in Table 3) show the results for currency derivatives usage using the monitoring variables. The *LnCG_Index*^{P} coefficients are not significant (Model 1A and 1B; p-value ≥ 0.10). While the coefficients for *LnBoard_Size*^{P} are positive, only the baseline coefficient is significant (Model 2A; p-value ≤ 0.01). Related work indicates that large boards are value-enhancing (see Faleye, 2015); so we find some support for this view. Both *NED*^{P} coefficients are negative (Models 3A and 3B; p-value ≤ 0.05). Overall, we conclude that there is not enough evidence to support H_1.

The positive coefficient for *LnBoard_Size*^{P} means that as the number of directors increases the likelihood of firms using currency derivatives increases. In contrast, the negative *NED*^{P} coefficients suggest that as the percentage of NEDs increases less derivatives are used. By implication, NEDs are accepting more risk on behalf of shareholders. The marginal effects (MEs) for the *NED*^{P} are modest (p-value ≤ 0.05)—between –

0.053 (Model 3A) and –0.030 (Model 3B), indicating that the predicted probability of NEDs influencing usage is not strong.

CEO-chair separation is a binary variable in our data. We do not estimate predicted values for CEO-chair separation. This is because of the estimation problems associated with obtaining reliable predicted values for binary variables. However, the binary value for CEO-chair separation is included in the $LnCG\_Index^P$, but shows no obvious effect. Up to 74.86% of our firm-year observations comprise currency derivatives users that have CEO-chair duality. While it is likely that CEO-chair duality impacts our results via $LnBoard\_Size^P$ to give a positive effect, boards with CEO-chair separation do not necessarily have greater effectiveness (see Brickley et al., 1997; Dey et al., 2011). The ME for $LnBoard\_Size^P$ is 0.539 (Model 1A; p-value ≤ 0.01). This value is larger (in absolute value) compared with those of NED^P. Thus, the predicted probability of $LnBoard\_Size^P$ affecting derivatives usage is strong. As such, a unit increase in $LnBoard\_Size^P$ increases derivatives usage by a factor of 25.154, i.e., $e^{3.225}$.

Bebchuk et al. (2009) and Chang and Zhang (2015) report a negative relation between entrenchment and firm value, implying that entrenched managers are more likely to undertake value-destroying corporate policies. One way to relate our results to their finding is to examine the role of monitoring mechanisms when directors have influence over investment decisions in the presence of derivatives use. To do so, we separately interact *Free-Cash-Flow_Total Assets*, *Q*, and *Z-score* with our monitoring and managerial compensation variables. Therefore, we sort the observations for each financial variable to capture the top and bottom third of the observations. We apply a value of one to each of the top and bottom third of the observations of each variable; zero otherwise. That way, we may capture a link with investment distortion costs. We assume that the strongest evidence for over- and underinvestment costs is in the top (bottom) third of each variable.

Table 3 shows that only $LnBoard\_Size^P \times Low\_Z\text{-}score$ has a positive coefficient (Model 2B; p-value ≤ 0.01). The positive coefficient indicates that *Low Z-score* firms in $LnBoard\_Size^P$ use more currency derivatives. *Low_Z-score* firms are more risky than *High_Z-score* firms; they are predicted to use more derivatives. In contrast, $LnBoard\_Size^P \times High\_Z\text{-}score$ has a negative coefficient (Model 2B; p-value ≤ 0.01), thus causing the link between board size and Z-score to be *U*-shaped in relation to usage. That is, board size positively influences currency derivatives usage for *Low_Z-score* firms, but negatively influences currency derivatives usage for *High Z-score* firms. *High Z-score* firms may reduce derivatives usage to increase overinvestment costs, particularly if executives stand to benefit more than shareholders in investment decisions.

The remaining coefficients for our monitoring mechanisms with interaction terms are negative (Models B1, 2B and B3; p-value ≤ 0.01). Derivatives usage is negatively related to $LnCG^P\_Index \times Low\_Z\text{-}score$, $LnBoard\_Size^P \times Low\_Q$ and $NED^P \times Low\_Q$ (p-value ≤ 0.10). *Q* proxies for investment opportunities, whereas *Z-score* proxies for the probability for financial distress. The use of derivatives is predicted to increase firm value for firms with low values on both measures. Large boards have increased problems of coordination and free-riding, implying that small boards may be more effective (Jensen, 1993). Since low *Q* firms are more likely to be undervalued relative to high *Q* firms, the need for capital investments would be more pressing. Marsden and Prevost (2005) report, however, that high growth firms with a higher proportion of NEDs use less financial derivatives amongst New Zealand firms. They indicate that the negative relation is due to the new Companies and Financial Reporting Acts of 1993, which increased the personal liability of directors for bad investment decisions. UK NEDs and boards have been given increased financial and risk management responsibilities over the years, under various codes of practice and financial reporting requirements. It is possible that the negative relations reflect a decrease in currency derivatives usage to a more optimal level.

4.3.2. Managerial compensation and currency derivatives usage

May (1995) and Tufano (1996) find that utility maximising managers tend to pursue risk-reducing strategies when their personal non-diversifiable wealth is tied to firm value. Thus, managerial compensation is positively related to currency derivatives usage based on H_2. Table 3 shows that *Stock_CompMV*^{P} has only one positive and significant coefficient (Model 4B; p-value ≤ 0.05), partly in support of H_2. The *Executive_CompMV*^{P} coefficients are both negative (Models 5A and 5B; p-value ≤ 0.10). The explanation for the mixed result is not certain since both variables proxy for compensation plans. If executives have more control over risk management strategy than external directors and external directors adopt an ineffective monitoring role (Agrawal and Knoeber, 1996; Franks et al., 2001), then the negative coefficients may be capturing a reduction in risk management programmes to benefit executive compensation plans, with *Executive_CompMV*^{P} having a negative effect. *Stock_CompMV*^{P}×*Low_Free-Cash-Flow_Total Assets* and *Stock_CompMV*^{P}×*Low_Z-score* also have negative coefficients (Panel 4B; p-value ≤ 0.05). This suggests that the positive coefficient for *Stock_CompMV*^{P} may not be too reliable. Theoretically, low free cash flow and *Z*-score firms should increase derivatives usage (Lessard, 1991; Tufano, 1998). We also find a *U*-shaped relation for derivatives usage and *Executive_CompMV*^{P} in *Z*-score, such that the coefficient for *Executive_CompMV*^{P}×*High_Z-score* is positive (Model 5B; p-value ≤ 0.10) and the coefficient for *Executive_CompMV*^{P}×*Low_Z-score* is negative (Model 5B; p-value ≤ 0.05). Overall, managerial compensation appears to lead to more risk-taking, with low *Z*-score firms being more strongly associated with a reduction in derivatives use.

Several theories link executive compensation to the ability of managers to extract economic rent (see Bebchuk and Fried, 2003). The ability to extract economic rents will be higher in poorly governed firms. If the use of derivatives also increases firm value, executive compensation will positively correlate to measures, such as *Q* and *Z-score* since, theoretically, derivatives usage benefits both managers and shareholders (Smith and Stulz, 1985). While the negative coefficients for our investment measures suggest an environment where financial risk taking increases, we find little evidence to suggest that managerial wealth is determined in an environment where risk reduction appears to be the norm. Tufano (1996) and Schrand and Unal (1998) report that managers holding common stocks manage more risk compared with those holding stock options. Data unavailability prevents us from examining the effects on investment distortion costs when managers hold stock options. We note, however, that the coefficients for *Stock Price_Volatility* are consistently negative across all our regressions, but only significant in *LnBoard_Size* (Model 2B; p-value ≤ 0.05).

4.3.3. *Underinvestment and financial distress and currency derivatives usage*

H_{3A} predicts a positive relation between currency derivatives usage and underinvestment costs. Using *IND_Avg_LEV* to proxy for firm leverage, derivatives usage is negatively related to *IND_Avg_LEV* (p-value ≤ 0.10). The negative coefficients are significant across most of our monitoring and management compensation variables, causing us to reject H_{3A}. Thus, on average, currency derivatives usage decreases with *IND_Avg_LEV* (leverage). However, Purnanandam's (2008) theoretical model predicts a positive relation for moderately leveraged firms and a negative relation for highly leveraged firms, since highly leveraged firms take longer to improve their future prospects. Thus, our result is not entirely out of line with this theoretical prediction, although we have not determined the extent of high or low leverage across our firms. *EBIT_Market Value* always has negative and significant coefficients (p-value ≤ 0.01). Nance et al. (1993) use *EBIT_Interest Expense* to proxy for leverage. They find a negative and insignificant coefficient. *Low_Q* is positively related to currency derivatives usage in $LnBoard\_Size^{P}$ (Model 2B; p-value ≤ 0.05), despite being negative when interacted with $LnBoard\_Size^{P}$ (Model 2B). The negative coefficient for $LnBoard\_Size^{P} \times Low\_Q$ captures usage for highly distressed firms. The coefficients for *Low_Free-Cash-Flow_Total Assets* are positive (p-value ≤ 0.05) across all estimates, except for $LnBoard\_Size^{P}$ where the coefficient is insignificant. This result provides support for H_{3A}. The *U*-shaped relation for *Z*-score in $LnBoard\_Size^{P}$ is worth a further consideration (Model 2B; p-value ≤ 0.01). Perhaps, this suggests that currency derivatives usage is less of a critical issue for under-performing firms. This view is, of course, inconsistent with the theory (Smith and Stulz, 1985). Currency derivatives usage is negatively related to *CAP_Exped_Total Sales* and *Dividend per Share* (p-value ≤ 0.01), thereby allowing us to reject H_{3A}.

4.3.4. *Overinvestment and currency derivatives usage*

Following Tufano (1998) and Stulz (1996), the availability of free cash flow can cause managers to accept negative NPV projects. Table 3 shows that the coefficients for *Free-Cash-Flow_Total Assets* are typically negative (p-value ≤ 0.10), giving some support for H_{3B}. The *CAP_Exped_PPE* coefficients are also negative in NED^{P} and $Executive\_CompMV^{P}$ (p-value ≤ 0.10). In general, these results support H_{3B} in the sense that derivatives usage decreases for these measures. Currency derivatives usage is positively (negatively) related to *High_Free-Cash-Flow_Total Assets* (*Low_Free-Cash-Flow_Total Assets*) for the most part, giving rise to the *U*-shaped effect predicted by H_{3A} and H_{3B}. This is an interesting result for investment distortion costs, which validates the theory.

Important links can be drawn between over/underinvestment costs and measures based on growth opportunities. Allayannis and Weston (2001) find that US derivatives users have higher *Q* and higher capital expenditures to sales ratios. Table 3 shows that the *R&D_Total Assets* coefficients are negative across all estimates (p-value $\leq$ 0.01), indicating that firms with R&D spending are less likely to use derivatives. This finding might hold if such firms also have excess free cash flows to fund the decline in cash flow associated with the failure to use derivatives. However, since our *High_Free-Cash-Flow_Total Assets* coefficients are also negative, there seems to be a role for using currency derivatives to protect available cash flows. This demonstrates some of the difficulties in testing H_{3B}.

4.3.5. Hedging substitutes and currency derivatives usage

Géczy et al. (1997) point out that the costs of financial distress can affect the debt choices of firms. Derivatives usage is negatively related to long-term debt if debt levels increase, due to risk-shifting. Froot et al. (1993) predict a positive relation between currency derivatives usage and liquidity, since hedging would preserve liquidity for new investments and dividend payments. Using hedging substitutes negates the need to use derivatives such that the relation between hedging substitutes and derivatives usage is negative. Table 3 shows that our proxies for hedging substitutes are not significant, except for *LnPre_Tax_Income* in NED^P in some cases (p-value ≤ 0.01). Even so, these coefficients carry the wrong predicted sign. Thus, we do not find support for H_4. While we do not establish hypotheses for taxation and firm size, it is useful to note that the *TXR* coefficients are insignificant, whereas the *LnMarket Value* and *LnTotal Assets* coefficients are positive when significant (p-value ≤ 0.10). *LnMarket Value* and *LnTotal Assets* proxy for size. Thus, these findings are in line with previous results (El-Masry, 2006).

4.4. IR derivatives usage

This sub-section presents the results for IR derivatives usage. Our baseline models are Model 6A, Model 7A, etc. Similarly, the models with interaction terms are Model 6B, Model 7B, and so forth.

4.4.1. Monitoring mechanisms and IR derivatives usage

Table 4 shows that, unlike the case of currency derivatives usage, the $LnCG\_Index^P$ coefficients are positive and significant (Models 6A and 6B; p-value ≤ 0.01), whereas $LnBoard\_Size^P$ has a negative coefficient (Models 7A; p-value ≤ 0.10). Thus, the results for currency and IR derivatives users have different coefficient signs. However, for IR derivatives users, NED^P has a negative coefficient (Model 8A; p-value ≤ 0.01), in line with the result for currency derivatives usage. Inside boards may choose to reduce derivatives usage if they dominate outside boards. However, the coefficient sign is consistent across both $LnBoard\_Size^P$ and NED^P. This result is not surprising since prior studies argue that CG in the UK is characterised as an environment where managers have a high level of discretion because of limited external discipline imposed by capital markets (Franks et al., 2001; Ozkan and Ozkan, 2004). Our result for NEDs contrasts with that of Borokhovich et al. (2004) for US firms. They suggest that NEDs participate in IR risk management to increase IR derivatives usage. While UK bankruptcy codes favour creditors much more than shareholders (Franks et al., 1996), this does not seem to lead to a strong focus on using IR derivatives. Thus, overall, we find very limited support for H_1. We note that the negative effect for $LnBoard\_Size^P$ is relatively small, thereby generating a log odds ratio of 0.014, i.e., $e^{-4.263}$ against a log odds ratio of 0.787, i.e., $e^{-0.239}$ for NED^P.

[*Table 4, about here*]

The contrasting coefficient signs for *LnBoard_Size*^{P} with respect to currency and IR derivatives usage may also suggest that UK board of directors assess the impacts of IR and currency risks differently. Our sample covers a period of very low IRs for the most part, with very little variability. In contrast, currency rates have had a lot of variability in recent years. Thus, currency fluctuations may cause more concerns for UK boards than IR fluctuations. Survey evidence also shows that a larger proportion of firms hedge currency exposure than IR exposure (see Bodnar et al., 1998; Panaretou, 2014). These factors may therefore contribute to variation in the results.

Advocates of good governance argue that boards, made up of a large proportion of NEDs, ensure that more pressure is put on internal boards to act in shareholders' best interest (see Fama and Jensen, 1983). Both the Sarbanes–Oxley Act (2002) and the UK Financial Reporting Council (2014) specify that audit committees comprise entirely of independent outside directors, with at least one member with recent and relevant financial experience.[25] This suggests that NEDs are likely to have knowledge of the associated financial risk. Coles et al. (2008) show that the *Q* measure is *U*-shaped in board size, such that large boards enhance value in complex organisations, whereas small boards are more appropriate for simple organisations. Our data does not allow us to assess the management skills of inside directors or NEDs. However, in simple terms, inside directors will require more specialist risk management skills for day-to-day risk management. Furthermore, NEDs may lack information about the firm's risks to influence treasury management strategy. Therefore, NEDs may be willing to undertake a less confrontation monitoring role, which in turn imposes limited discipline on inside directors (see also, Agrawal and Knoeber, 1996; Franks et al., 2001). This may explain the similarity in the coefficient signs for *LnBoard_Size*^{P} and *NED*^{P}. Alternatively, inside boards may simply be under-hedging to enhance their own interest. In theory, compensation contracts can be designed to depend on firm value in the presence of hedging (Smith and Stulz, 1985).

Except for *LnBoard_Size*^{P}×*Low_Free-Cash-Flow_Total Assets*, all the coefficients for the interaction terms are negative when significant (Model 7B; p-value ≤ 0.10).[26] Unlike the results for currency derivatives usage, we have no evidence of a *U*-shaped relation between IR derivatives usage and our monitoring variables. The firms still reduce IR derivatives in terms of the investment measures. For example, IR derivatives usage is negatively related to both *LnBoard_Size*^{P}×*Low_Q* and *LnBoard_Size*^{P}×*Low_Z-score* (Model 7B; p-value ≤ 0.05). The coefficients for *NED*^{P}×*Low_Q* and *NED*^{P}×*Low_Z-score* are both negative (Model 8B; p-value ≤ 0.05). Theoretically, *Low_Q* and *Low_Z-score* firms are more risky and should use more derivatives (see Smith and Stulz, 1985). We rule out potential speculative activities by our sample firms, since many of their financial reports state that speculation in risk management is forbidden.

[25] One of the responsibilities of the audit committee is "… to review the company's internal financial controls and, unless expressly addressed by a separate board risk committee composed of independent directors, or by the board itself, to review the company's internal control and risk management systems" (The UK Financial Reporting Council, 2014, p. 23).

[26] In some cases, we were unable to obtain convergence for our logistic regressions when *High_Z-score* was included in the estimation. Correspondingly, we excluded variables that interact with *High_Z-score* for these estimations due to the failure of the model to convergence.

4.4.2. *Managerial compensation and IR derivatives usage*

Table 3 shows that IR derivatives usage positively relates to both *Stock_CompMV*^{P} and *Executive_CompMV*^{P} (Models 9A to 10A and 9B to 10B; *p*-value ≤ 0.01), in support of H_2. This finding is in line with theoretical and empirical studies. That is, Stulz (1984) predicts that utility maximising managers will increase hedging when compensation contracts are linked to firm value, and Schrand and Unal (1998) find that US firms use more IR derivatives when managerial wealth is tied to firm value. The coefficients for *Stock_CompMV*^{P}×*Low_Free-Cash-Flow_Total Assets* and *Stock_CompMV*^{P}×*High_Q* are negative (Model 9B; *p*-value ≤ 0.10). Similarly, *Executive_CompMV*^{P} ×*Low_Free-Cash-Flow_Total Asset* is negative (Model 10B; *p*-value ≤ 0.05). However, *Executive_CompMV*^{P} ×*High_Q* is negative, whereas *Executive_CompMV*^{P} ×*Low_Q* is positive (Model 10B; *p*-value ≤ 0.01), giving rise to a *U*-shaped relation in usage.

4.4.3. *Underinvestment and financial distress and IR derivatives usage*

Table 4 shows that IR derivatives usage is positively related to *IND_Avg_LEV*, only in respect of the managerial compensation variables (*p*-value ≤ 0.10; Table 4). This finding supports H_{3A}. The positive relation contrasts with the negative relation for currency derivatives usage. However, Leland (1998) and Graham and Rogers (2002) report that firms use IR derivatives to increase leverage. Furthermore, the Titman (1992) model demonstrates how the availability of IR swaps affects the choice between short- and long-term borrowings. However, usage only seems to be influenced by leverage in the context of managerial compensation plans. The failure to find significant coefficients for our monitoring mechanism variables may be due to our use of industry average leverage. However, the *Debt_Maturity* coefficients are positive in all cases (*p*-value ≤ 0.10), in support of an increase in the debt structure. The negative coefficients for *Interest_Cover* and *Z-score* (*p*-value ≤ 0.10) are also in line with the result for *Debt_Maturity*. *Low_Q* is positive (*p*-value ≤ 0.10) in *LnBoard_Size*^{P} and *NED*^{P}, but negative in *Executive_CompMV*^{P} in line with the above results.

4.4.4. *Overinvestment and IR derivatives usage*

IR derivatives usage is negatively related to *Free-Cash-Flow_Total Assets* in *LnBoard_Size*^{P} and *NED*^{P} (*p*-value ≤ 0.10), in support for H_{3B}. The coefficients for *High_Free-Cash-Flow_Total Assets* are not significant. The *CAP_Exped_PPE* coefficients are negative for only *Stock_CompMV*^{P} (*p*-value ≤ 0.01). If managers see stock compensation as an indicator of their wealth in the firm, then the negative coefficient for *CAP_Exped_PPE* is unexpected, since high levels of capital expenditures suggest the exploitation of investment opportunities. However, the negative coefficient may indicate a reduction in IR derivative usage due to overinvestment costs. *High_Q* is positively related for *NED*^{P} and managerial compensation (*p*-value ≤ 0.05), contrary to our prediction for H_{3B}. Overall, the support for H_{3B} is not too strong.

4.4.5. *Hedging substitutes and IR derivatives usage*

In general, the results do not support H_4. The coefficients for *Current Ratio*, *LnPre_Tax_Income* and *ROA* are typically positive when significant (*p*-value ≤ 0.10). If firms use hedging substitutes, they will rely less on derivatives. The use of hedging substitutes allows firms to place less reliance on external markets and this enables them to pursue overinvestment strategies.

5. IV–probit regressions

We now present the findings based on the IV–probit regressions (see Eq. (4)). The IVs used are shown in Panel B of Appendix I. We settle on a given set of IVs as long as the *p*-value for the Wald χ^2 statistic for exogeneity is less than 0.10. We also use the general to specific methodology (see Pagan, 1987) to reduce the number of coefficients with insignificant year and industry effects, as long as the -2 log likelihood ratio is minimised and the Wald χ^2 statistic for the goodness of fit of the model remains significant. The use of fixed effect dummies in IV–probit models are known to cause estimation problems. So, we settled on one or two year and industry dummies, using the general to specific methodology as a guide. Across our IV–probit regressions, the number of firm-year observations that are correctly classified is in the range of 73.29% (Model 11A, Table 5) to 95.42% (Model 17B, Table 6). The classificatory efficiency of the IV–probit models outperform the naïve proportional chance model at less than a 1% level. The Wald χ^2 statistic also rejects the null hypothesis that all the slope coefficients are jointly zero (*p*-value ≤ 0.01).

5.1. Currency derivatives usage

Table 5 shows the coefficient estimates for currency derivatives usage. The coefficients for monitoring mechanisms are consistently positive and significant (*p*-value ≤ 0.10; Models 11A to 13A and 11B to 13B). These results give strong support for H_1, unlike those of the two-stage logistic regressions. As stated before, the contradictory results under the two-stage logistic regressions may be due to the inability of the IV–GMM to generate reliable predicted values. Under the IV–probit regressions, *LnBoard_Size* seems to have the greatest influence on currency derivatives usage compared with *LnCG_Index* and *NED*. Indeed, *LnBoard_Size* has a coefficient of 2.005 (Model 12A; *p*-value ≤ 0.10), compared with 1.071 (Model 11A; *p*-value ≤ 0.01) for *LnCG_Index* and 0.084 (Model 13A; *p*-value ≤ 0.01) for *NED*. The stronger influence of *LnBoard_Size* is consistent with the result for currency derivatives usage (see Table 3).

[*Table 5, about here*]

Interacting the monitoring mechanism variables with our investment opportunity measures generates negative coefficients in all cases. Most of the negative coefficients are significant (*p*-value ≤ 0.10). For example, the coefficients for both *LnBoard_Size*×*High_Q* and *LnBoard_Size*×*Low_Q* are –4.733 and –3.188, respectively (Model 12B; *p*-value ≤ 0.05). This means that both *High_Q* and *Low_Q* firms (in *LnBoard_Size*) reduce currency derivatives usage. The result for *LnBoard_Size*×*Low_Q* is in line with those of the two-stage logistic regressions, although the coefficient for *LnBoard_Size*×*High_*Q is not significant for this estimation method. Based on the magnitudes of both coefficients in Table 5, there is some tendency for *High_Q* firms (in *LnBoard_Size*) to decrease currency derivatives usage more than *Low_Q* firms (all else being equal).

The coefficients for *Stock_CompMV* and *Executive_CompMV* are also positive (*p*-value ≤ 0.01), in support of H_2. These coefficients are larger than those of monitoring mechanisms. Interacting the compensation measures with the investment distortion measures generates negative coefficients in some cases (p-value ≤ 0.10). This feature is more pronounced for *Executive_CompMV* compared with *Stock_CompMV*.

Measures for over- and underinvestment carry both positive and negative coefficients (p-value ≤ 0.10). Measures for *High* (*Low*)*_Free-Cash-Flow_Total Assets*, *Z-score*, and *Q* are typically positive when significant (p-value ≤ 0.05), although the coefficients for *Dividend per Share* are consistently negative when significant (p-value ≤ 0.10). *Z-score* carries mixed coefficient signs for *LnCG_Index* and *Stock_CompMV* (p-value ≤ 0.10). Thus, the support for H_{3A} and H_{3B} seems to be mixed. The *IND_Avg_LEV* coefficients are always negative, when significant (p-value ≤ 0.10). The evidence for hedging substitutes is generally weak.

5.2. IR derivatives usage

The IV–probit estimates for IR derivatives usage are shown in Table 6. All our monitoring and managerial compensation variables are significant and positively related to IR derivatives usage (p-value ≤ 0.01). This result is in line with earlier results for currency derivatives under the IV–probit estimations. These results provide support for H_1 and H_2. When the interaction terms have significant coefficients, they are always negatively related to IR derivatives usage (p-value ≤ 0.10). Thus, similar to earlier results, firms that have high or low investment opportunity measures reduce IR derivatives usage in relation to monitoring and managerial compensation. The *IND_Avg_LEV* coefficients are positive and significant (p-value ≤ 0.01), but mostly in our baseline models. This finding supports H_{3A}. In the context of our results, not only is the relation between IR derivatives usage and leverage positive, but firms with *High_Q* and *Low_Q* also increase IR derivatives usage (p-value ≤ 0.10). These positive coefficients suggest that decisions about investment plans are linked with IR derivatives usage to affect leverage, giving rise to a positive effect. These results do not always hold across other related measures. The coefficients for *High_Free-Cash-Flow_Total Assets* are consistently positive and significant (p-value ≤ 0.10), in support of H_{3B}. There is mixed support for H_4.

[*Table 5, about here*]

5.3. Combined derivatives users and non-users

The results for combined derivative usage are not shown to save space, but these results are available on request. The monitoring and managerial compensation variables are positively related to combined derivatives usage, in line with previous results (p-value ≤ 0.01). The coefficients are generally larger compared with those of currency and IR derivatives usage. This may reflect potential contamination of the combined samples relative to the clean samples. The negative and monotonic effect of investment distortion costs on usage is maintained. In general, inferences based on combined derivatives usage are generally consistent with those for the clean samples for the IV–probit regressions.

6. Conclusion

This paper examines the relation between derivatives usage and monitoring mechanisms, managerial incentives, and investment distortion costs. We also consider the role of hedging substitutes in relation to derivatives usage since hedging substitutes provide an alternative mechanism for firms to hedge. Our main focus is on separate samples of currency and IR derivatives users and non-users. Using two-stage logistic regressions, we find contrasting results for the relation between derivatives usage and our monitoring mechanisms, as well as managerial compensation. Board size and stock compensation are positively related to currency derivatives usage. NEDs and executive compensation are negatively related to currency derivatives usage. In contrast, board size and NEDs are negatively related to IR derivatives usage. However, *LnCG_Index* is positively related to IR derivatives usage. We believe that some of the observed negative coefficients may reflect the inability of the IV–GMM to generate reliable predictors for our two-stage logistic regressions. We take this view, since the IV–probit regressions generate coefficients with the expected positive sign for these measures. In most cases, there is a negative and monotonic relation between derivatives usage and our measures of investment distortion costs. This finding holds across estimation methods. Firms tend to reduce derivatives use irrespective of the riskiness of firms. Our sample covers a period of low IR volatility, whereas currency rates have been relatively volatile. The low IRs over the period of our study may explain the negative relation between IR derivatives usage and our interaction terms. The same cannot be said for currency derivatives usage. So, alternative explanations need to be considered.

The negative relation between derivatives usage and some of our measures might indicate sub-optimal behaviour on the part of firms. While managerial risk aversion may cause firms to use derivatives (Smith and Stulz, 1985), some firms may under-hedge, over-hedge or even not hedge, depending on how their wealth is tied to firm value. Gay et al. (2003) and Huang et al. (2007) argue that firms are likely to over-hedge when they face increases in quantity (output) and market price risks. They suggest that firms should use more non-linear derivatives, e.g., financial options, to resolve the over-hedging problem. Since the negative relation between derivatives usage and our interaction variables relate to investment decisions, a further explanation deserves consideration. As such, we suggest that managers reduce derivatives usage in situations where they are likely to benefit more than shareholders (see Froot et al., 1993; Tufano, 1998). In this case, the relation between derivatives usage and our measures will be negative. Future research should be extended to incorporate external governance measures to compare the relative influence of internal and external monitoring in investment and hedging decisions. Also, alternative specifications for Eq. (2) might be explored to see if better predicted values can be obtained for the two-stage logistic regression. This is in line with the view that the logistic regression provides a better fit to the data compared with the probit regression.

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Appendix I: Definitions and descriptions of (raw) dependent variables and instrumental variables

Variables	**Definitions and descriptions**
Panel A: Dependent variables for the first-stage regression	
LnCG_Index	The natural logarithm of one plus the corporate governance index based on 14 governance components using a zero/one dummy for CEO-chair separation, presence/ absence of an audit committee, and so on (see Appendix II).
LnBoard_Size	The natural logarithm of the total number of directors on the board of each firm.
NED	The percentage of non-executive directors to the total number of directors.
Stock_CompMV	The total stock-based compensation (excluding stock options) divided by market value in each year, multiplied by 100.
Executive_CompMV	The total senior executive compensation awarded to top management for a given fiscal year divided by market value for the year, multiplied by 100. This includes all stock based compensations plus the usual cash payments, such as salaries and bonuses and other fringe benefits.
Panel B: Industry-based instrumental variables year by year	
Industry average leverage (*IND_Avg_LEV*)	The average of total debts divided by total assets for the industry.
Industry average interest cover (*IND_Avg_Interest_Cover*)	The average interest coverage ratio for the industry.
Industry average earnings before interest and tax divided by market value (*IND_Avg_EBIT_Market Value*)	The average earnings before interest and taxes (EBIT) for the industry divided by the average market capitalization value for the industry.
Industry average *Z*-score (*IND_Avg_Z-score*)	The average Altman *Z*-score for the industry.
Industry average free cash flow (*IND_Avg_Free-Cash-Flow_Total Assets*)	The average free cash flow for the industry divided by average total assets for the industry.
Industry average R&D to Total Assets (*IND_Avg_R&D_Total Assets*)	The average R&D for the industry divided by the average total assets for the industry.
Industry average Q *(IND_Avg_Q)*	The average Tobin's *Q* for the industry.
Industry average of dividend per share (*IND_Avg_Dividend per Share)*	The average dividends for the industry divided by the average number of shares outstanding for the industry.
Industry average log of market capitalisation measured as debt plus equity (*LnMarket Value*)	The natural logarithm of the total market value of firms for the industry.
Industry average log of total assets (*LnTotal Assets*)	The natural logarithm of the total assets of the firms for the industry.
Industry average log of total sales (*LnSales*)	The natural logarithm of the total sales of the firms for the industry.

Panel A shows the endogenous dependent variables used for the IV–GMM estimations (see Eqs. (1) and (2)). The associated explanatory variables, used to generate the full IV–GMM estimates for Eq. (1), are shown in Appendix III. The results for Eq. (1) are reported in Table 2 (see Section 4.2). Panel B shows the IVs used in the IV–GMM estimations. The averages of the IVs are constructed across five broad industry sectors, year by year. For all IV–GMM estimations, the chosen IVs are those that provide support for good model specifications in terms of no endogeneity, no over-riding restrictions, and no weak instruments. Typically, five to seven IVs are needed for each estimation.

Appendix II: Descriptions of components used to generate the corporate governance (CG) index

Descriptions of zero/one variables	DataStream code
1. CEO-chair separation and whether Chair was previously CEO.	*CGBSO09V*
2. Whether shareholders have the right to vote on Executive Remuneration prior to adoption of stock based compensation plans.	*CGCPDP056*
3. Presence/absence of staggered board structure in firms.	*CGSRDP053*
4. Presence/absence of Audit Committee.	*ECSLDP005*
5. Presence/absence of Remuneration Committee.	*CGCPDP005*
6. Presence/absence of Nomination Committee.	*CGBSDP005*
7. Presence/absence of Corporate Social Responsibility (CSR) Sustainability Committee. We include this committee since Bauer et al. (2015) show that there is a tendency for shareholders' proposal belonging to CRS group to effect change.	*CGVSDP005*
8. Presence/absence of appropriate internal structure and information tools to improve effectiveness of Board Functions.	*CGBFDP010*
9. Presence/absence of policy to maintain effective and independent Audit Committee.	*CGBFDP0011*
10. Presence/absence of policy to maintain effective and independent CSR Committee.	*CGBFDP0014*
11. Presence/absence of policy to maintain effective and independent Compensation Committee.	*CGBFDP0013*
12. Presence/absence of policy to maintain all-purpose policy on effectiveness and independence Board Committee.	*CGBFDP0017*
13. Presence/absence of policy to maintain effective and independent Nomination Committee.	*CGBFDP0012*
14. Presence/absence of Corporate Governance Committee.	*CGBFDP005*

This appendix indicates the zero/one dummy variables used to construct the *CG_Index*. All the dummy variables are taken from DataStream to construct the CG index across firms, year by year.

Appendix III: Descriptions of explanatory variables used in estimations

Variables	Definitions	Exp. signs
Monitoring mechanisms		
LnCG_Index^P	The predicted values of corporate governance index based on 14 zero/one governance components, for measures such as CEO-chair separation, presence/ absence of an audit committee, and so on (see Appendix II).	+
LnBoard_Size^P	Predicted values for the number of directors on the board.	+
NED^P	Predicted values for the percentage of non-executive directors divided by the total number of directors in the board.	+
Managerial incentives		
Stock_CompMV^P	The predicted values for total stock-based compensation (excluding stock options) divided by the market value.	+
Executive_CompMV^P	Predicted values for total senior executive compensations divided by market value.	+
Stock Price_Volatility	A stock's average annual price movement (high and low) from its average price for each year.	+
Underinvestment and financial distress		
Leverage	Total debts divided by total assets.	+
IND_Avg_LEV	Average leverage measure for the industry.	+
Interest_Cover	Interest coverage ratio: earnings before interest and taxes (EBIT) divided by interest rate expense.	–
Debt_Maturity	Average debt to maturity of a firm using the Eisdorfer (2008) model. That is, Debt_Maturity = (0.5 × book value of short-term debts + 5 × book value of long-term debts) / total debts.	+
LT Debts_Total Debts	Long-term debts divided by total debts.	+
EBIT_Market Value	EBIT divided by market capitalization value.	–
Z-score	The Altman *Z*-score model for predicting bankruptcies is: *Z*-score = 1.2 × (working capital / Total assets) + 1.4 × (Retained earnings / Total assets) + 3.3 × (EBIT/Total Assets) + 0.6 × (Market value of equity/Total liabilities) + 0.999 × (Sales/Total assets).	+
Low_Q	A dummy variable set to one if the *Q* falls in the bottom third of each sample of *Q* observations for currency, IR, combined users, and non-users; zero otherwise. Low *Q* firms are those with low profitable investment opportunities.	+
Low_Z-score	A dummy variable set to one if the *Z*-score for a firm falls in the bottom third of each sample of *Z*-score observations for currency, IR, combined users, and non-users; zero otherwise.	+
Low_Free-Cash-Flow_Total Assets	A dummy variable set to one if the free cash flow to total assets for a firm falls in the bottom third of each sample of free cash flow to total assets observations for currency, IR, combined users, and non-users; zero otherwise.	+
Overinvestment		
Free-Cash-Flow_Total Assets	The free cash flow is measured as the sum of operating income before depreciation less interest expense, less corporation income tax, less capital expenditures divided by the book values of total assets (see Harford et al., 2012).	–
High_Free-Cash-Flow_Total Assets	A dummy variable set to one if the free cash flow to total assets for a firm falls in the top third of each sample of free cash flow to total assets observations, for currency, IR and non-users; zero otherwise.	–
CAP_Exped_PPE	Capital expenditures divided by the sum of property, plant, and equipment.	–
CAP_Exped_Total Sales	Capital expenditure divided by total sales.	–
High_Q	A dummy variable set to one if the *Q* for a firm falls in the top third of each sample of *Q* observations for currency, IR, combined users and non-users; zero otherwise. High *Q* firms as designated as firms with high profitable investment opportunities.	–
High_Z-score	A dummy variable set to one if the *Z*-score for a firm falls in the top third of each sample of *Z*-score for currency, IR, combined users, and non-users; zero otherwise.	–
Growth and investment opportunities		
R&D_Total Assets	Total R&D expenditures divided by total assets.	+
Q	The Tobin's *Q*, measured as market value divided by book value of assets. Market value is based on the total number of common shares outstanding multiplied by annual stock price.	+
Dividend per Share	Annual dividends paid divided by the total number of shares outstanding.	+
Hedging substitutes		
Convertible Debts_Total Debts	The total amount of convertible debts held divided by total debts.	–
Fixed Assets_Total Assets	Fixed assets divided by total assets.	–
Current Ratio	Current assets divided by current liabilities.	–
LnPre_Tax_Income	The natural logarithm of the pre-tax income.	+
Cash_Total Assets	Cash shown in balance sheet divided by total assets.	–
ROA	The return on assets, defined as net income divided by to total assets.	+
Size		
LnMarket Value	The natural logarithm of market value.	+
LnTotal Assets	The natural logarithm of total assets.	+
Expected taxes		
TXR	The total tax payments divided by pre-tax income.	+

Table 1: Derivatives users by year and industry sector

Firm-year	**All (combined) derivatives users**	**Currency derivatives users & others**	**Currency derivatives users only**	**IR derivatives users & others**	**IR derivatives users only**	**Commodity derivatives users & others**	**Commodity derivatives users only**	**Non-users**	**All users and non-users**
Panel A: Firm-year observations by year									
2005	105	89	43	58	14	17	0	56	161
2006	114	98	48	62	14	17	0	65	179
2007	128	106	50	71	15	20	3	67	195
2008	132	109	54	73	18	19	0	69	201
2009	132	112	53	74	15	20	1	71	203
2010	130	114	51	73	13	20	0	76	206
2011	132	110	51	77	15	21	0	76	208
2012	129	113	48	77	13	21	0	81	210
2013	135	115	54	76	16	22	1	77	212
2014	136	114	52	78	17	24	2	75	211
2015	126	109	47	75	13	23	1	79	205
Panel B: Firm-year observations by industry									
Oil & Gas	81	74	18	49	2	34	2	61	142
Basic Materials	109	91	31	56	0	62	5	105	214
Industrials	498	442	241	257	44	45	0	176	674
Consumer Goods	179	152	56	112	16	43	0	77	256
Health Care	89	81	46	43	8	0	0	126	215
Consumer Services	292	219	78	207	72	29	1	102	394
Telecommunications	22	22	11	11	0	0	0	31	53
Utilities	13	11	0	13	2	11	0	7	20
Technology	116	97	70	46	19	0	0	107	223
Total	**1,399**	**1,189**	**551**	**794**	**163**	**224**	**8**	**792**	**2,191**

This table indicates the number of currency, IR, and commodity derivatives users by year and industry sector. "Currency derivatives users & others" mainly are users of currency derivatives and occasional users of IR and/or commodity derivatives. A related definition applies for "IR derivatives users & others" and "Commodity derivatives users & others". "Currency derivatives users only" are users of only currency derivatives. Related definitions apply to "IR derivatives users only" and "Commodity derivatives users only". "Non-users" are firms that do not use any derivative instrument to hedge exposure. Details about derivatives usage are obtained from the financial reports of the sample of firms. Non-users typically declare in their financial reports that they have exposures to currency, IR, and/or commodity price risk, but do not hedge.

Table 2: Coefficient for all groups of derivatives users and non-users estimated using IV–GMM for firm-specific variables

	LnCG_Index	*LnBoard Size*	*NED*	*Stock_CompMV*	*Executive_CompMV*	*LnCG_Index*	*LnBoard Size*	*NED*	*Stock_CompMV*	*Executive_CompMV*
	Coeff.	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**
	Panel A: Currency derivatives users					*Panel B: IR derivatives users*				
Leverage	0.044	0.175	–0.399^{c}	–0.008	–0.035	–1.958	–1.094^{b}	0.773	0.345	–0.278
	(1.109)	(0.282)	(0.223)	(0.281)	(0.286)	(1.728)	–0.491	–0.83	–1.013	–1.118
Stock Price_Volatility	4.489^{a}	0.801^{b}	–0.423^{c}	0.533^{b}	–1.070^{b}	–3.389^{a}	–0.215	0.096	1.768^{a}	–0.274
	(1.367)	(0.343)	(0.251)	(0.255)	(0.500)	(0.876)	–0.264	–0.227	–0.622	–0.501
Interest_Cover	0.001	0.002^{c}	0.001	–0.003^{a}	–0.001	–0.001^{b}	0.001	0.001	0.001	0.001
	(0.003)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Z-score	–0.332^{a}	0.033	–0.074^{a}	0.057^{a}	0.079^{b}	–0.026^{b}	–0.006	–0.002	0.011	0.013^{c}
	(0.109)	(0.037)	(0.016)	(0.019)	(0.036)	(0.013)	(0.004)	(0.003)	(0.012)	(0.008)
Debt_Maturity	–0.016	0.009	0.004	–0.047a	–0.021	–0.062	–0.002	–0.004	–0.015	–0.027
	(0.042)	(0.014)	(0.01)	(0.018)	(0.022)	(0.049)	(0.013)	(0.018)	(0.026)	(0.022)
Free-Cash-Flow_Total Assets	–2.998^{b}	2.367^{a}	0.169	0.795^{c}	4.185^{a}	–0.140	–0.765^{a}	0.027	0.137	0.422
	(1.271)	(0.826)	(0.533)	(0.444)	(0.712)	(0.759)	(0.265)	(0.197)	(0.450)	(0.672)
EBIT_Market Value	2.368^{c}	–1.676^{a}	0.649^{c}	–2.651^{a}	–1.409^{a}	–0.753	–1.212^{b}	0.672	1.885^{c}	–1.203
	(1.373)	(0.451)	(0.343)	(0.422)	(0.547)	(1.449)	(0.496)	(0.573)	(1.111)	(1.373)
CAP_Exped_PPE	0.285	0.474^{b}	–0.108	–0.297	–0.063	1.201^{a}	0.336^{a}	–0.071	0.230	0.140
	(0.326)	(0.228)	(0.146)	(0.195)	(0.234)	(0.252)	(0.081)	(0.056)	(0.151)	(0.207)
Cap_Exped_Total Sales	–1.893^{c}	–0.869	0.392	–0.285	–1.612^{c}	–1.561	0.336	0.932^{c}	0.171	0.942
	(1.060)	(0.967)	(0.687)	(1.255)	(0.946)	(1.498)	(0.389)	(0.530)	(1.196)	(0.856)
R&D_Total Assets	0.061	–0.242^{a}	0.100^{c}	0.242^{b}	0.455^{a}	0.386^{b}	0.102^{c}	–0.040	–0.088	0.159
	(0.353)	(0.093)	(0.056)	(0.116)	(0.102)	(0.153)	(0.053)	(0.064)	(0.131)	(0.136)
Q	0.012	0.003	0.005^{c}	0.016^{c}	–0.002	–0.010	0.013^{a}	–0.009^{c}	–0.001	0.025^{a}
	(0.023)	(0.003)	(0.002)	(0.008)	(0.009)	(0.016)	(0.005)	(0.005)	(0.014)	(0.009)
Current Ratio	0.300^{b}	–0.024	0.096^{a}	–0.056	–0.219^{a}	0.206	0.097^{b}	–0.031	0.003	–0.011
	(0.138)	(0.056)	(0.035)	(0.052)	(0.072)	(0.129)	(0.044)	(0.043)	(0.070)	(0.065)
LnPre-Tax_Income	0.317^{c}	–0.082	0.071^{c}	0.108^{a}	–0.233^{a}	0.090	0.069^{c}	0.040	0.177^{c}	0.281^{a}
	(0.170)	(0.058)	(0.041)	(0.039)	(0.069)	(0.126)	(0.042)	(0.036)	(0.093)	(0.090)
ROA	–2.318	0.571	–0.843^{c}	0.585	–0.296	–0.322	–1.535^{a}	0.146	–0.644	–2.171^{a}
	(2.500)	(0.691)	(0.438)	(0.547)	(0.881)	(1.094)	(0.405)	(0.300)	(0.762)	(0.605)
Dividend per Share	–0.980^{b}	0.884^{a}	–0.422^{a}	0.043	1.324^{a}	–1.473^{a}	–0.389^{a}	0.383^{a}	0.518c	–0.471^{b}
	(0.483)	(0.187)	(0.157)	(0.280)	(0.229)	(0.454)	(0.138)	(0.131)	(0.290)	(0.220)
LnMarket Value	0.968^{a}	–0.033	0.030	–0.392^{a}	–0.403^{a}	0.489^{a}	0.058^{c}	–0.033	–0.102	–0.553^{a}
	(0.186)	(0.096)	(0.054)	(0.077)	(0.093)	(0.097)	(0.034)	(0.031)	(0.091)	(0.087)
LnTotal Assets	–0.477^{b}	0.193^{a}	–0.103^{c}	0.491^{a}	0.378^{a}	0.013	–0.001	0.004	–0.005	–0.033^{b}
	(0.241)	(0.071)	(0.056)	(0.095)	(0.098)	(0.028)	(0.007)	(0.006)	(0.016)	(0.014)
LnSales	–0.075	–0.102	0.097^{c}	–0.074^{c}	–0.074	0.104	0.053^{b}	–0.024	–0.036	0.106^{b}
	(0.161)	(0.063)	(0.050)	(0.042)	(0.060)	(0.093)	(0.026)	(0.025)	(0.065)	(0.047)
TXR	0.217	0.120	0.149^{c}	–0.057	–0.068	–0.612^{b}	–0.216^{b}	0.070	0.424^{b}	–0.130
	(0.289)	(0.133)	(0.088)	(0.120)	(0.121)	(0.302)	(0.104)	(0.095)	(0.193)	(0.168)
Constant	–3.350^{a}	1.563^{a}	0.114	–0.375	2.460^{a}	–1.140^{c}	1.191^{a}	0.539^{b}	–0.336	2.357^{a}
	(0.614)	(0.426)	(0.419)	(0.388)	(0.561)	(0.583)	(0.206)	(0.213)	(0.438)	(0.497)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Continued

Table 2 (Continued)

	LnCG_Index	*LnBoard Size*	*NED*	*Stock_CompMV*	*Executive_CompMV*	*LnCG_Index*	*LnBoard Size*	*NED*	*Stock_CompMV*	*Executive_CompMV*
	Coeff.	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**
	Panel A: Currency derivatives users					*Panel B: IR derivatives users*				
Diagnostic tests										
Number of obs.	122	69	69	64	66	257	139	135	131	132
Wald χ^2	7,283.91[a]	1,128.96[a]	696.51[a]	989.96[a]	11,564.32[a]	1,130.10[a]	292.78[a]	330.38[a]	176.96[a]	310.28[a]
Root MSE	0.486	0.127	0.074	0.106	0.122	0.599	0.13	0.089	0.303	0.268
Hansen $J\ \chi^2$	1.669	11.78	10.279	10.312	6.197	3.630	7.542	2.312	7.754	11.700
GMM C statistic $\chi2$	0.300	0.181	0.046	2.348	0.384	0.171	1.961	0.487	0.219	0.162
First stage Adj. R^2	0.721	0.875	0.857	0.894	0.836	0.510	0.683	0.644	0.707	0.684
First stage partial R^2	0.098	0.291	0.294	0.370	0.331	0.092	0.203	0.055	0.228	0.216
F-statistic for weak instrument	2.107[c]	1.988[c]	1.922[c]	2.089[c]	2.897[b]	2.438[c]	3.424[a]	2.183[c]	3.456[a]	3.624[a]
	Panel C: Combined currency and IR derivatives users					*Panel D: Non-users*				
Leverage	0.872	0.153	–0.001	–0.522	–0.080	1.721	–0.285	0.094	–0.671	0.449
	(2.301)	(0.460)	(0.409)	(0.884)	(0.641)	(2.007)	(0.566)	(0.271)	(0.514)	(0.636)
Stock Price_Volatility	–0.907[b]	0.326[b]	–0.014	–0.097	–0.074	–0.042	–1.411[b]	0.656[b]	1.455[b]	–0.099
	(0.423)	(0.136)	(0.094)	(0.182)	(0.209)	(0.801)	(0.687)	(0.262)	(0.669)	(0.818)
Interest_Cover	0.001	0.001	0.001	–0.001a	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)
Z-score	0.020	0.008	0.013[c]	0.014	0.001	0.051	–0.048[a]	0.004	–0.007	0.016
	(0.032)	(0.010)	(0.008)	(0.019)	(0.017)	(0.035)	'(0.017)	(0.012)	(0.031)	(0.026)
Debt_Maturity	–0.025	0.019	0.007	–0.052[c]	–0.020	0.031	0.008	0.005	0.062[a]	0.074[a]
	(0.056)	(0.016)	(0.012)	(0.028)	(0.024)	(0.039)	(0.018)	(0.009)	(0.023)	(0.026)
Free-Cash-Flow_Total Assets	0.987	0.008	0.227	–0.128	–0.811	–0.557	0.584	–0.271	1.130	0.729
	(0.869)	(0.350)	(0.202)	(0.616)	(1.067)	(0.636)	(0.650)	(0.406)	(0.808)	(0.911)
EBIT_Market Value	2.101[a]	–0.125	–0.362[a]	–0.934[a]	–0.821[a]	–1.881[a]	0.226	–1.028[a]	–0.874[c]	0.288
	(0.427)	(0.175)	(0.121)	(0.273)	(0.211)	(0.493)	(0.462)	(0.211)	(0.523)	(0.538)
CAP_Exped_PPE	–0.301	0.320[a]	0.001	–0.058	–0.093	–0.025	0.068	0.045	–0.112	–0.153[c]
	(0.499)	(0.114)	(0.088)	(0.215)	(0.164)	(0.039)	'(0.071)	(0.052)	(0.109)	(0.093)

Continued

Table 2 (Continued)

	LnCG_Index	*LnBoard Size*	*NED*	*Stock_CompMV*	*Executive_CompMV*	*LnCG_Index*	*LnBoard Size*	*NED*	*Stock_CompMV*	*Executive_CompMV*
	Coeff.	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**
	Panel C: Combined currency and IR derivatives users					*Panel D: Non-users*				
Cap_Exped_Total Sales	0.538	–0.269	–0.005	0.099	–0.098	–0.318	–1.054	0.338	3.836[b]	–2.065
	(0.806)	(0.174)	(0.123)	(0.328)	(0.339)	(0.363)	(1.001)	(0.587)	(1.673)	(1.518)
R&D_Total Assets	0.225	–0.119	0.017	0.115	0.023	0.107	–0.057	0.025	–0.212[b]	0.011
	(0.335)	(0.079)	(0.076)	(0.165)	(0.159)	(0.086)	(0.062)	(0.035)	(0.092)	(0.098)
Q	–0.015	0.001	0.005	0.013[c]	0.017	–0.001	0.001	–0.001	–0.027[a]	–0.012
	–0.03	(0.005)	(0.004)	(0.008)	(0.014)	(0.023)	(0.004)	(0.004)	(0.008)	(0.009)
Current Ratio	0.107	–0.031	–0.046[a]	–0.030	0.038	0.007	–0.061[a]	0.039[a]	–0.095[a]	–0.065[b]
	(0.079)	(0.027)	(0.017)	(0.040)	(0.048)	(0.046)	(0.019)	(0.011)	(0.024)	(0.033)
LnPre-Tax_Income	–0.131	–0.012	0.038	0.010	0.139[a]	0.152[c]	0.009	0.059[b]	0.046	0.274[a]
	(0.099)	(0.032)	(0.025)	(0.085)	(0.051)	(0.085)	(0.045)	(0.030)	(0.076)	(0.102)
ROA	0.102	0.203	0.084	2.500[b]	0.950[c]	0.001	–0.820[b]	0.752[b]	1.279[c]	0.674
	(1.268)	(0.402)	(0.295)	(1.244)	(0.560)	(0.791)	(0.355)	(0.300)	(0.726)	(0.580)
Dividend per Share	–0.439[b]	0.119[c]	0.008	0.121	0.227[a]	–0.050	–0.154	0.204[c]	–0.101	–0.060
	(0.174)	(0.066)	(0.043)	(0.099)	(0.082)	(0.268)	(0.133)	(0.108)	(0.192)	(0.254)
LnMarket Value	0.457[a]	0.069[b]	–0.005	–0.349[a]	–0.451[a]	0.125	0.175[a]	–0.072[b]	–0.120	–0.57[a]
	(0.102)	(0.032)	(0.019)	(0.060)	(0.076)	(0.102)	(0.045)	(0.031)	(0.084)	(0.102)
LnTotal Assets	0.140	0.074	0.076b	0.362[a]	0.054	0.209	–0.144[b]	0.051	0.013	0.334[b]
	(0.133)	(0.046)	(0.033)	(0.117)	(0.059)	(0.142)	(0.073)	(0.043)	(0.142)	(0.153)
LnSales	–0.032	–0.027	–0.071[a]	–0.041	0.065	0.280[a]	0.055	–0.087[a]	–0.096	–0.252[b]
	(0.099)	(0.033)	(0.022)	(0.058)	(0.045)	(0.089)	(0.077)	(0.032)	(0.081)	(0.108)
TXR	–0.140	0.051	0.048	0.155	–0.029	–0.759[a]	–0.285[b]	0.369[a]	0.139	0.163
	(0.164)	(0.070)	(0.045)	(0.175)	(0.108)	(0.175)	(0.146)	(0.101)	(0.247)	(0.386)
Constant	–2.207[a]	1.179[a]	0.056	0.558	2.249[a]	–2.713[a]	2.117[a]	0.285	1.243	2.196[a]
	(0.403)	(0.136)	(0.122)	(0.345)	(0.248)	(0.487)	(0.467)	(0.291)	(0.811)	(0.777)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Diagnostic tests										
Number of observations	418	297	288	281	287	248	84	80	77	83
Wald χ^2	1,443.03[a]	693.45[a]	288.80[a]	154.45[a]	381.72[a]	1,142.23[a]	772.71[a]	664.37[a]	685.84[a]	6,002.20[a]
Root MSE	0.638	0.165	0.12	0.246	0.248	0.557	0.12	0.082	0.205	0.293
Hansen J statistic (χ^2)	0.109	0.122	2.332	1.909	2.444	5.989	6.808	7.066	11.556	11.413
Hayashi C statistic (χ^2)	0.088	0.254	0.06	0.044	0.08	0.599	2.384	0.017	1.609	0.712
First-stage Adj. R^2	0.422	0.451	0.446	0.435	0.451	0.498	0.735	0.725	0.756	0.745
First-stage partial R^2	0.013	0.026	0.030	0.026	0.023	0.036	0.222	0.186	0.242	0.277
F-statistic for weak instrument	3.310[b]	4.095[b]	4.689[a]	3.599[b]	3.649[b]	1.982[c]	2.044[c]	2.390[c]	1.844[c]	2.539[c]

Variable definitions are in Appendices I and III. The general method of moments (GMM) method is estimated together with the instrumental variables (IVs) chosen from the set shown in Panel B of Appendix I. Not all the IVs are used in the estimation. The chosen IVs are those that ensure adequate model specifications in terms of over-riding restrictions, endogeneity, and no weak instruments. The Hansen J statistic is a test of over-riding restrictions. The Hayashi C statistic is a test for endogeneity. The partial R^2 measures the correlation between *Leverage* and the IVs, after partialing out other variables. The F-statistic is a test for weak instruments. [a], [b], and [c] denote statistical significance at a 1-, 5-, and 10% level, respectively. The IV–GMM is estimated using robust standard errors.

Table 3: Coefficient estimates of the logistic regressions for currency derivatives usage based on a two-stage estimation procedure

	LnCG_Index^P				*LnBoard_Size*^{P}				*NED*^{P}				*Stock_CompMV*^{P}				*Executive_CompMV*^{P}			
	Model 1A		**Model 1B**		**Model 2A**		**Model 2B**		**Model 3A**		**Model 3B**		**Model 4A**		**Model 4B**		**Model 5A**		**Model 5B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Monitoring mechanisms																				
LnCG_Index^P	–0.478	–0.081	0.494	0.069																
	(0.333)		(0.553)																	
LnCG_Index^P*×High_Free-Cash-Flow_Total Assets*			–0.227	–0.032																
			(0.519)																	
LnCG_Index^P*×Low_Free-Cash-Flow_Total Assets*			0.033	0.005																
			(1.064)																	
LnCG_Index^P*×High_Q*			–0.166	–0.023																
			(0.645)																	
LnCG_Index^P*×Low_Q*			0.111	0.015																
			(0.421)																	
LnCG_Index^P*×High_Z-score*			0.280	0.039																
			(0.766)																	
LnCG_Index^P*×Low_Z-score*			–1.530[a]	–0.214[a]																
			(0.477)																	
LnBoard_Size^P					3.225[a]	0.539[a]	1.474	0.184												
					(1.038)		(2.328)													
LnBoard_Size^P*×High_Free-Cash-Flow_Total Assets*							–0.666	–0.083												
							(3.256)													
LnBoard_Size^P*×Low_Free-Cash-Flow_Total Assets*							1.561	1.950												
							(1.087)													
LnBoard_Size^P*×High_Q*							5.034	0.629												
							(3.240)													
LnBoard_Size^P*×Low_Q*							–1.556[a]	–1.943[a]												
							(0.369)													
LnBoard_Size^P*×High_Z-score*							–1.307[a]	–1.632[a]												
							(0.405)													
LnBoard_Size^P*×Low_Z-score*							1.748[a]	2.183[a]												
							(0.370)													
NED^P									–0.339[a]	–0.053[a]	–0.229[b]	–0.030[b]								
									(0.065)		(0.094)									
NED^P*×High_Free-Cash-Flow_Total Assets*											0.021	0.003								
											(0.069)									
NED^P*×Low_Free-Cash-Flow_Total Assets*											–0.079	–0.010								
											(0.095)									
NED^P*×High_Q*											–0.164[c]	–0.022[c]								
											(0.094)									
NED^P*×Low_Q*											–0.055	–0.007								
											(0.074)									
NED^P*×High_Z-score*											–0.151	–0.020								
											(0.098)									
NED^P*×Low_Z-score*											–0.080	–0.011								
											(0.071)									

Continued

Table 3 (Continued)

	LnCG_Index^{P}				*LnBoard_Size*^{P}				*NED*^{P}				*Stock_CompMV*^{P}				*Executive_CompMV*^{P}			
	Model 1A		**Model 1B**		**Model 2A**		**Model 2B**		**Model 3A**		**Model 3B**		**Model 4A**		**Model 4B**		**Model 5A**		**Model 5B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Managerial Incentives																				
Stock_CompMV^{P}													0.965	0.166	3.089^{b}	0.424^{b}				
													(0.725)		(1.388)					
Stock_CompMV^{P}×*High_Free-Cash-Flow_Total Assets*															3.433	0.472				
															(2.483)					
Stock_CompMV^{P}×*Low_Free-Cash-Flow_Total Assets*															-8.625^{b}	-1.185^{b}				
															(3.912)					
Stock_CompMV^{P}×*High_Q*															–1.442	–0.198				
															(2.265)					
Stock_CompMV^{P}×*Low_Q*															1.798	0.247				
															(1.352)					
Stock_CompMV^{P}×*High_Z-score*															–4.014	–0.551				
															(4.446)					
Stock_CompMV^{P}×*Low_Z-score*															-4.288^{a}	-0.589^{a}				
															(1.497)					
Executive_CompMV^{P}																	-7.453^{a}	-1.030^{a}	-4.035^{c}	-0.436^{c}
																	(0.813)		(2.211)	
Executive_CompMV^{P}×*High_Free-Cash-Flow_Total Assets*																			–0.772	–0.083
																			(2.396)	
Executive_CompMV^{P}×*Low_Free-Cash-Flow_Total Assets*																			–8.243	–0.890
																			(6.605)	
Executive_CompMV^{P}×*High_Q*																			-1.006^{a}	-1.086^{a}
																			(3.774)	
Executive_CompMV^{P}×*Low_Q*																			3.891	0.420
																			(3.196)	
Executive_CompMV^{P}×*High_Z-score*																			5.099^{c}	0.550^{c}
																			(3.078)	
Executive_CompMV^{P}×*Low_Z-score*																			-6.956^{b}	-0.751^{b}
																			(3.556)	
Stock Price_Volatility	–2.645	–0.450	–1.831	–0.256	–2.661	–0.445	-4.645^{b}	-0.580^{b}	–0.597	–0.093	–2.078	–0.274	–2.675	–0.461	–2.991	–0.411	–1.052	–0.145	–1.351	–0.146
	(1.762)		(1.911)		(1.738)		(2.012)		(1.902)		(2.215)		(1.660)		(2.110)		(1.733)		(2.320)	

Continued

Table 3 (Continued)

	LnCG_Index^{P}				*LnBoard_Size*^{P}				*NED*^{P}				*Stock_CompMV*^{P}				*Executive_CompMV*^{P}			
	Model 1A		**Model 1B**		**Model 2A**		**Model 2B**		**Model 3A**		**Model 3B**		**Model 4A**		**Model 4B**		**Model 5A**		**Model 5B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Underinvestment and financial distress																				
IND_Avg_LEV	–6.685^{b}	–1.138^{b}	–1.056^{a}	–1.478^{a}	–6.631^{b}	–1.109^{b}	–9.815^{b}	–1.226^{b}	–6.832^{b}	–1.070^{b}	–4.516	–0.594	–4.618	–0.796	–9.879^{a}	–1.357^{a}	–6.303	–0.871^{c}	–9.391^{c}	–1.014^{c}
	(3.110)		(0.359)		(3.174)		(4.076)		(3.251)		(3.623)		(2.983)		(3.647)		(3.847)		(5.168)	
Interest_Cover	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	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)	
Z-score	0.062	0.011	0.032	0.004	0.080^{c}	0.013^{c}	0.004	0.001	0.067	0.011	0.001	0.001	0.039	0.007	0.019	0.003	0.107^{c}	0.015^{c}	0.091	0.010
	(0.042)		(0.051)		(0.045)		(0.052)		(0.052)		(0.048)		(0.040)		(0.059)		(0.059)		(0.061)	
Debt_Maturity	0.027	0.005	0.066	0.009	–0.007	–0.001	–0.016	–0.002	0.142^{c}	0.022^{c}	0.154	0.020^{c}	0.066	0.011	0.134	0.018	0.077	0.011	0.069	0.007
	(0.071)		(0.087)		(0.073)		(0.090)		(0.074)		(0.095)		(0.072)		(0.086)		(0.074)		(0.098)	
Low_Q			0.890	0.124			3.471^{a}	4.334^{a}			2.678	0.352			0.572	0.079			0.014	0.002
			(0.561)				(0.796)				(2.229)				(0.545)				(1.356)	
EBIT_Market Value	–7.766^{a}	–1.322^{a}	–7.971^{a}	–1.115^{a}	–7.578^{a}	–1.268^{a}	–6.827^{a}	–0.853^{a}	–7.909^{a}	–1.238^{a}	–7.426^{a}	–0.977^{a}	–7.560^{a}	–1.302^{a}	–8.737^{a}	–1.200^{a}	–6.063^{a}	–0.838^{a}	–7.023^{a}	–0.758^{a}
	(2.017)		(2.066)		(2.016)		(1.823)		(1.846)		(1.797)		(1.968)		(2.291)		(1.939)		(2.104)	
CAP_Exped_Total Sales	–6.300^{a}	–1.073^{a}	–8.238^{a}	–1.153^{a}	–5.821^{a}	–0.974^{a}	–9.460^{a}	–1.181^{a}	–0.883	–0.138	–2.963	–0.390	–7.588^{a}	–1.307^{a}	–1.066^{a}	–1.464^{a}	–3.587^{c}	–0.496^{c}	–7.404^{a}	–0.799^{a}
	(1.861)		(2.431)		(1.888)		(2.743)		(1.654)		(1.922)		(1.991)		(3.212)		(2.053)		(2.589)	
Dividend per Share	–4.170^{a}	–0.710^{a}	–4.040^{a}	–0.565^{a}	–3.649^{a}	–0.610^{a}	–1.832	–0.229	–3.728^{a}	–0.584^{a}	–3.662^{a}	–0.482^{a}	–3.631^{a}	–0.625^{a}	–3.413^{a}	–0.469^{a}	–5.355^{a}	–0.740^{a}	–3.922^{a}	–0.423^{a}
	(1.421)		(1.052)		(1.330)		(1.355)		(1.421)		(1.238)		(1.369)		(1.174)		(1.208)		(1.235)	
Low_Z-score			1.565^{a}	0.219^{a}			–3.788^{a}	–4.731^{a}			2.116	0.279			1.107^{c}	0.152^{c}			2.422	0.261
			(0.598)				(0.799)				(2.218)				(0.576)				(1.593)	
Low_Free-Cash-Flow_Total Assets			2.884^{c}	0.404^{c}			–2.894	–3.614			6.474^{b}	0.852^{b}			7.429^{a}	1.020^{a}			7.795^{b}	0.841^{b}
			(1.499)				(2.257)				(3.175)				(2.197)				(3.677)	
Overinvestment																				
Free-Cash-Flow_Total Assets	–5.016^{b}	–0.854^{b}	6.091	0.852	–4.878^{b}	–0.816^{b}	6.634	0.829	–6.455^{b}	–1.011^{a}	6.235^{c}	0.821^{c}	–5.438^{b}	–0.937^{a}	7.287^{b}	1.001^{b}	–5.616^{c}	–0.776^{c}	4.459	0.481
	(2.261)		(4.077)		(2.303)		(4.781)		(2.611)		(3.769)		(2.162)		(3.715)		(3.023)		(4.610)	
High_Free-Cash-Flow_Total Assets			–1.552^{b}	–0.217^{b}			–0.406	–0.051			–2.539	–0.334			–2.798^{a}	–0.384^{a}			–1.555	–0.168
			(0.713)				(6.839)				(2.150)				(0.803)				(0.964)	
CAP_Exped_PPE	–0.501	–0.085	–0.567	–0.079	–0.467	–0.078	–0.394	–0.049	–1.009^{c}	–0.158^{c}	–0.660	–0.087	–0.400	–0.069	–0.274	–0.038	–1.075^{c}	–0.149^{c}	–1.174^{b}	–0.127^{b}
	(0.395)		(0.419)		(0.374)		(0.364)		(0.586)		(0.555)		(0.398)		(0.334)		(0.633)		(0.572)	
High_Q			–0.324	–0.045			–1.129	–1.410^{c}			4.404	0.580			–0.031	–0.004			2.976^{c}	0.321^{c}
			(0.743)				(0.689)				(2.895)				(0.868)				(1.699)	
High_Z-score			0.727	0.102			2.843^{a}	3.550^{a}			5.395^{c}	0.710^{c}			2.046	0.281			–1.329	–0.143
			(0.952)				(0.857)				(3.045)				(1.509)				(1.375)	
Growth and investment opportunities																				
R&D_Total Assets	–1.489^{a}	–0.253^{a}	–1.791^{a}	–0.251^{a}	–1.501^{a}	–0.251^{a}	–1.296^{a}	–0.162^{a}	–1.368^{a}	–0.214^{a}	–1.444^{a}	–0.190^{a}	–1.237^{a}	–0.213^{a}	–1.748^{a}	–0.240^{a}	–1.415^{a}	–0.196^{a}	–1.704^{a}	–0.184^{a}
	(0.364)		(0.456)		(0.362)		(0.422)		(0.330)		(0.401)		(0.347)		(0.456)		(0.340)		(0.424)	
Q	–0.041	–0.007	0.002	0.001	–0.047	–0.008	0.019	0.002	–0.012	–0.002	0.047	0.006	–0.033	–0.006	0.024	0.003	–0.010	–0.001	0.110	0.012
	(0.047)		(0.070)		(0.048)		(0.066)		(0.049)		(0.065)		(0.048)		(0.082)		(0.054)		(0.087)	
Hedging substitutes																				
Current Ratio	–0.102	–0.017	–0.076	–0.011	–0.068	–0.011	–0.187	–0.023	–0.255	–0.040	–0.259	–0.034	–0.123	–0.021	–0.246	–0.034	–0.187	–0.026	–0.287	–0.031
	(0.154)		(0.193)		(0.154)		(0.164)		(0.189)		(0.214)		(0.148)		(0.180)		(0.159)		(0.232)	
LnPre_Tax_Income	0.329	0.056	0.427	0.060	0.363	0.061	0.520	0.065	0.511^{c}	0.080^{c}	0.623^{b}	0.082^{b}	0.249	0.043	0.438	0.060	0.451	0.062	0.484	0.052
	(0.272)		(0.316)		(0.275)		(0.345)		(0.288)		(0.316)		(0.247)		(0.322)		(0.320)		(0.329)	
ROA	1.867	0.318	1.764	0.247	1.890	0.316	1.853	0.231	2.016	0.316	0.865	0.114	3.146	0.542	1.053	0.145	3.184	0.440	4.365	0.471
	(2.814)		(3.745)		(2.858)		(3.618)		(3.010)		(3.377)		(2.644)		(3.771)		(3.661)		(4.098)	

Continued

Table 3 (Continued)

	LnCG_Index^{P}				*LnBoard_Size*^{P}				*NED*^{P}				*Stock_CompMV*^{P}				*Executive_CompMV*^{P}			
	Model 1A		**Model 1B**		**Model 2A**		**Model 2B**		**Model 3A**		**Model 3B**		**Model 4A**		**Model 4B**		**Model 5A**		**Model 5B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Size																				
LnMarket Value	0.330	0.056	0.619[b]	0.087[b]	0.263	0.044	0.437	0.055	0.454[c]	0.071[c]	0.693[a]	0.091[a]	0.303	0.052	0.570[b]	0.078[b]	0.255	0.035	0.780[a]	0.084[a]
	(0.219)		(0.259)		(0.224)		(0.313)		(0.238)		(0.252)		(0.212)		(0.267)		(0.273)		(0.297)	
LnTotal Assets	0.185[b]	0.032[b]	0.053	0.007	0.234[b]	0.039[a]	0.094	0.012	0.065	0.010	–0.050	–0.007	0.229[b]	0.039[a]	0.098	0.013	0.330[a]	0.046[a]	0.253[b]	0.027[b]
	(0.093)		(0.107)		(0.093)		(0.116)		(0.090)		(0.106)		(0.092)		(0.104)		(0.097)		(0.107)	
LnSales	0.103	0.018	–0.210	–0.029	–0.166	–0.028	–0.408[c]	–0.051[c]	0.486[b]	0.076[b]	0.219	0.029	–0.082	–0.014	–0.513[b]	–0.071[b]	0.048	0.007	–0.352	–0.038
	(0.213)		(0.264)		(0.204)		(0.246)		(0.220)		(0.248)		(0.193)		(0.226)		(0.201)		(0.239)	
TXR	0.168	0.029	–0.317	–0.044	0.258	0.043	0.279	0.035	0.268	0.042	0.052	0.007	0.413	0.071	–0.181	–0.025	0.864	0.119	0.807	0.087
	(0.621)		(0.782)		(0.659)		(0.921)		(0.606)		(0.702)		(0.552)		(0.845)		(0.733)		(0.808)	
Constant	–0.701		–1.482		–6.641		–0.945		5.551		2.965		–0.710		–0.101		1.092		–0.877	
	(1.201)		(1.663)		(2.342)		(4.875)		(1.677)		(2.773)		(1.127)		(1.927)		(1.442)		(2.244)	
Industry effect	YES		YES		YES		YES		YES		YES		YES		YES		YES		YES	
Year effect	YES		YES		YES		YES		YES		YES		YES		YES		YES		YES	
Diagnostic tests																				
Number of observations	507		507		507		507		507		507		507		507		507		507	
Wald χ^2	129.35[a]		140.17[a]		131.63[a]		168.41[a]		126.90[a]		179.63[a]		125.16[a]		153.54[a]		156.88[a]		172.71[a]	
Log pseudolikelihood	–256.72		–217.89		–252.07		–196.47		–238.55		–206.34		–259.35		–214.74		–215.10		–171.89	
Pseudo R^2	0.269		0.380		0.280		0.441		0.321		0.413		0.262		0.389		0.388		0.511	
Pearson χ^2 (goodness-of-fit)	474.28		540.46		461.82		468.10		506.00		463.86		482.20		542.94		440.15		581.37	
Akakie information criteria	571.45		551.78		566.13		468.97		533.10		486.68		566.69		507.47		480.20		419.78	
Correctly classified (%)	75.54		80.28		75.35		83.43		76.73		80.08		74.16		80.47		78.90		85.60	

Variable definitions are in Appendices I and III. The superscript ^{P} indicates that the coefficient is based on the predicted values of the two-stage IV–GMM (see Eq. (2)). Models 1A, 2A, 3A, etc. are the baseline models. Models 1B, 2B, 3B, etc. are the corresponding models with interaction terms. ME denotes the marginal effect. It represents the derivative of the approximate change in y for one unit change in x. Theoretically, ME should be between zero and one. ME may be outside the range of zero and one if the slope of the curve changes quickly. In this case, we retain the ME values that are outside the range of zero and one. Correctly classified denotes the performance of each logistic regression relative to a naive proportional chance model (see Joy and Tollefson, 1975). [a], [b], and [c] denote statistical significance at a 1-, 5-, and 10-percent level, respectively. The heteroscedastic-robust standard errors are in parentheses. Year and industry dummies are used in all estimations. Most of the year and industry effects are insignificant. We therefore apply the general-to-specific methodology commonly used in full-system estimation in econometrics, by sequentially removing the year and industry coefficients with the largest p-value first, as long as this procedure minimises the -2 log likelihood ratio (see Pagan, 1987, for a review of the general-to-specific methodology). This procedure is only applied to the year and industry coefficients that are insignificant.

Table 4: Coefficient estimates of the logistic regressions for IR derivatives usage based on a two-stage estimation procedure

	LnCG_Index^{P}				LnBoard_Size^{P}				NED^{P}				Stock_CompMV^{P}				Executive_CompMV^{P}			
	Model 6A		Model 6B		Model 7A		Model 7B		Model 8A		Model 8B		Model 9A		Model 9B		Model 10A		Model 10B	
	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME
Monitoring mechanisms																				
LnCG_Index^{P}	1.349[a]	0.164[a]	3.471[a]	0.219[a]																
	(0.524)		(0.901)																	
LnCG_Index^{P}×*High_Free-Cash-Flow_Total Assets*			–0.606	–0.038																
			(0.851)																	
LnCG_Index^{P}×*Low_Free-Cash-Flow_Total Assets*			–0.085	–0.005																
			(1.536)																	
LnCG_Index^{P}×*High_Q*			–0.361	–0.023																
			(0.835)																	
LnCG_Index^{P}×*Low_Q*			–1.833[c]	–0.116[c]																
			(1.100)																	
LnCG_Index^{P}×*Low_Z-score*			–3.137[b]	–0.198[a]																
			(1.297)																	
LnBoard_Size^{P}					–4.263[c]	–0.529[b]	2.669	0.178												
					(2.288)		(4.493)													
LnBoard_Size^{P}×*High_Free-Cash-Flow_Total Assets*							–2.163	–0.144												
							(3.822)													
LnBoard_Size^{P}×*Low_Free-Cash-Flow_Total Assets*							1.511[b]	1.009[b]												
							(0.758)													
LnBoard_Size^{P}×*High_Q*							–0.735	–0.049												
							(3.975)													
LnBoard_Size^{P}×*Low_Q*							–2.241[a]	–1.496[a]												
							(0.682)													
LnBoard_Size^{P}×*Low_Z-score*							–1.119[b]	–0.747[b]												
							(0.571)													
NED^{P}									–0.239[a]	–0.027[a]	0.166	0.011								
									(0.049)		(0.119)									
NED^{P}×*High_Free-Cash-Flow_Total Assets*											–0.127	–0.008								
											(0.103)									
NED^{P}×*Low_Free-Cash-Flow_Total Assets*											–0.373	–0.024								
											(0.242)									
NED^{P}×*High_Q*											–0.152	–0.010								
											(0.106)									
NED^{P}×*Low_Q*											–0.367[b]	–0.023[b]								
											(0.168)									
NED^{P}×*Low_Z-score*											–0.506[a]	–0.032[a]								
											(0.148)									

Continued

Table 4 (Continued)

	LnCG_Index^P				*LnBoard_Size^P*				*NED^P*				*Stock_CompMV^P*				*Executive_CompMV^P*			
	Model 6A		**Model 6B**		**Model 7A**		**Model 7B**		**Model 8A**		**Model 8B**		**Model 9A**		**Model 9B**		**Model 10A**		**Model 10B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Managerial Incentives																				
Stock_CompMV^P													1.543^a	1.802^a	1.828^a	1.264^a				
													(0.392)		(0.545)					
Stock_CompMV^P×High_Free-Cash-Flow_Total Assets															4.131	0.286				
															(4.993)					
Stock_CompMV^P×Low_Free-Cash-Flow_Total Assets															–1.375^c	–0.951^c				
															(0.740)					
Stock_CompMV^P×High_Q															–8.562^b	–0.592^b				
															(4.358)					
Stock_CompMV^P×Low_Q															–0.683	–0.047				
															(8.309)					
Stock_CompMV^P×Low_Z-score															–1.605	–0.111				
															(4.588)					
Executive_CompMV^P																	2.015^b	0.261^b	5.018^a	0.322^a
																	(0.887)		(1.750)	
Executive_CompMV^P×High_Free-Cash-Flow_Total Assets																			–0.440	–0.028
																			(1.532)	
Executive_CompMV^P×Low_Free-Cash-Flow_Total Assets																			–5.764^b	–0.370^b
																			(2.739)	
Executive_CompMV^P×High_Q																			–8.096^a	–0.520^a
																			(2.378)	
Executive_CompMV^P×Low_Q																			7.411^a	0.476^a
																			(2.488)	
Executive_CompMV^P×Low_Z-score																			–8.098^a	–0.520^a
																			(2.261)	
Stock Price_Volatility	–4.989^c	–0.605^c	–1.479^a	–0.935^a	–4.364^c	–0.542^c	–1.544^a	–1.031^a	–2.745	–0.304	–6.089	–0.386	–8.246^a	–0.963^a	–1.556^a	–1.076^a	–1.029^a	–1.331^a	–1.686^a	–1.083^a
	(2.920)		(0.431)		(2.488)		(0.424)		(2.831)		(4.441)		(2.846)		(0.439)		(0.273)		(0.509)	

Continued

Table 4 (Continued)

	LnCG_Index^{P}				*LnBoard_Size*^{P}				*NED*^{P}				*Stock_CompMV*^{P}				*Executive_CompMV*^{P}			
	Model 6A		**Model 6B**		**Model 7A**		**Model 7B**		**Model 8A**		**Model 8B**		**Model 9A**		**Model 9B**		**Model 10A**		**Model 10B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Underinvestment and financial distress																				
IND_Avg_LEV	–8.106	–0.982	–8.335	–0.527	–2.639	–0.328	5.319	0.355	–0.663	–0.734	–1.933	–0.123	9.989[b]	1.167[b]	6.356	0.439	8.112[c]	1.050[c]	1.181[c]	0.759[c]
	(9.390)		(9.958)		(6.558)		(5.452)		(1.016)		(5.722)		(4.117)		(4.948)		(4.255)		(0.626)	
Interest_Cover	–0.011[c]	–0.001[c]	–0.016	–0.001	–0.015[c]	–0.002[c]	–0.019	–0.001	–0.015	–0.002	–0.020	–0.001[c]	–0.023[b]	–0.003[b]	–0.024[c]	–0.002[c]	–0.012	–0.002	–0.016	–0.001
	(0.007)		(0.011)		(0.008)		(0.012)		(0.009)		(0.013)		(0.011)		(0.014)		(0.007)		(0.011)	
Z-score	–0.609[a]	–0.074[a]	–1.316[a]	–0.083[a]	–0.550[a]	–0.068[a]	–1.076[a]	–0.072[a]	–0.715[a]	–0.079[a]	–1.084[a]	–0.069[a]	–0.690[a]	–0.081[a]	–0.994[a]	–0.069[a]	–0.399[a]	–0.052[a]	–1.115[a]	–0.072[a]
	(0.158)		(0.415)		(0.155)		(0.325)		(0.176)		(0.321)		(0.165)		(0.291)		(0.142)		(0.300)	
Debt_Maturity	0.203[c]	0.025[c]	0.286	0.018	0.197[c]	0.024[c]	0.325[b]	0.022[b]	0.272[b]	0.030[b]	0.464[a]	0.029[a]	0.359[a]	0.042[a]	0.329[b]	0.023[b]	0.309[a]	0.040[a]	0.365[b]	0.023[b]
	(0.117)		(0.186)		(0.112)		(0.162)		(0.136)		(0.181)		(0.126)		(0.143)		(0.115)		(0.175)	
Low_Q			–0.170	–0.011			4.479[a]	2.991[a]			8.859[c]	0.562[c]			–0.456	–0.032			–4.148[a]	–0.266[a]
			(1.213)				(1.393)				(4.647)				(2.514)				(1.543)	
EBIT_Market Value	–8.848[a]	–1.072[a]	–8.006[c]	–0.506[c]	–1.028[a]	–1.277[a]	–8.532[c]	–0.570[c]	–1.046[a]	–1.158[a]	–1.443[a]	–0.915[a]	–3.097	–0.362	–0.425	–0.029	–5.105[b]	–0.661[b]	–5.021	–0.323
	(3.391)		(4.559)		(0.337)		(4.921)		(0.354)		(0.553)		(2.340)		(3.554)		(2.223)		(4.674)	
CAP_Exped_Total Sales	–4.059[a]	–0.492[a]	–1.011[a]	–0.639[a]	–3.456[a]	–0.429[a]	–1.032b	–0.689[b]	0.801	0.089	–1.367b	–0.867[b]	–1.548[a]	–1.808[a]	–2.355[a]	–1.628[a]	–4.406[a]	–0.570[a]	–1.459b	–0.937[a]
	(1.278)		(0.379)		(1.225)		(0.440)		(1.456)		(0.593)		(0.473)		(0.708)		(1.544)		(0.578)	
Dividend per Share	–5.344[a]	–0.648[a]	–7.753[a]	–0.490[a]	–4.910[a]	–0.610[a]	–8.051[a]	–0.538[a]	–3.901[a]	–0.432[a]	–4.705[b]	–0.298[b]	–3.125[a]	–0.365[a]	–3.853[a]	–0.266[a]	–4.694[a]	–0.607[a]	–7.990[a]	–0.513[a]
	(1.166)		(2.870)		(1.194)		(2.037)		(1.462)		(2.025)		(0.948)		(1.260)		(1.264)		(2.400)	
Low_Z-score			–3.976[a]	–0.251[a]			1.742	1.163			8.584[b]	0.544[b]			–4.419[a]	–0.306[a]			–1.379	–0.089
			(1.078)				(1.130)				(3.670)				(1.409)				(1.160)	
Low_Free-Cash-Flow_Total Assets			7.513[a]	0.475[a]			–2.253	–1.504			2.214[b]	1.404[a]			1.626[a]	1.124[a]			1.500[a]	0.964[a]
			(2.683)				(1.570)				(0.924)				(0.432)				(0.404)	
Overinvestment																				
Free-Cash-Flow_Total Assets	–4.490	–0.544	8.529	0.539	–5.103	–0.633[c]	7.587	0.507	–8.212[b]	–0.910[b]	–3.032	–0.192	–0.693	–0.081	7.053	0.488	–2.808	–0.363	–3.152	–0.202
	(3.005)		(6.207)		(3.113)		(5.540)		(3.950)		(8.110)		(4.580)		(6.262)		(3.301)		(7.313)	
High_Free-Cash-Flow_Total Assets			–0.534	–0.034			3.682	0.246			3.136	0.199			–1.669	–0.115			–0.084	–0.005
			(1.048)				(7.766)				(2.994)				(1.365)				(1.170)	
CAP_Exped_PPE	–0.125	–0.015	–0.197	–0.012	–0.099	–0.012	–0.605	–0.040	–0.515	–0.057	–0.956	–0.061	–3.177[a]	–0.371[a]	–3.693[a]	–0.255[a]	–0.203	–0.026	–1.101	–0.071
	(0.164)		(0.211)		(0.184)		(0.965)		(0.375)		(0.879)		(0.994)		(1.123)		(0.502)		(1.18)	
High_Q			1.590	0.100			2.220	0.148			5.471	0.347[c]			3.480[b]	0.241[b]			5.196[a]	0.334[a]
			(1.361)				(8.425)				(3.409)				(1.387)				(1.299)	
Growth and investment opportunities																				
R&D_Total Assets	–0.668	–0.081	–0.397	–0.025	–0.878[c]	–0.109[c]	–0.518	–0.035	–1.408[a]	–0.156[a]	–1.434[b]	–0.091[b]	–0.779	–0.091	–0.703	–0.049	–0.648	–0.084	–1.946[a]	–0.125[a]
	(0.471)		(0.666)		(0.507)		(0.566)		(0.461)		(0.638)		(0.587)		(0.557)		(0.486)		(0.598)	
Q	–0.095	–0.012	–0.108	–0.007	–0.176[b]	–0.022[b]	–0.140c	–0.009[c]	–0.251[b]	–0.028[b]	–0.258[b]	–0.016[a]	–0.072	–0.008	–0.068	–0.005	–0.127[c]	–0.016[c]	0.057	0.004
	(0.068)		(0.097)		(0.084)		(0.080)		(0.107)		(0.105)		(0.077)		(0.089)		(0.075)		(0.073)	

Continued

Table 4 (Continued)

	LnCG_Index^{P}				*LnBoard_Size*^{P}				*NED*^{P}				*Stock_CompMV*^{P}				*Executive_CompMV*^{P}			
	Model 6A		**Model 6B**		**Model 7A**		**Model 7B**		**Model 8A**		**Model 8B**		**Model 9A**		**Model 9B**		**Model 10A**		**Model 10B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Hedging substitutes																				
Current Ratio	0.271^{c}	0.033^{c}	0.123	0.008	0.194	0.024	0.060	0.004	0.442^{a}	0.049^{a}	–0.114	–0.007	–0.093	–0.011	–0.416^{b}	–0.029^{b}	–0.122	–0.016	–0.083	–0.005
	(0.148)		(0.196)		(0.135)		(0.207)		(0.168)		(0.301)		(0.126)		(0.187)		(0.132)		(0.211)	
LnPre_Tax_Income	0.220	0.027	0.996^{c}	0.063^{b}	0.442	0.055	1.031^{b}	0.069^{b}	0.562	0.062	1.291^{b}	0.082^{b}	–0.146	–0.017	0.459	0.032	0.008	0.001	0.574	0.037
	(0.405)		(0.520)		(0.382)		(0.482)		(0.370)		(0.562)		(0.317)		(0.455)		(0.341)		(0.445)	
ROA	1.083^{a}	1.313^{a}	6.472	0.409	1.080^{a}	1.340^{a}	3.707	0.248	13.074^{a}	1.448^{a}	1.011	0.641	1.175a	1.372^{a}	9.846^{b}	0.681^{b}	8.742^{b}	1.131^{b}	1.246^{b}	0.801^{b}
	(0.385)		(5.242)		(0.386)		(4.548)		(4.509)		(0.717)		(0.411)		(4.920)		(3.831)		(0.571)	
Size																				
LnMarket Value	0.911^{c}	0.110^{c}	–1.435^{b}	–0.091^{b}	1.253^{a}	0.156^{a}	–0.501	–0.033	2.023^{a}	0.224^{a}	–0.267	–0.017	2.269^{a}	0.265^{a}	–0.193	–0.013	1.293^{a}	0.167^{a}	–0.222	–0.014
	(0.475)		(0.732)		(0.392)		(0.656)		(0.489)		(0.779)		(0.506)		(0.747)		(0.384)		(0.757)	
LnTotal Assets	0.116	0.014	2.560^{b}	0.162^{b}	–0.364	–0.045	0.036	0.002	–1.489^{b}	–0.165^{b}	0.504	0.032	–0.277	–0.032	1.130	0.078	–0.089	–0.012	0.993	0.064
	(0.597)		(1.110)		(0.429)		(0.923)		(0.594)		(1.104)		(0.458)		(0.942)		(0.463)		(1.027)	
LnSales	–0.921^{b}	–0.112^{b}	–2.149^{a}	–0.136^{a}	–0.302	–0.038	–0.002	0.001	0.215	0.024	–0.753	–0.048	–1.249^{a}	–0.146^{a}	–1.272^{b}	–0.088^{b}	–0.378	–0.049	–0.646	–0.041
	(0.426)		(0.706)		(0.319)		(0.626)		(0.339)		(0.697)		(0.433)		(0.570)		(0.338)		(0.517)	
TXR	–0.408	–0.049	0.286	0.018	–0.140	–0.017	0.125	0.008	0.090	0.010	0.227	0.014	–0.497	–0.058	0.337	0.023	–0.547	–0.071	–0.504	–0.032
	(0.772)		(1.189)		(0.753)		(0.965)		(0.784)		(1.182)		(0.777)		(1.056)		(0.757)		(0.959)	
Constant	–0.247		9.261^{a}		5.866		2.942		2.934		0.985		–5.262^{a}		4.121		–3.415^{b}		2.390	
	(2.051)		(2.891)		(4.500)		(8.592)		(2.115)		(3.812)		(1.705)		(2.538)		(1.739)		(3.378)	
Industry effect	YES		YES		YES		YES		YES		YES		YES		YES		YES		YES	
Year effect	YES		YES		YES		YES		YES		YES		YES		YES		YES		YES	
Diagnostic tests																				
Number of observations	370		370		370		370		370		370		370		370		370		370	
Wald χ^2	121.91^{a}		120.21^{a}		106.95^{a}		121.20^{a}		123.40^{a}		88.85^{a}		85.02^{a}		112.65^{a}		95.56^{a}		108.59^{a}	
Log pseudolikelihood	–139.88		–74.93		–142.45		–79.28		–127.91		–75.05		–133.87		–82.41		–147.15		–76.01	
Pseudo R^2	0.404		0.681		0.393		0.662		0.455		0.680		0.429		0.649		0.373		0.676	
Pearson χ^2 (goodness-of-fit)	331.75		223.42		364.60		226.02		312.94		275.16		332.32		227.58		328.75		235.10	
Akakie information criteria	349.76		217.87		342.89		224.57		325.82		216.10		294.77		232.81		342.29		220.03	
Correctly classified (%)	83.51		91.08		81.62		90.27		84.05		91.62		84.59		90.27		79.73		90.54	

Variable definitions are in Appendices I and III. The superscript ^{P} indicates that the coefficient is based on the predicted values of the two-stage IV–GMM (see Eq. (2)). Models 6A, 7A, 8A, etc. are the baseline models. Models 6B, 7B, 8B, etc. are the corresponding models with interaction terms. ME denotes the marginal effect. It represents the derivative of the approximate change in *y* for one unit change in *x*. Theoretically, ME should be between zero and one. ME may be outside the range of zero and one if the slope of the curve changes quickly. In this case, we retain the ME values that are outside the range of zero and one. Correctly classified denotes the performance of each logistic regression relative to a naive proportional chance model (see Joy and Tollefson, 1975). ^{a}, ^{b}, and ^{c} denote statistical significance at a 1-, 5-, and 10-percent level, respectively. The heteroscedastic-robust standard errors are in parentheses. Year and industry dummies are used in all estimations. Most of the year and industry effects are insignificant. We therefore apply the general-to-specific methodology commonly used in full-system estimation in econometrics, by sequentially removing the year and industry coefficients with the largest *p*-value first, as long as this procedure minimises the -2 log likelihood ratio (see Pagan, 1987, for a review of the general-to-specific methodology). This procedure is only applied to the year and industry coefficients that are insignificant.

Table 5: Coefficient estimates of the IV–probit regressions for currency derivatives usage

	LnCG_Index				*LnBoard_Size*				*NED*				*Stock_CompMV*				*Executive_CompMV*			
	Model 11A		**Model 11B**		**Model 12A**		**Model 12B**		**Model 13A**		**Model 13B**		**Model 14A**		**Model 14B**		**Model 15A**		**Model 15B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Monitoring mechanisms																				
LnCG_Index	1.071^{a}	–0.039	2.099^{a}	–0.047																
	(0.247)		(0.210)																	
LnCG_Index×High_Free-Cash-Flow_Total Assets			–0.567^{a}	0.081																
			(0.151)																	
LnCG_Index×Low_Free-Cash-Flow_Total Assets			–0.473^{a}	0.025																
			(0.160)																	
LnCG_Index×High_Q			–0.807^{a}	0.016																
			(0.139)																	
LnCG_Index×Low_Q			–0.837^{a}	–0.097																
			(0.165)																	
LnCG_Index×High_Z-score			–0.581^{a}	–0.053																
			(0.146)																	
LnCG_Index×Low_Z-score			–0.905^{a}	0.001																
			(0.114)																	
LnBoard_Size					2.005^{c}	–0.730^{c}	7.123^{a}	–0.720												
					(1.134)		(2.299)													
LnBoard_Size×High_Free-Cash-Flow_Total Assets							–4.184^{a}	–0.121												
							(1.320)													
LnBoard_Size×Low_Free-Cash-Flow_Total Assets							–1.458	0.902^{b}												
							(1.517)													
LnBoard_Size×High_Q							–4.733^{a}	–0.570												
							(1.745)													
LnBoard_Size×Low_Q							–3.188^{b}	–0.209												
							(1.351)													
LnBoard_Size×High_Z-score							–0.173	1.027^{a}												
							(1.674)													
LnBoard_Size×Low_Z-score							–4.066^{c}	0.301												
							(2.118)													
NED									0.084^{a}	0.002	0.120^{b}	0.004								
									(0.009)		(0.060)									
NED×High_Free-Cash-Flow_Total Assets											–0.034	0.006								
											(0.030)									
NED×Low_Free-Cash-Flow_Total Assets											–0.044	–0.020								
											(0.074)									
NED×High_Q											–0.083^{b}	–0.012								
											(0.040)									
NED×Low_Q											–0.075^{a}	–0.003								
											(0.025)									
NED×High_Z-score											–0.067	–0.014								
											(0.042)									
NED×Low_Z-score											–0.068^{b}	0.004								
											(0.028)									

Continued

Table 5 (Continued)

	LnCG_Index				*LnBoard_Size*				*NED*				*Stock_CompMV*				*Executive_CompMV*			
	Model 11A		**Model 11B**		**Model 12A**		**Model 12B**		**Model 13A**		**Model 13B**		**Model 14A**		**Model 14B**		**Model 15A**		**Model 15B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Managerial incentives																				
Stock_CompMV													2.785^{a}	0.152	3.282^{a}	–0.140				
													(0.680)		(1.269)					
Stock_CompMV×High_Free-Cash-Flow_Total Assets															–0.262	0.246				
															(0.780)					
Stock_CompMV×Low_Free-Cash-Flow_Total Assets															0.094	0.026				
															(0.734)					
Stock_CompMV×High_Q															0.310	0.399				
															(1.127)					
Stock_CompMV×Low_Q															–0.857	0.010				
															(0.824)					
Stock_CompMV×High_Z-score															–3.934^{a}	–0.280				
															(1.279)					
Stock_CompMV×Low_Z-score															–3.339^{a}	0.343				
															(1.152)					
Executive_CompMV																	1.794	–0.101	7.871^{a}	–0.524
																	(6.553)		(1.058)	
Executive_CompMV×High_Free-Cash-Flow_Total Assets																			–2.117^{a}	0.332
																			(0.459)	
Executive_CompMV×Low_Free-Cash-Flow_Total Assets																			–2.291^{c}	0.345
																			(1.373)	
Executive_CompMV×High_Q																			–1.801^{b}	0.487
																			(0.859)	
Executive_CompMV×Low_Q																			–2.727^{a}	0.105
																			(0.534)	
Executive_CompMV×High_Z-score																			–3.565^{a}	–0.470
																			(0.888)	
Executive_CompMV×Low_Z-score																			–5.190^{a}	0.053
																			(0.920)	
Stock Price_Volatility	0.777	–0.486	0.690	–0.548	–1.633	–1.951^{a}	–3.913	–2.509^{a}	–8.212^{a}	–2.592^{a}	–6.303^{c}	–2.438^{a}	–1.060^{a}	–1.700	4.035	–1.691	–7.723	–1.868	–2.906	–2.445
	(1.075)		(1.190)		(2.866)		(2.949)		(2.595)		(3.233)		(0.242)		(3.140)		(6.289)		(2.983)	

Continued

Table 5 (Continued)

	LnCG_Index				*LnBoard_Size*				*NED*				*Stock_CompMV*				*Executive_CompMV*			
	Model 11A		Model 11B		Model 12A		Model 12B		Model 13A		Model 13B		Model 14A		Model 14B		Model 15A		Model 15B	
	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME	Coeff.	ME
Underinvestment and financial distress																				
IND_Avg_LEV	–6.332[b]	–0.118	–3.649[c]	–0.049	–6.547[c]	0.158	–4.649[c]	0.151	0.956	0.172	7.770	–0.313	5.998	0.102	–1.363[a]	–0.063	0.956	–0.084	3.880	–0.271
	(3.027)		(2.170)		(3.364)		(2.653)		(4.305)		(6.426)		(4.035)		(0.130)		(1.435)		(4.010)	
Interest_Cover	–0.001	0.001	0.001	0.001	–0.002	0.001	–0.002[c]	0.001	0.001	0.001	0.002	0.001	0.002[c]	0.001	–0.004[a]	0.001	0.003	0.001	0.001	0.001
	(0.001)		(0.001)		(0.001)		(0.001)		(0.001)		(0.003)		(0.001)		(0.001)		(0.003)		(0.001)	
Z-score	–0.045[c]	0.004	–0.026	0.001	–0.021	0.009	0.018	0.015	0.056	0.011	0.031	0.003	0.053[c]	0.008	–0.029	0.003	0.071	–0.005	0.024	0.005
	(0.027)		(0.021)		(0.045)		(0.038)		(0.048)		(0.045)		(0.032)		(0.032)		(0.058)		(0.038)	
Debt_Maturity	0.153[a]	0.015	0.093[b]	0.026	0.022	–0.030	0.013	–0.032	–0.116	–0.043	–0.149	0.002	–0.175[c]	–0.022	0.110b	0.004	–0.188	–0.007	–0.099	0.003
	(0.048)		(0.048)		(0.091)		(0.081)		(0.098)		(0.132)		(0.092)		(0.054)		(0.137)		(0.076)	
Low_Q			0.861[b]	0.254			7.153[b]	0.483			2.458[a]	0.160			0.523	0.062			1.736[a]	–0.031
			(0.349)				(2.867)				(0.721)				(0.419)				(0.308)	
EBIT_Market Value	0.150	–1.276[a]	–0.077	–0.635[c]	–3.000	–0.284	1.527	0.502	3.801[b]	0.782	1.443	0.851	6.392[a]	0.652	–6.337[a]	0.432	4.813	0.452	0.739	0.356
	(0.955)		(0.973)		(1.922)		(2.311)		(1.889)		(2.621)		(1.861)		(2.349)		(3.015)		(2.000)	
CAP_Exped_Total Sales	–0.437	–1.537[c]	–1.777	–1.900[b]	1.978	–0.512	–4.174	–1.437	–6.726[b]	–0.613	–3.872	–0.371	–6.209[b]	–1.558[b]	–9.269[c]	–2.831	–2.992	–1.066	–1.499	0.025
	(1.357)		(2.100)		(3.833)		(3.927)		(3.316)		(3.102)		(2.538)		(4.794)		(1.602)		(2.507)	
Dividend per Share	–0.664	–0.675[b]	–0.787	–0.465[b]	–1.383	–0.740[a]	–1.900[c]	–0.787[a]	–2.552[a]	–0.998[a]	–1.243	–0.772[b]	–2.225[c]	–0.789[a]	–2.759	–0.984	–0.474	–0.637	–0.043	–0.451
	(0.647)		(0.628)		(0.962)		(0.988)		(0.991)		(1.724)		(1.198)		(1.726)		(1.088)		(0.622)	
Low_Z-score			0.698[a]	0.089			8.711[b]	–0.623			2.192[b]	–0.171			1.720[a]	–0.238			1.973[a]	0.018
			(0.214)				(4.434)				(1.025)				(0.592)				(0.493)	
Low_Free-Cash-Flow_Total Assets			1.283[b]	0.598[a]			5.035[c]	–1.447			2.633	1.424			0.094	0.684			1.017	0.417
			(0.587)				(3.041)				(3.737)				(1.052)				(0.650)	
Overinvestment																				
Free-Cash-Flow_Total Assets	–0.469	–0.916[c]	1.466	1.362[b]	–1.831	–1.338[a]	0.186	–0.369	–4.602[a]	–1.005[c]	0.362	0.642	–2.238	–1.007	–2.806	0.018	1.648	–0.599	–3.894	0.393
	(1.075)		(1.683)		(1.677)		(2.309)		(1.639)		(2.855)		(2.585)		(2.713)		(6.735)		(3.238)	
High_Free-Cash-Flow_Total Assets			0.389	–0.318[b]			8.662[a]	0.111			0.766	–0.302			0.171	–0.218			1.084[a]	–0.227
			(0.397)				(2.792)				(0.904)				(0.454)				(0.312)	
CAP_Exped_PPE	–0.098	0.002	–0.095	–0.021	0.493[c]	0.078	0.343	0.130	0.385	0.079	0.262	–0.031	–0.329	–0.030	0.671[b]	–0.026	–0.415	0.119	0.768[b]	0.072
	(0.076)		(0.089)		(0.275)		(0.326)		(0.284)		(0.328)		(0.270)		(0.284)		(0.900)		(0.313)	
High_Q			1.143[a]	–0.097			9.987[a]	1.129			2.501[b]	0.297			0.077	–0.111			0.440	–0.214
			(0.250)				(3.792)				(1.220)				(0.410)				(0.366)	
High_Z-score			0.570[b]	0.123			0.706	–2.128[a]			2.126	0.466			0.491	0.141			1.021[a]	0.247
			(0.262)				(3.539)				(1.556)				(0.419)				(0.359)	
Growth and investment opportunities																				
R&D_Total Assets	–0.547[a]	–0.232[a]	–0.577[a]	–0.217[a]	–0.567[b]	–0.146[c]	–0.456[c]	–0.100	–0.464	–0.079	–0.169	–0.046	–0.084	–0.247	–0.571[c]	–0.125	–0.335	–0.165	–0.421	–0.130
	(0.152)		(0.207)		(0.233)		(0.257)		(0.359)		(0.403)		(0.777)		(0.326)		(0.620)		(0.410)	
Q	0.037	–0.010	0.010	–0.007	–0.030	–0.019[c]	–0.043	–0.019[c]	–0.021	–0.020[c]	–0.048[c]	–0.011	–0.039	–0.025[c]	0.072[b]	–0.016	–0.005	–0.123	–0.019	–0.013
	(0.035)		(0.028)		(0.036)		(0.034)		(0.031)		(0.029)		(0.061)		(0.034)		(0.225)		(0.026)	

Continued

Table 5 (Continued)

	LnCG_Index				*LnBoard_Size*				*NED*				*Stock_CompMV*				*Executive_CompMV*			
	Model 11A		**Model 11B**		**Model 12A**		**Model 12B**		**Model 13A**		**Model 13B**		**Model 14A**		**Model 14B**		**Model 15A**		**Model 15B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Hedging substitutes																				
Current Ratio	–0.111[c]	–0.029	–0.001	0.001	–0.047	–0.068[c]	–0.158	–0.061[c]	–0.167	–0.054	–0.145	–0.101[c]	0.058	–0.043	–0.003	–0.091	0.094	–0.041	–0.076	–0.037
	(0.066)		(0.053)		(0.123)		(0.133)		(0.112)		(0.228)		(0.206)		(0.196)		(0.185)		(0.093)	
LnPre_Tax_Income	–0.132	0.090	–0.039	0.124[b]	0.222	0.096	0.447	0.156[b]	–0.165	0.033	0.269	0.136	0.089	0.153	0.313	0.190	0.144	0.066	–0.242	0.139
	(0.117)		(0.168)		(0.281)		(0.322)		(0.241)		(0.502)		(0.436)		(0.424)		(1.177)		(0.289)	
ROA	0.898	–0.154	0.488	–0.981	1.227	–0.419	–0.510	–0.632	–2.448	–0.271	–0.169	–0.386	–3.581	–0.679	1.482	–0.480	–3.523	–0.788	0.595	–0.879
	(1.270)		(1.562)		(1.802)		(2.200)		(3.056)		(2.953)		(3.232)		(2.747)		(4.571)		(2.740)	
Size																				
LnMarket Value	–0.135	0.119[c]	–0.234	0.203[b]	0.414	0.172[c]	0.398	0.139	0.637[b]	0.153[c]	–0.085	0.048	0.226	0.090	0.463	–0.001	–1.058	0.153	0.990[b]	0.028
	(0.131)		(0.207)		(0.288)		(0.328)		(0.323)		(0.398)		(0.372)		(0.316)		(3.274)		(0.502)	
LnTotal Assets	–0.226	–0.114	–0.030	–0.310[b]	–0.214	–0.057	–0.083	–0.077	–0.262	–0.113	0.063	–0.065	–0.521	–0.171	–0.327	0.007	–0.308	–0.160	–0.532	–0.150
	(0.219)		(0.366)		(0.318)		(0.461)		(0.421)		(0.558)		(0.484)		(0.418)		(0.904)		(0.465)	
LnSales	–0.156	0.017	–0.172	0.069	–0.310	–0.059	–0.448[c]	–0.078	–0.259	–0.004	–0.211	–0.091	0.200	–0.031	–0.387	–0.163	0.090	–0.014	0.088	–0.024
	(0.113)		(0.129)		(0.218)		(0.264)		(0.183)		(0.369)		(0.257)		(0.288)		(0.236)		(0.211)	
TXR	0.688[a]	–0.016	0.266	–0.137	–0.972	–0.056	–0.831	–0.012	–0.713	–0.170	0.585	0.056	–0.191	–0.093	–0.456	0.028	0.290	–0.238	0.246	–0.192
	(0.220)		(0.294)		(0.713)		(0.660)		(0.894)		(1.316)		(1.070)		(0.781)		(3.137)		(0.921)	
Constant	2.690[a]		0.681		–1.849		–1.330[b]		0.879		–1.754		2.679		0.050		0.658		–5.269[b]	
	(0.697)		(0.702)		(2.702)		(0.569)		(1.227)		(2.452)		(1.976)		(2.700)		(1.405)		(2.151)	
Infudtry effect	YES		YES		YES		YES		YES		YES		YES		YES		YES		YES	
Year effect	YES		YES		YES		YES		YES		YES		YES		YES		YES		YES	
Diagnostic tests																				
Number of observations	498		507		223		223		216		216		206		206		212		212	
Wald χ^2	751.35[a]		935.09[a]		140.10[a]		245.13[a]		249.08[a]		334.42[a]		226.88[a]		478.05[a]		256.13[a]		398.02[a]	
Log pseudolikelihood	–239.77		64.79		252.9		407.7		–683.47		–536.80		96.17		347.1		66.7		320.6	
Wald χ^2 of exogeneity	145.71[a]		33.95[a]		23.86[a]		23.18[a]		13.77[a]		24.19[a]		4.56[c]		44.65[a]		15.04[a]		93.43[a]	
Akakie information criteria	675.53		118.42		–331.75		–575.29		1,548.94		1,301.60		–16.33		–436.22		54.59		–377.09	
Correctly classified (%)	73.29		83.43		80.27		84.75		82.41		82.41		83.50		84.95		80.6		84.43	

Variable definitions are in Appendices I and III. The instrumental variables (IVs) are chosen from the list of the industry average measures shown in Panel B of Appendix I. Not all the IVs in the list are used. The chosen IVs are those that satisfy the exogeneity condition. ME denotes marginal effects. It represents the derivative of the approximate change in y for one unit change in x. Theoretically, ME should be between zero and one. ME may be outside the range of zero and one if the slope of the curve changes quickly. In this case, we retain the ME values that are outside the range of zero and one. Models 11A, 12A, 13A, etc. are the baseline models. Models 11B, 12B, 13B, etc. are the corresponding models with interaction terms. [a], [b], and [c] denote statistical significance at a 1-, 5-, and 10-percent level, respectively. The heteroscedastic-robust standard errors are in parenthesis. Year and industry dummies are used in all estimations. Most of the year and industry effects are insignificant. We therefore apply the general-to-specific methodology commonly used in full-system estimation in econometrics, by sequentially removing the year and industry coefficients with the largest p-value first, as long as this procedure minimises the -2 log likelihood ratio (see Pagan, 1987, for a review of the general-to-specific methodology). This procedure only applies to the year and industry coefficients that are insignificant. The final model contains one or two year and industry dummy variables. The percentage correctly classified is the percentage of firm-year observations that is correctly classified. The statistical significance of the percentage correctly classified is determined using the Joy and Tollefson (1975) approach where the percentage correctly classified is tested against a naive proportional chance model.

Table 6: Coefficient estimates of the IV–probit regressions for IR derivatives usage

	LnCG_Index				*LnBoard_Size*				*NED*				*Stock_CompMV*				*Executive_CompMV*			
	Model 16A		**Model 16B**		**Model 17A**		**Model 17B**		**Model 18A**		**Model 18B**		**Model 19A**		**Model 19B**		**Model 20A**		**Model 20B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Monitoring mechanisms																				
LnCG_Index	1.034[c]	–0.021	2.494[a]	–0.044																
	(0.573)		(0.234)																	
LnCG_Index×High_Free-Cash-Flow_Total Assets			–0.937[a]	–0.024																
			(0.126)																	
LnCG_Index×Low_Free-Cash-Flow_Total Assets			–0.306	–0.002																
			(0.221)																	
LnCG_Index×High_Q			–1.042[a]	–0.025																
			(0.164)																	
LnCG_Index×Low_Q			–0.880[a]	0.026																
			(0.144)																	
LnCG_Index×High_Z-score			–0.083	0.220[a]																
			(0.248)																	
LnCG_Index×Low_Z-score			–0.872[a]	0.110[a]																
			(0.171)																	
LnBoard_Size					2.571[a]	–0.886[a]	1.225[a]	–1.208												
					(0.986)		(0.194)													
LnBoard_Size×High_Free-Cash-Flow_Total Assets							–6.024[a]	0.075												
							(1.552)													
LnBoard_Size×Low_Free-Cash-Flow_Total Assets							0.997	4.014												
							(3.638)													
LnBoard_Size×High_Q							–9.478[a]	1.106												
							(1.699)													
LnBoard_Size×Low_Q							–6.239[a]	–1.062												
							(1.871)													
LnBoard_Size×Low_Z-score							–6.554[a]	0.193												
							(2.052)													
NED									0.037[b]	–0.006	0.234[a]	0.022								
									(0.019)		(0.031)									
NED×High_Free-Cash-Flow_Total Assets											–0.131[a]	–0.018								
											(0.026)									
NED×Low_Free-Cash-Flow_Total Assets											–0.106	–0.049[b]								
											(0.069)									
NED×High_Q											–0.168[a]	–0.025[c]								
											(0.033)									
NED×Low_Q											–0.093[a]	–0.010								
											(0.024)									
NED×Low_Z-score											–0.154[a]	–0.021								
											(0.030)									

Continued

Table 6 (Continued)

	LnCG_Index				*LnBoard_Size*				*NED*				*Stock_CompMV*				*Executive_CompMV*			
	Model 16A		**Model 16B**		**Model 17A**		**Model 17B**		**Model 18A**		**Model 18B**		**Model 19A**		**Model 19B**		**Model 20A**		**Model 20B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Managerial incentives																				
Stock_CompMV													3.139[a]	–0.312	1.394[a]	–0.007				
													(1.029)		(0.420)					
Stock_CompMV×High_Free-Cash-Flow_Total Assets															–1.387[a]	–0.840				
															(0.332)					
Stock_CompMV×Low_Free-Cash-Flow_Total Assets															8.425	1.988				
															(5.617)					
Stock_CompMV×High_Q															–9.623[b]	–1.500[b]				
															(4.012)					
Stock_CompMV×Low_Q															–1.641[c]	–3.165[c]				
															(0.863)					
Stock_CompMV×Low_Z-score															–8.372	0.856				
															(6.573)					
Executive_CompMV																	2.379[a]	–0.155	6.033[a]	–0.776
																	(0.635)		(1.454)	
Executive_CompMV×High_Free-Cash-Flow_Total Assets																			–1.956[b]	0.569
																			(0.961)	
Executive_CompMV×Low_Free-Cash-Flow_Total Assets																			0.312	0.801[b]
																			(0.712)	
Executive_CompMV×High_Q																			–3.989[a]	–0.160
																			(1.136)	
Executive_CompMV×Low_Q																			–2.177[a]	0.566[c]
																			(0.743)	
Executive_CompMV×Low_Z-score																			–4.424[a]	0.197
																			(1.346)	
Stock Price_Volatility	–4.557[a]	–1.292[a]	–3.761[a]	–0.974[a]	–5.992[a]	–2.365[a]	–3.850	–3.612	–1.604	–2.623[a]	0.096	–2.800[a]	–7.916[a]	–2.649[a]	–1.463	–4.035[a]	–4.521	–2.469[a]	–1.176	–2.045[a]
	(1.532)		(1.399)		(2.111)		(2.642)		(2.416)		(3.927)		(3.027)		(1.1.54)		(3.791)		(2.381)	

Continued

Table 6 (Continued)

	LnCG_Index				*LnBoard_Size*				*NED*				*Stock_CompMV*				*Executive_CompMV*			
	Model 16A		**Model 16B**		**Model 17A**		**Model 17B**		**Model 18A**		**Model 18B**		**Model 19A**		**Model 19B**		**Model 20A**		**Model 20B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Underinvestment and financial distress																				
IND_Avg_LEV	5.200[b]	0.265	2.451	0.195	5.578[a]	–0.191	2.557	–0.124	9.356[a]	–0.229	–0.943	1.134	5.890[a]	0.384	7.313	0.997	5.196[b]	0.510	6.219[a]	0.579
	(2.441)		(2.209)		(1.458)		(1.637)		(1.630)		(2.299)		(1.727)		(6.048)		(2.214)		(2.274)	
Interest_Cover	0.001	–0.001	0.001	0.001	–0.006	–0.003[b]	–0.010	–0.007[c]	–0.007	–0.005[b]										
	(0.002)		(0.001)		(0.005)		(0.006)		(0.005)											
Z-score	–0.055	–0.060[b]	–0.144	–0.103[a]	0.165[b]	–0.005	0.089	0.026	0.264[b]	0.013	–0.315[a]	–0.049	0.038	–0.022	–0.627	–0.147[a]	0.208[a]	–0.017	0.012	–0.061
	(0.067)		(0.101)		(0.080)		(0.095)		(0.109)		(0.085)		(0.066)		(0.465)		(0.064)		(0.118)	
Debt_Maturity	–0.098	0.031	–0.132[a]	0.014	0.068	0.031	0.085	–0.013	0.071	0.040[c]	–0.050	0.040					–0.097	0.047[c]	–0.102	0.040[c]
	(0.066)		(0.051)		(0.086)		(0.102)		(0.087)		(0.079)						(0.074)		(0.077)	
Low_Q			0.500[a]	–0.029			12.318[a]	1.579			2.992[a]	0.270			–1.483	–0.617[c]			1.063[b]	–0.469[c]
			(0.191)				(3.636)				(0.755)				(2.617)				(0.530)	
EBIT_Market Value	–0.460	–0.587	–0.261	–0.404	–0.423	–1.328[a]	0.487	0.042	1.251	–0.111	2.390	1.586[a]	3.692[b]	–0.300	1.059	0.399	3.457[c]	–0.164	–0.480	0.775
	(1.633)		(1.138)		(2.093)		(2.115)		(1.908)		(2.528)		(1.532)		(3.085)		(1.937)		(1.879)	
CAP_Exped_Total Sales	–1.067	–0.305	–0.890	–0.359[c]	–2.875	1.397	–0.093	3.081	–6.979[a]	0.655	1.982	0.970	–6.212[b]	–0.484	1.094	1.718[b]	–9.561[a]	–1.422	–4.682[b]	2.370[b]
	(0.708)		(0.629)		(3.265)		(3.753)		(2.650)		(2.391)		(2.704)		(7.406)		(1.949)		(2.216)	
Dividend per Share	–0.402	–0.517[a]	–1.064	–0.591[a]	–0.540	–0.894[a]	–0.583	–1.326	–1.131	–0.821[a]	–2.025	–1.198[a]	–1.326	–0.498[b]	–6.865	–1.699[a]	–0.246	–0.469[c]	–0.385	–0.666[a]
	(0.721)		(0.730)		(0.901)		(1.122)		(0.915)		(1.770)		(0.989)		(4.735)		(0.674)		(0.833)	
Low_Z-score			–0.751[c]	–0.462[a]			12.055[a]	–1.275			3.546[a]	–0.142			–4.422	–1.624[c]			0.870	–0.433
			(0.448)				(4.605)				(0.806)				(6.174)				(0.833)	
Low_Free-Cash-Flow_Total Assets			1.089[b]	0.449[a]			–0.025	–7.258			4.767	2.715[b]			2.586	0.445			0.151	–0.105
			(0.499)				(6.812)				(3.761)				(2.702)				(0.550)	
Overinvestment																				
Free-Cash-Flow_Total Assets	–0.070	–0.284	1.954	1.105[a]	2.697	0.176	0.260	2.521	–6.094[b]	0.952	–5.436	–2.217[c]	–3.692	–0.415	2.085	1.803	–4.409[c]	–0.788	–3.727	–0.920
	(1.617)		(2.022)		(3.059)		(2.719)		(2.940)		(3.350)		(2.908)		(5.586)		(2.325)		(2.984)	
High_Free-Cash-Flow_Total Assets			0.604[b]	–0.042			1.254[a]	–0.368			3.947[a]	0.479			1.962[c]	–0.096			0.893[c]	–0.182
			(0.260)				(0.329)				(0.722)				(1.090)				(0.485)	
CAP_Exped_PPE	–0.006	–0.047	0.007	–0.003	–0.940	–0.289	–1.050	–0.785[b]	–0.703	–0.243	0.834	–0.103					–0.116	–0.003	–0.123	–0.096
	(0.110)		(0.090)		(0.643)		(0.816)		(0.561)		(0.558)						(0.420)		(0.362)	
High_Q			1.331[a]	0.093			2.107[a]	–2.085			5.167[a]	0.658			6.149[c]	1.263[b]			2.060[a]	0.244
			(0.281)				(0.357)				(0.878)				(3.560)				(0.635)	
Growth and investment opportunities																				
R&D_Total Assets	–0.109	–0.059	–0.248b	–0.063[c]	–0.616	–0.335[a]	–0.207	–0.413	–1.512[a]	–0.268[b]	–0.708	–0.440[b]	–0.354	–0.297[a]	–1.900	–0.410[a]	–0.121	–0.423[a]	–1.067[a]	–0.401[a]
	(0.143)		(0.117)		(0.406)		(0.351)		(0.415)		(0.580)		(0.385)		(1.219)		(0.411)		(0.371)	
Q	–0.083	–0.021[b]	–0.034	–0.011	–0.087[c]	–0.035[a]	–0.080[c]	–0.041	–0.092[b]	–0.042[a]	–0.055	–0.048[a]	–0.087	–0.055[a]	–0.458	–0.128[b]	–0.025	–0.065[a]	–0.037	–0.066[a]
	(0.053)		(0.033)		(0.045)		(0.042)		(0.043)		(0.062)		(0.060)		(0.373)		(0.067)		(0.047)	

Continued

Table 6 (Continued)

	LnCG_Index				*LnBoard_Size*				*NED*				*Stock_CompMV*				*Executive_CompMV*			
	Model 16A		**Model 16B**		**Model 17A**		**Model 17B**		**Model 18A**		**Model 18B**		**Model 19A**		**Model 19B**		**Model 20A**		**Model 20B**	
	Coeff.	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**	**Coeff.**	**ME**
Hedging substitutes																				
Current Ratio	0.089	0.014	0.003	–0.015	0.051	–0.098[a]	–0.043	–0.241[c]	–0.244[b]	–0.015	–0.372[b]	–0.113[b]	0.196	–0.042	–0.489	–0.134[a]	0.070	–0.014	0.186	–0.040
	(0.067)		(0.061)		(0.156)		(0.206)		(0.114)		(0.189)		(0.142)		(0.446)		(0.084)		(0.118)	
LnPre_Tax_Income	–0.061	–0.001	–0.154	0.026	0.075	0.155[a]	0.111	0.142[b]	0.612[a]	0.111[c]										
	(0.167)		(0.123)		(0.227)		(0.282)		(0.211)											
ROA	–1.224	1.086	2.384	0.470	–2.067	0.619	1.071	0.532	–3.852	0.938[c]	1.012[a]	2.369	–2.925	1.449[b]	3.390	7.666[a]	–3.161	1.394[c]	–1.665	1.226[b]
	(2.649)		(1.679)		(2.809)		(1.939)		(3.852)		(0.324)		(3.605)		(2.641)		(2.215)		(2.365)	
Size																				
LnMarket Value	–0.017	0.149	–0.819[a]	–0.018	0.101	0.011	–1.295[c]	–0.599[c]	0.876[a]	–0.120	–0.320[c]	–0.017	0.919[a]	0.089	–4.153	–1.029[a]	1.104[a]	0.056	0.545[b]	–0.128
	(0.306)		(0.206)		(0.236)		(0.679)		(0.302)		(0.181)		(0.207)		(3.326)		(0.180)		(0.221)	
LnTotal Assets	–0.567[a]	–0.067	0.426[c]	0.026	–0.310	0.030	1.160	0.673	–1.001[a]	0.101			–0.823[b]	0.049	5.149	1.296[a]				
	(0.199)		(0.232)		(0.372)		(0.755)		(0.324)				(0.366)		(4.090)					
LnSales	0.013	0.013	–0.224	–0.015	0.144	–0.175	–0.373	–0.361	0.197	–0.230[c]	–0.119	–0.005	0.401	–0.185[b]	–2.098	–0.621[a]	–0.098	–0.188	0.175	–0.146
	(0.249)		(0.146)		(0.337)		(0.351)		(0.289)		(0.251)		(0.283)		(1.696)		(0.232)		(0.355)	
TXR	0.207	–0.067	0.496	0.047	0.814	0.216	–1.968[c]	–0.880	–0.982	0.673[a]	–0.935	–0.436[c]	–0.278	0.121	–5.750[a]	–1.035[c]	0.437	0.198	0.018	0.075
	(0.391)		(0.342)		(0.828)		(1.037)		(0.796)		(0.883)		(0.576)		(2.055)		(0.469)		(0.593)	
Constant	3.513[c]		3.506[a]		–4.853[c]		–2.158[a]		–5.701[b]		–2.077		–2.903		1.120		–8.102[a]		–7.525[a]	
	(2.009)		(0.980)		(2.907)		(5.020)		(2.700)		(2.325)		(2.342)		(1.164)		(2.200)		(2.895)	
Industry effect	YES		YES		YES		YES		YES		YES		YES		YES		YES		YES	
Year effect	YES		YES		YES		YES		YES		YES		YES		YES		YES		YES	
Diagnostic tests																				
Number of observations	370		370		153		153		145		161		152		156		156		156	
Wald χ^2	464.22[a]		627.1[a]		177.21[a]		207.99[a]		298.51[a]		361.47[a]		222.43[a]		189.37[a]		345.13[a]		377.17[a]	
Log pseudolikelihood	–216.45		90.98		178.8		317		–429.96		–351.61		124.2		335.4		56.41		256.6	
Wald χ^2 of exogeneity	43.32[a]		126.46[a]		107.42[a]		70.38[a]		139.52[a]		52.66[a]		80.10[a]		9.21[a]		212.76[a]		143.46[a]	
Akakie information criteria	604.9		54.05		–165.69		–426.02		1,057.92		897.2		–78.31		–466.71		61.17		–301.39	
Correctly classified (%)	79.19		94.59		88.24		95.42		91.72		91.93		90.79		93.59		88.46		92.31	

Variable definitions are in Appendices I and III. The instrumental variables (IVs) are chosen from the list of the industry average measures shown in Panel B of Appendix I. Not all the IVs in the list are used. The chosen IVs are those that satisfy the exogeneity condition. ME denotes marginal effects. It represents the derivative of the approximate change in y for one unit change in x. Theoretically, ME should be between zero and one. ME may be outside the range of zero and one if the slope of the curve changes quickly. In this case, we retain ME values that are outside the range of zero and one. Models 16A, 17A, 18A, etc. are the baseline models. Models 16B, 17B, 18B, etc. are the corresponding models with interaction terms. [a], [b], and [c] denote statistical significance at a 1-, 5-, and 10-percent level, respectively. The heteroscedastic-robust standard errors are presented in parenthesis. Year and industry dummies are used in all estimations. Most of the year and industry effects are insignificant. We therefore apply the general-to-specific methodology commonly used in full-system estimation in econometrics, by sequentially removing the year and industry coefficients with the largest p-value first, as long as this procedure minimises the -2 log likelihood ratio (see Pagan, 1987, for a review of the general-to-specific methodology). This procedure only applies to the year and industry coefficients that are insignificant. The final model contains one or two year and industry dummies The percentage correctly classified is the percentage of firm-year observations that is correctly classified. The statistical significance of the percentage correctly classified is determined using the Joy and Tollefson (1975) approach where the percentage correctly classified is tested against a naive proportional chance model.