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Directors' share dealings and corporate insolvencies: Evidence from the UK

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Abstract

This paper investigates the relation between insider trading and the likelihood of insolvency with a specific focus on the directors' sale and purchase transactions preceding insolvency. We use a unique dataset on directors' dealings in 474 non-financial UK firms, of which 117 filed for insolvency, over the period 2000-2010. We show that the directors of insolvent firms increase their purchase transactions significantly as the insolvency approaches. The results also reveal a significant relation between three different measures of insider trading activity and the likelihood of insolvency, which is observed to be positive only during the last six-month trading period. The relation is negative for the earlier trading periods. While the earlier purchase transactions appear to be motivated by superior information held by insiders, the purchase trades closer to the insolvency date are possibly initiated by directors' motives to influence the market's perception of the firm in an attempt to avert or delay insolvency.

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1. Introduction

Corporate bankruptcies² have serious consequences for creditors as well as owners of firms. When a firm goes bankrupt, the value of shareholders' claims on the firm's assets normally becomes zero and creditors can expect to recover their claims only partially because of the costs of bankruptcy. The size of these costs is determined mainly by the nature of the bankrupt firm's assets, the complexity of its business and financial structure, the firm's size and agency conflicts between directors, shareholders and debt holders. Furthermore, the costs that are born by managers can be more significant as their reputation and human capital are damaged in bankruptcy (Eckbo, Thorburn and Wang 2012; Gilson 1989). The costs implications have led researchers to investigate the factors that are likely to be associated with corporate bankruptcies. However, while there has been considerable research examining the factors contributing to the likelihood of bankruptcy (see, e.g., Altman 1986; Campbell, Hilscher and Szilagyi 2008; Hillegeist et al. 2004; Ohlson 1980), the extent to which insider trading is relevant in explaining corporate bankruptcies is largely unknown. This paper aims to fill this gap by investigating empirically the relation between insider trading and the likelihood of insolvency in the UK.

Insider trading is relevant to the investigation of corporate bankruptcies for at least two reasons. First, it is recognised that insiders have a better insight into their companies' prospects and hence have informational advantage over outside investors. Therefore, while insiders trade on the superior information they hold, outsiders can make abnormal profits by replicating insiders' trading strategies. Prior studies of insider trading indeed provide strong evidence in support of this view. It is shown that buy-and-hold returns from trades that mimic insiders generate abnormal profits in the long-term, taken as evidence that insiders trade on superior private information (see e.g. Jiang and Zaman 2010; Lakonishok and Lee 2001; Ozkan and

² Corporate bankruptcy is referred to as insolvency in the United Kingdom. We use these terms interchangeably throughout paper.

Trzeciakiewicz 2014; Seyhun 1986). Second, it is also shown that the market's reaction to directors' dealings is significant. While purchases made by directors are seen as a signal of positive information, the market's reaction to sale transactions is generally negative (see, e.g., Fidrmuc, Georgen and Renneboog 2006; Jaffe 1974;). Accordingly, to the extent that insider trading is informative for the firm's future performance and the market reacts to trades significantly in the short-term, the trading behaviour of directors prior to bankruptcy is also likely to be informative for the subsequent event of bankruptcy.

In light of the above discussion, we argue that directors are likely to have additional incentives to trade shares preceding insolvency. For example, they are likely to sell shares as the value of their holdings is expected to reduce to zero in insolvency. However, insiders may have incentives to impact the market's perception of their firms by purchasing shares near insolvency. In both cases, directors are expected to trade shares actively prior to insolvency, which may generate a meaningful relationship between insider trades prior to insolvency and the likelihood of insolvency. Furthermore, the motives of directors for doing so are expected to be stronger in the period preceding the announcement of insolvency. Finally, we do not rule out the possibility that trades can partially be motivated by the directors' (possibly biased) view that shares are under- or overvalued during the period leading up to insolvency.³

The main objective of this paper is to provide further insights into the questions whether and how insider trading behaviour in insolvent firms prior to insolvency differs from that in similar solvent firms. In doing so, we examine empirically the relation between directors' dealings and the probability of insolvency using a unique dataset of 474 non-financial UK firms, of which 117 filed for insolvency during the period 2000 to 2010.

The analysis is carried out in two stages. First, to shed light on the patterns of directors' dealings before the event of insolvency, we provide a detailed analysis of share purchases and

³ It is shown in the literature that insiders of solvent firms also trade on the basis of their contrarian beliefs, buying (selling) undervalued (overvalued) shares in an attempt to take advantage of any perceived misvaluation (Jiang and Zaman 2010).

sales, which are made by the directors of insolvent firms prior to insolvency. We also compare these trades with those made during the same period by the directors of solvent firms that operate within the same industry. Second, we examine the relevance of the trading characteristics of directors in determining the likelihood of insolvency. Specifically, we employ a logistic regression with a dichotomous dependent variable, taking the value of one if the firm goes insolvent during the sample period and otherwise zero. While in the first stage we examine mainly the patterns of trading characteristics before insolvency, in the second stage we empirically investigate the link between directors' share dealings and the likelihood of insolvency. We do not assert in the paper that insider trading directly affects the probability of insolvency in such a way that it can be used in bankruptcy prediction models. Although this is not to say that insider trading has no bearing on the likelihood of insolvency, we argue that the distinct patterns of insider trading can be associated with the subsequently observed insolvency. We conjecture that the relation arises from the concerns that managers may have regarding the damage that insolvency can inflict on their reputation and human capital.

In both stages of our empirical analysis, three non-overlapping windows are considered to examine whether the trading patterns of directors change as insolvency approaches, namely 0–6, 6–12, and 12–24 months before the last recorded insider trading activity. The most relevant period for understanding the trading motives of insiders in this respect is likely to be the months leading up to the point in time when the last trade is observed.

Our analysis in the first stage shows that in the last trading period (i.e. 0–6m) insiders change their trading patterns considerably. Specifically, we find that during this period a significantly greater number of directors trade. Additionally, we observe that during this period both the total and average number of trades per director increase sharply. Moreover, importantly, these changes detected are largely driven by purchase transactions. That is, both the number of directors who purchase stocks and the total number of their purchase transactions increase significantly in the last trading period, while the sale transactions are stable across the last two

trading periods. Finally, during the last trading period we observe that the average purchase transaction value goes up more significantly than the average value of sales. Our findings contrast those reported in early literature which present evidence on the abnormalities in insider trading patterns ahead of corporate bankruptcies in the US (see e.g. Gosnell, Keown and Pikerton 1992; Loderer and Sheehan 1989; Ma 2001; Seyhun and Bradley 1997). They generally find that the directors' insider trading decline before the bankruptcy announcement. Moreover, it is shown that insiders increase the volume of sales and thereby attempt to avoid significant losses in their holdings.

The logistic regression analysis shows that insider trading, where the main variable of interest is the net purchase ratio (NPR), is significantly related to the likelihood of insolvency. However, the nature of the relationship between NPR and the likelihood of insolvency changes across the periods. While the relation is negative in the distant periods, it becomes positive and significant during the period preceding insolvency. The findings also reveal that both trade volume and the trading activity of directors are associated positively with the probability of insolvency in the last period leading up to insolvency. Conversely, they exert a negative influence on the likelihood in the earlier two trading periods.

This study contributes to the literature on insider trading and corporate bankruptcies in several important ways. Firstly, to our knowledge, this is the first attempt in the literature to explore the association between insider trading and the likelihood of insolvency. By examining the insider trading in insolvent firms, this study provides important insights into our understanding of managerial behaviour in the presence of severe asymmetric information and costly corporate bankruptcies.

Secondly, this paper investigates the relation between insider trading and insolvency in an interesting setting that has distinct characteristics in relation to corporate bankruptcy procedures. Compared to the US, the UK insolvency code provides stronger protection to creditors, making it relatively easier for creditors to force financially distressed firms into

insolvency (Acharya, Sundaram and Kose 2011; Ozkan 1996). Moreover, whereas under Chapter 11 in the US the incumbent management is allowed to maintain control of the firm's assets, in the UK the managers of insolvent firms surrender control to insolvency practitioners. Therefore, these features of the UK insolvency code, combined with the aforementioned expected managerial costs of insolvency, gives rise to opportunity to shed further light on the managerial incentives that can have implications for other stakeholders in the firm.

Thirdly, our study contributes to efforts to understand the interaction between corporate governance characteristics and corporate bankruptcies. To the extent that good corporate governance reduces the cost of financing and enhances firm performance, an effective corporate governance structure is expected to reduce the probability of insolvency. We note that prior research investigating the role of corporate governance in determining the probability of bankruptcy is dominated by studies carried out for US firms (Daily and Dalton 1994a&b; Fitch and Slezak 2008; Gilson 1990; Platt and Platt 2012). However, although the UK and the US have similar corporate governance structures, there are also enough important differences regarding, for example, the monitoring and disciplining of company directors by institutional investors. We therefore argue that these differences warrant further investigation into the role of corporate governance in determining the likelihood of insolvency.

The remainder of the paper is organized as follows. In Section 2, we discuss the regulatory framework, which sets out the rules regarding directors' dealings. Sections 3 and 4, respectively, describe the methodology and data used in the study. Section 5 presents the results of univariate and multivariate analyses. Section 6 provides a discussion on the findings and section 7 concludes the paper.

2. The Regulatory Framework on Directors' Dealings and Insolvency in the UK

The main legislation and source of company law in the UK, which regulates the dealings of directors, including stock purchases and sales by directors, is the Companies Act 2006.

Under the law, directors are required to notify the company of any dealings in its shares no later than on the fifth business day following the transaction. Companies must in turn notify the Company Announcements Office of the London Stock Exchange without delay and no later than the end of the next business day following receipt of the information by the company. In addition, the Model Code on directors' dealings, set out in Chapter 9 of the Listing Rules (LR9 Annex 1)⁴, provides further guidance for companies and directors in relation to directors' dealings. Several of the requirements are of particular importance in the context of insider trading prior to insolvency. For example, regarding the purpose of directors' dealings, it states that directors must not deal in any securities of the company on considerations of a short-term nature. The Code also requires directors not to deal during "close period" (also known as the blackout period) that is the period of two months preceding the announcement of the company's annual or half-yearly results. More importantly, directors must not deal at any time when they are in possession of unpublished price-sensitive information in relation to the security.

There is, to our knowledge, no separate legislation regulating directors' dealings in financial distress prior to insolvency. However, the wrongful trading provision in the Insolvency Act 1986 (Section 214) should provide a benchmark that directors can use to judge whether a wrongful trading claim can be brought forward against them as a result of their trades in their own shares when their company is in financial distress. Under the law, directors will incur liability for wrongful trading if they continued to carry on their business when they knew that there was no reasonable prospect of the company avoiding insolvent liquidation. It is, therefore, reasonable to assume that directors would stop trading in their shares once they have established that their company faces insolvency and hence a wrongful trading claim can be put forward against them in insolvent liquidation.

⁴ See http://www.fsa.gov.uk/library/policy/listing_rules for an extensive analysis of the current and historic Listing Rules in the UK.

The 1986 Insolvency Act establishes four routes to formal reorganization, namely liquidation, receivership, administration and company voluntary arrangements (CVAs). The most common insolvency procedure in the UK is administration. The main objective of administration is the survival of the company as a going concern. Although this aspect of the UK insolvency procedures is similar to Chapter 11 of the US, there is an important difference between the two procedures, which may help explain some of the insider trading characteristics observed in the UK. In the UK, the control of the company passes to an insolvency practitioner (the administrator) who takes over management and conducts the day-to-day management of the company without any personal liability. Whereas the displacement of management is a significant outcome of insolvency in the UK, filing for Chapter 11 in the US safeguards directors' position.

Taken together, the loss of control can hence be used to explain why the directors in the UK would be reluctant to file for administration. On the other hand, it can be argued that the wrongful trading provision (Section 214 of the Insolvency Act 1986) provides incentives for directors to resort to administration as doing so would reduce the likelihood of potential personal liability.

3. Methodology and determinants of insolvency likelihood

3.1 Methodology

We model the probability of insolvency using a logistic regression where the dependent variable is binary, taking the value of 1 if the firm goes insolvent and 0 otherwise. We estimate the following model.

$$\Pr(y=1|x_i)=G(\beta_0+\beta_1x_1+\dots+\beta_kx_k) \quad (1)$$

where $P(x)$ is the probability of the insolvency outcome occurring (i.e. the outcome $y = 1$) given the vector of explanatory variables x_i . Time and industry dummies are included in all

specifications. Although statistically significant logit coefficients of the independent variables indicate that they have influence on the predicted probability of insolvency, their economic interpretation is not as straightforward as, for instance, it is for OLS estimates. While OLS beta coefficients show the effect of a marginal change in explanatory variables on dependent variable, logit beta coefficients are expressed in terms of log-odds units, specified by

$$\Pr(y=1|x) = e^{(\beta_0 + \beta_1 x_1 + \dots + \beta_k x_k)} / (1 + e^{(\beta_0 + \beta_1 x_1 + \dots + \beta_k x_k)}) \quad (2)$$

The signs of estimated coefficients indicate whether higher values of independent variables lead to a lower or higher likelihood of a $y = 1$ outcome. To assess how different values of x influence the likelihood of insolvency, one can use either odds ratios or fitted probabilities. The odds ratio shows how the likelihood of a $y = 1$ outcome (i.e. insolvency) changes between two values of an explanatory variable. However, given that the odds ratio requires a benchmark value of an independent variable, it is not helpful to estimate predicted values of a $y = 1$ outcome for a given value of x . Instead, the preferred method is first to substitute the desired values of explanatory variables in the estimated logit model to calculate logit odds value for the model. Substituting this value in Equation 2 allows us to derive the probability of insolvency for a specific value of an explanatory variable while holding all other independent variables at their mean values.

3.2 Determinants of the likelihood of insolvency – explanatory variables

To examine the trading motives of insiders prior to insolvency, we consider the following proxies of insider trading: 1) net purchase ratio (NPR), measured as the ratio of the difference between aggregate purchases and sales to the sum of aggregate purchases and sales made by insiders, where a positive value indicates greater purchase than sale activities and *vice versa*; 2) the number of transactions, given by the total number of purchases and sales made by insiders; and 3) the percentage of actively trading members on the board of directors. While the first variable is to capture the impact of the type of directors' transactions, the last two

variables are included to test the extent to which the trading activities of directors impact the likelihood of insolvency⁵.

In our investigation, similar to previous research, we also control for several important accounting and market characteristics as potential determinants of the likelihood of going bankrupt (e.g., Altman and Narayanan 1977; Charitou, Neophytou and Chatalambous 2004; Shumway 2001). It is shown in this strand of the literature that leverage, firm size, stock returns and their volatility are the main factors that impact on the probability of bankruptcy. In addition, we acknowledge the potential role of corporate governance in reducing the agency and asymmetric information problems within corporations and hence the likelihood of bankruptcy (see e.g. Lajili and Zéghal 2010; Poletti-Hughes and Ozkan 2014; Sudarsanam, Wright and Huang 2011). The distinct UK corporate governance features, including insufficient external market discipline, lack of efficient monitoring of company directors by institutional investors, make the inclusion of firm-specific corporate governance characteristics in the analysis essential. Also, apart from the attributes that may facilitate insider trading, an effective corporate governance structure plays an important role in reducing the probability of insolvency through the resulting lower cost of and easier access to external financing (Poletti-Hughes and Ozkan 2014).

To investigate the role of corporate governance in determining the likelihood of insolvency, we consider four measures, namely board size and independence, managerial and institutional ownership. Board size is expected to lower the likelihood of insolvency. Contrary to the view that small boards are more efficient and better organized than larger boards, which should lead to better firm performance (see, e.g., Yermack 1996), firms with larger boards would have a lower probability of insolvency if directors provide firms with more business contacts (Platt and Platt 2012). Board independence has been widely researched in the literature. It is argued that boards with greater number of independent directors are more likely to monitor and

⁵ The full list and definition of the variables used in the model is given in Appendix 1.

discipline the firm's management, and hence help align the interests of shareholders and managers (Shleifer and Vishny 1997). Furthermore, financially distressed firms should have a better chance of survival as the access of independent boards to external finance is expected to be easier, which is essential to avoid bankruptcy. Finally, it is also shown that the market reacts more positively to decisions taken by outsider-dominated firms (Borokhovich, Parrino and Trapani 1996). Consequently, we predict that board independence is negatively associated with the likelihood of insolvency.

We expect the impact of board ownership on the likelihood of insolvency to be negative. There is a great deal of research arguing that managerial ownership can help align the interests of managers and shareholders. This happens because managers bear greater part of the costs of their actions as their equity ownership of the firm increases (Jensen and Meckling 1976). Better aligned interests, in turn, reduce the costs of asymmetric information and agency problems, lowering the likelihood of insolvency.

We also examine the role of institutional ownership in determining the likelihood of bankruptcy. There are two competing views regarding the corporate governance role of institutional investors and hence we do not have a clear-cut prediction as to the role of institutional ownership in determining the probability of insolvency. On the one hand, the theoretical view that dominated the literature for years is that large institutional investors can help mitigate the effects of agency and information asymmetry problems in firms characterised by dispersed ownership structure. Compared to individual investors, they have greater voting powers when the rest of the equity ownership is dispersed among large number of shareholders. In line with this "active monitoring hypothesis", the positive impact of institutional ownership on the quality of overall corporate disclosure of firms, and hence the decrease in the firm's cost of debt through the reduced risk of default, is well-documented (see, e.g., Ajinkya, Bhoraj, and Sengupta, 2005). On the other hand, it is argued that the myopic behaviour of institutional investors can result in a passive corporate governance role (McConnell and Servaes 1990). In

line with this view, it is shown that institutional investors, despite their large ownership position in the UK firms, do not take an active role in corporate governance, adopt a passive stance towards monitoring and disciplining firms' management, and hence have little influence on managers (Franks, Mayer and Renneboog 2001). Moreover, institutional investors can collude with managers to extract private benefits and enable the firm's managers to get entrenched (Pound, 1988).

4. Data

4.1. Sample selection

This study is based on a unique set of data, which combines information from three different sources, namely Companies House, DataStream, and Morningstar UK. We start by identifying the listed non-financial UK firms that entered insolvency procedures over the period 2000 to 2010. For this purpose, we used the current activity status of companies posted on the Companies House website (<http://www.companieshouse.gov.uk>), which, in addition to the full name and status of companies, contains the date of filing for insolvency. We classify firms as insolvent by using a binary variable, with 1 representing their status as one of the following insolvency procedures: administration, liquidation, receivership, or voluntary administration; and 0 otherwise. Consequently, we identify 234 listed non-financial firms that entered insolvency procedures during the sample period.

Subsequently, using International Securities Identification Numbers (ISINs), we append accounting and market data from the Datastream and corporate governance and insider trading information from the Morningstar UK. We observe that there are firms which stop producing financial statements well ahead of entering insolvency, and hence we restrict our sample to those companies for which the gap between the date of the last available financial statements with fully available information and the date of entering insolvency does not exceed three years. As a result of this restriction, and the limited availability of corporate governance or

insider trading data, we lose about half of the firms from our initial sample, and finalise the dataset with 117 insolvent companies with the complete set of information.

The insider trading data obtained from Morningstar UK includes information on the transactions of all directors and other major shareholders. For our analysis, we select purchases and sales performed by only executive and non-executive directors on the board as they are more likely to be better informed than others. Trading data were collected up to two years before the last observed trading date that is taken as the point in time when directors are assumed to stop trading due to expected insolvency concerns. We find that the amount of time between the last trading date of directors and the date of insolvency filing is on average two years.⁶ Finally, we aggregated the characteristics of multiple transactions for three non-overlapping windows, namely the six-month period prior to the last observed director trading date (0–6m); the earlier six-to-twelve month period (6–12m); and the preceding one-to-two year period (12–24m).

To examine the likelihood of insolvency, we match the insolvent companies with those in the control sample, created using the following process. First, in line with previous research (see, e.g., Keasey and Watson 1987; Morris 1997; Piesse and Wood 1992), we choose as many solvent companies as possible to match with the insolvent ones in terms of industry classification benchmark (ICB) and year of observation. Subsequently, due to the main focus of the study, namely insider trading, we remove those firms from the control sample, for which the trading information for the period under consideration is not available. Finally, we limit our control sample to up to ten solvent firms for every insolvent firm, which are of similar size, measured by the value of total assets. As a result, we end up with a sample of 474 firms of

⁶ This is in line with the findings of previous research (e.g., see, Hernandez Tinoco and Wilson 2013). However, it should be noted that our analysis refers to the date of the last share transaction (purchase or sale) by the directors of insolvent firms. This date does not necessarily correspond to the date when the financial distress is observed externally. The directors of insolvent firms are likely to stop trading much earlier to avoid accusations that they trade in company shares when they are in possession of unpublished price-sensitive information.

which 117 are insolvent.⁷ Out of four insolvency procedures, administration is the most frequently used, with 66 firms filing for this insolvency procedure. There are 32 and 13 firms which filed for liquidation and receivership respectively, while there are only 6 firms in the sample, which were declared insolvent through voluntary arrangements.

[Insert Table 1 here]

Table 1 presents the composition of the firms used in the analysis. Specifically, Panel A of the table shows the number of insolvent and solvent firms for each year in the sample period. The highest number of firms observed during the period is 68 in 2003, 23 of which are insolvent. Moreover, there are only 14 observations in 2005, with eight solvent and six insolvent firms. It is also worth mentioning that there are only three insolvent firms included in the sample in 2009, while the total number of firms is 25. Panel B presents the distribution of firms across the industries classified on the basis of Industry Classification Benchmark. The distribution is generally well balanced across the industries with the exception of the technology sector, represented by only 13 (five solvent and eight insolvent) firms. Although not reported in the table, the average age for insolvent (solvent) firms in our sample is 16 (17), where firm age is measured by the number of years since the firm was first listed on the stock exchange. All the firms in the sample are listed on the London Stock Exchange.

4.2. Characteristics of transactions

⁷ As discussed in Zmijewski (1984), sample selection bias is likely to arise in insolvency models that use non-random sampling as the ratio of cases to controls differs from that of the population, such as in matched pairs where the ratio is 50:50. Zmijewski (1984) finds that the sampling bias decreases as the ratio of cases to controls approaches that of the population. Therefore, to reduce selection bias caused by overestimating the “failure” observations with regards to those of the population, we follow the one-to-many sampling design which has been recently applied by Platt and Platt (2012) in a study of corporate board attitudes and bankruptcy. However, for robustness purposes, we also perform our analysis on 117 pairs of insolvent and solvent UK listed firms, matched on the basis of firm size and industry classification as in Platt and Platt (1990), and Tennyson et al (1990). The results are consistent throughout the analysis and hence are not discussed separately.

Table 2 presents information on several important characteristics of the open-market purchases and sales carried out by the directors in both solvent and insolvent firms. This information is provided for the three windows separately.

Panel A reports the total number of transactions observed, together with the average transaction size measured both in sterling (£) terms and as a share of market value. Panel B, on the other hand, gives information on the volume of trade per director. In particular, it shows the total number of trading directors observed and their average volume of trade measured in sterling terms and as a share of market value. We also provide mean-difference tests for the values reported across insolvent and solvent firms.⁸ In discussing the results we focus on the last two six-month trading windows, namely 0–6m and 6–12m periods, to underline the changes in the pattern of trading within the last 12 months of insiders' activity in insolvent firms.

Our investigation leads to several important observations. Starting with Panel A, firstly, it is clear that the number of purchase transactions increases during the last trading period. While the increase is observed for both solvent and insolvent firms, the changes for the group of insolvent firms are significantly greater. Specifically, the number of purchase transactions in insolvent firms increase from 152 in the 6–12m window to 413 in the 0–6m trading window, suggesting about a 172 percent increase. The percentage increase for the same variable in solvent firms is 11 percent, corresponding to an increase from 823 in the 6–12m period to 914 transactions in the 0–6m period. Secondly, compared to purchases, there are fewer sale transactions during the last two trading windows. There are 48 (36) sales made by the insolvent-firm directors in the 0–6m (6–12m) window, corresponding to a 33 percent increase. The number of directors engaging in sale transactions is also small, increasing from 26 in the 6–12m window to 33 during the last-trading period. Interestingly, compared to the previous six-

⁸ Although we report the parametric test results for comparing the mean values of the variables across the two groups, our findings are also verified using two non-parametric tests, namely both Mann-Whitney and Wilcoxon tests.

month period, in solvent firms both the number of sale trades and the number of directors making these trades fall during the last-trading window, from 200 to 170 and from 146 to 135 respectively. Finally, the average value of purchase transactions in insolvent firms increases in the last trading period by 35 percent from £20K to £27K. This corresponds to an increase in the ratio of the average value of purchase transactions to the market capitalisation of insolvent firms, from 0.11 to 0.15 percent. However, although the ratio also increases for sale transactions from 0.21 to 0.31 percent, the average value drops by about 27 percent from £154K in the 6-12m period to £112K in the 0-6m period. Finally, we have mixed findings for the solvent firms during the same windows. That is, while the average purchase (sale) transaction value increases (decreases) from £25K (£163K) to £30K (£133K), the average value ratios are more stable between the two six-month periods.

[Insert Table 2 here]

Turning to the findings in Panel B, the number of trading directors who make purchase transactions in insolvent firms significantly increases from 95 in the 6–12m window to (298) in the 0–6m trading window, suggesting about a 212 percent increase. On the other hand, the number of directors who make sale transactions in the last period is only 33, increasing by about 27 percent from 26. Furthermore, similar to the findings provided in Panel A, the average value of purchase transactions per director in insolvent firms also increases during the last trading period. Specifically, an average director's aggregate purchase (sale) trade is about £37K (£164K) in this period, increased (decreased) from £32K (£213K) in the 6-12m period by about 16 (23) percent. Moreover, the corresponding increase in the ratio of the average value of purchase (sale) transactions to the market capitalisation is from 0.17 (0.29) to 0.20 (0.45) percent. Finally, as for the solvent firms, similar to the conclusion for Panel A, we argue that pattern is not clear-cut. That is, similar to insolvent firms, the average purchase (sale) transaction value increases (decreases) in solvent firms, namely from £43K (£223K) to £54K

(£168K). However, the average value ratios are stable for both purchases and sales between the two six-month periods.⁹

It is possible that although the directors of insolvent firms purchase shares prior to insolvency, they may find it difficult to sell their holdings later as the market for shares becomes illiquid due to insolvency concerns.¹⁰ To investigate this issue we measure trading liquidity using a volume-related measure similar to that in Lee and Swaminathan (2000) and Chordia, Roll and Subrahmanyam (2001). Specifically, we estimate the liquidity for both solvent and insolvent firms for all the periods considered in our estimations by the trading volume measure $Q_t = \sum_{i=1}^{N_t} q_i$, where N_t denotes the number of trades between $t-1$ and t and q_i is the number of shares of trade i . Our findings suggest that, compared to the 6-12m period, the trading volume, i.e. liquidity, increases in the insolvent group of firms in the last trading window before insolvency, by about 56 percent. During the same period, the liquidity for solvent firms increases by only about 9 percent. We accordingly argue that the illiquidity of the insolvent firms' shares is not likely to be a matter of concern to the trading directors.

Overall, the analysis of the findings presented in Table 2 suggests that the purchase behaviour of the insolvent-firm directors prior to insolvency is distinct and sufficiently unambiguous. In the last six-month trading period prior to insolvency, directors increase their purchases much more notably than sale transactions, evidenced by the significant changes in the number of transactions, the transaction volume measured both in sterling terms and relative to market value, and the number of trading directors. The findings suggest that the characteristics of directors' dealings, in particular purchase trades, during the period prior to insolvency can be informative as to the subsequent event of insolvency.

⁹ In addition to the analysis provided in Table 2, we also examined only the last trades which were carried out by the directors of insolvent firms. In line with the results for the aggregated trades, we find that about 91 percent of the last open-market insider transactions made in insolvent firms are purchase trades. On average, there are 1.96 trades made by the directors, of which only 0.18 are sale transactions. Also, the ratio of purchase transactions to market capitalisation is about 0.44 percent, compared to about 0.26 percent for the whole period.

¹⁰ We thank an anonymous referee for raising this point.

5. Results

5.1. Summary statistics and univariate analysis

In Table 3 we report the mean values and their standard deviations for the whole sample and separately for the solvent and insolvent firms. Furthermore, the mean difference t-test results for each variable are reported, where the null hypothesis is that the mean values of the variables across the solvent and insolvent groups are equal. We present our findings by grouping the variables in four categories: corporate governance, accounting and market variables, and directors' trading.

[Insert Table 3 here]

Starting with the discussion of the corporate governance characteristics, the results reveal significant differences between solvent and insolvent firms with respect to board size, independence and institutional ownership. We find that the companies that filed for insolvency have on average smaller boards, with about six members, compared to approximately seven directors sitting on the average solvent firm's board. We also show that the composition of the board across the two samples is significantly different. Specifically, the non-executive directors of insolvent firms constitute on average about 47 percent of the board, compared with more than 52 percent in solvent firms. The results suggest that the boards of solvent firms in our sample tend to be more independent than the insolvent firms. Despite the differences in the total number of directors represented on the board, the equity ownership of board members is almost the same in both groups at about 13 percent. Finally, we find that the average institutional ownership portfolio in the insolvent sample of firms is significantly higher than that for the control firms, about 31 and 21 percent respectively.

There are also significant differences between the two samples regarding the accounting variables used in the analysis. Not surprisingly, the mean leverage ratio (about 28 percent) for insolvent firms is significantly higher than for the solvent firms (about 16 percent). Compared

to the firms in the solvent sub-sample, insolvent firms are significantly smaller and a smaller percentage of them pay out dividends to shareholders during the sample period. As for the market variables, the stock return for insolvent firms prior to the event of insolvency is negative, approximately -32 percent, and significantly lower than the average return on the solvent firms' stocks, which is just under 10 percent. The volatility of past returns is expectedly higher for insolvent firms. Overall, the comparison of the relevant accounting and market variables indicates that the insolvent firms used in the analysis exhibit greater risk and a higher degree of financial constraint. Moreover, the differences seem to be perceived by the market correctly, reflected in lower returns and greater stock return volatility.

Turning to the results on insider trading measures, we present important differences between the two samples with regards to the mean values of net purchase ratio (NPR), the number of trades in a firm, and the insider activity ratio before the insolvency event. More specifically, the NPR for insolvent firms in the last trading period is significantly greater than that for solvent firms, which are respectively 0.70 and 0.35. This finding suggests that on aggregate, compared to solvent firms, the directors of insolvent firms make significantly more purchase than sale transactions prior to insolvency. However, the difference in the NPR between the two groups during the other trading periods is not statistically significant. The results also indicate that although the average number of trades in firms filing for insolvency is significantly smaller in the further trading periods, namely 6-12m and 12-24m periods, it becomes greater for insolvent firms in the last trading period. This is in contrast to Seyhun and Bradley (1997) who find that insiders mostly sell their stocks prior to insolvency. It is also important to observe that the average number of trades in insolvent firms increases in the 0-6m period to 3.94 from about 1.61 in the 6-12m period. On the other hand, in solvent firms it increases only slightly to 3.04 from 2.87 during the same period. A similar pattern emerges regarding the average value of active directors. That is, while the ratio of active number of directors to board size is higher in an average solvent firm in the earlier periods, the ratio becomes significantly higher for

insolvent firms in the last period. It is also worth mentioning that the active insiders ratio for insolvent firms increases from about 18 percent in the 6-12m period to 51 percent in the 0-6m period, whereas it remains almost unchanged at about 25 percent for solvent firms. This is in line with the findings of Ryan (2005), who reports that in situations of increased interest from analysts, insider trading volume decreases.

Our preliminary findings indicate that the patterns of directors' dealings differ significantly between the insolvent and solvent groups of firms during the relatively long period before the insolvency event. However, the striking finding from our analysis is that the directors of firms in the insolvent group increase the volume and number of their purchases nearer the insolvency. Combined with the findings in the previous section, our descriptive analysis suggests that the way in which the directors of insolvent firms trade in their own shares may prove to be relevant in estimating the probability of insolvency.

5.2. Multivariate logit analysis

This section investigates the determinants of the likelihood of insolvency. In Table 4 we present the results from four different logit specifications. Model 1 is our baseline model, estimating the likelihood of insolvency as a function of only the accounting, market and corporate governance variables. In Models 2 to 4 we incorporate our three measures of directors' insider trading, which are the main variables of interest in our analysis.

5.2.1. Corporate governance, accounting and market variables and the likelihood of insolvency

Starting with Model 1, we find that the majority of the estimated coefficients are generally significant and in line with the predictions as to their impact on the likelihood of insolvency. Specifically, the findings for the corporate governance characteristics suggest that firms with larger and more independent boards are less likely to be insolvent. The negative and significantly estimated coefficient of board size is inconsistent with the traditional view (see,

e.g., Yermack 1996) that small boards are more efficient and better organized than larger boards, which should lead to better firm performance and hence a lower probability of insolvency. Instead, firms with larger boards are less likely to be insolvent, supporting the evidence provided by Platt and Platt (2012) that larger boards probably provide firms with more business contacts, enabling them to avoid insolvency. However, it should be noted that financially distressed, in particular near-insolvent, firms are likely to lose directors prior to the insolvency (Darrat, Gray and Wu 2010). This may then lead to a negative relation between the number of directors and the insolvency event by construction, possibly partly explaining our finding.

[Insert Table 4 here]

The negative impact of board independence on the likelihood of insolvency is consistent with the findings of prior research showing that the market reacts more positively to decisions taken by outsider-dominated firms (Borokhovich, Parrino and Trapani 1996) and more independent boards are likely to be better monitors (Shleifer and Vishny 1997). To the extent that boards with greater non-executive director representation are more likely to make better decisions and act in shareholders' interests, greater board independence should lead to better performance, lower cost of capital, and hence lower the probability of financial distress. Furthermore, financially distressed firms should have a better chance of survival as the access of independent boards to external finance is expected to be easier, which is essential to avoid bankruptcy.

As for the impact of equity ownership variables, we do not find a significant relation between board ownership and the likelihood of insolvency, while the negative sign is consistent with our predictions. This finding does not support the view that board ownership is expected to align the interests of managers and owners and therefore to reduce the costs of agency problems within corporations (Jensen and Meckling 1976). However, the relation between

institutional ownership and the likelihood of insolvency is positive and highly significant. This provides further support for the argument that financial institutions, despite their large ownership position, do not take an active role in corporate governance in the UK, adopt a passive stance towards monitoring and disciplining firms' management, and hence have little influence on managers (Franks, Mayer and Renneboog 2001).

Not surprisingly, we find a highly significant and positive association between leverage and the likelihood of insolvency. The estimated negative relation between dividend policy and the probability of insolvency, albeit rather weak, may arise because the firm's dividend policy can indicate its flexibility to resort to internal resources when needed and be seen as an inverse proxy for the degree of financial constraint. Dividend paying firms are also expected to be more profitable, which would also lower the probability of insolvency. We find that past stock returns exert a negative and significant effect on the likelihood of insolvency. In addition, the volatility of stock returns is positively related to the likelihood of insolvency. While the high stock return volatility can increase the likelihood of insolvency *per se*, we also note that the volatility, observed during the period prior to the insolvency, may be the outcome of the expected insolvency. We do not investigate this issue further as we do not examine financial distress separately from insolvency. Finally, one result that is inconsistent with a priori expectations relates to firm size. Although the sign of the estimated coefficient of firm size is expectedly negative, suggesting a lower probability of insolvency for larger firms, the relation is not statistically significant. Our findings in relation to the control variables from the baseline model hold robustly and hence we do not discuss them again in the rest of the paper.

5.2.2. Trading activity of directors and the likelihood of insolvency

As explained earlier, in estimating the relation between insider trading and the likelihood of insolvency we use three different proxies in relation to the trading activity of directors. Moreover, each proxy is measured over three different time windows to test if the nature of directors' dealings changes as the insolvency approaches, namely the six-months (0–6m), the

six-to-twelve-months (6–12m), and the one-to-two-years (12–24m) periods prior to the date when the last trading was observed. In Model 2 we examine the impact of net purchase ratio (NPR), which is defined as the ratio of the difference between aggregate purchases and sales to the sum of aggregate purchases and sales made by insiders. The results reveal that the influence NPR exerts on the likelihood of insolvency is positive and significant during the last six-month period of trading. However, the estimated relation in the earlier periods is negative, albeit statistically significant only in the 6–12m period. These findings are in support of the earlier descriptive analysis that directors increase their purchase transactions before they cease trading completely, possibly to reduce the risk of litigation related to insider trading. Also, the negative impact of NPR on the likelihood of insolvency in earlier periods would be in line with the view that insider purchases are informative indicating that managers are normally more likely to purchase when the expected future performance of their firms is favourable.

In Model 3 we estimate the relation between the likelihood of insolvency and the total number of trades performed by insiders, used as a proxy for trading activity, without distinguishing between purchases and sales. The estimated coefficient of this variable in the first window (0–6m) is positive and highly significant. As shown earlier, the observed increases in the last trading period are mainly due to open market purchases rather than sales. It is therefore likely that the positively estimated relation between the number of insider transactions and the likelihood of insolvency provides further support for the suggestion that insiders become significantly more active in purchasing shares before they stop trading. It is also important to note that the positive relation is not in line with the view that insiders would be more cautious and diligent when trading ahead of adverse events such as insolvency. However, this view seems to hold for the earlier windows. The impact of the number of trades is negative and significant, having an opposite impact on the probability of insolvency. The contrast in the findings between the first and the last two trading periods further supports the

conjecture, and our initial findings in the previous section, that the trading behaviour of insiders is likely to change significantly in the period leading up to insolvency.

In Model 4 we investigate the relation between the activity of the board, measured by the ratio of the number of trading directors to board size, and the likelihood of entering insolvency. The findings are very similar to those we report above with respect to the impact of the number of trades on insolvency. Specifically, we find that while insider activity exerts a negative influence on the estimated likelihood of insolvency during the last six-month period, the relation is reversed during the earlier two windows.

In conclusion, the results in Table 4 provide strong evidence in support of the view that the trading behaviour of directors before insolvency is significantly associated with the likelihood of insolvency. More importantly, the estimated relation is not homogeneous and changes in the opposite direction between the last six-months trading period and the two earlier periods.

5.3. Sensitivity analysis: insider trading and the probability of insolvency

As discussed earlier, the reported coefficients in Table 4 are not sufficient to evaluate the marginal impacts of the changes in the variables of interest on the probability of insolvency. Therefore in Figures 1 to 3, we provide a sensitivity analysis by evaluating the predicted probabilities of insolvency against insider trading variables during the three trading periods. In all of the figures, we plot the probabilities using the models reported in Table 4. For example, in estimating and plotting the probability of insolvency at different levels of NPR in Figure 1, we use the estimated results for Model 2. We evaluate the rest of the independent variables at their mean values except the categorical control variables (i.e. year and industry dummies), which are evaluated as though there are equal number of observations in each category, and therefore are equally probable.

Overall, the plots suggest that the probability of insolvency is generally more sensitive to changes in insider trading measures in the last trading period (0–6m) regardless of the variable

used in estimating the probabilities. Furthermore, the upward and downward sloping curves plotted in Figures 1–3 are expectedly in line with the estimated coefficients regarding each aspect of insider trading. Figure 1 shows that the sensitivity of the probability of insolvency, given by the slope, increases significantly in the 0–6 month period as the value of net purchase ratio (NPR) increases. For example, the probability increases from about 6 percent to around 24 percent as the value of NPR ranges from -1 to 1. However, the probability of insolvency is much less sensitive to changes in NPR in the earlier windows. The estimated probability curve is now downward sloping in the earlier 6–12 month window. For the same change in NPR, the probability of insolvency drops to about 12 percent from 27 percent. While the curve is still negatively sloped in the last period, the sensitivity is even lower, where the decrease in the probability for the same range of change in NPR is only about three percentage points.

[Insert Figures 1 to 3 here]

Figures 2 and 3 present a similar analysis for the number of transactions and active insiders respectively. Specifically, as shown in Figure 2, the probability of insolvency increases from about 8 percent to above 80 percent as insiders in a typical firm increase the number of their trades from 0 to 20 during the last six-months trading period. However, in the earlier two periods the slope is negative, suggesting that the probability of insolvency decreases as the number of trades increases. Finally, the probability of insolvency increases from about 8 to just under 70 percent as the ratio of directors engaged in trading goes up from 0 to 100 percent. On the contrary, but in line with the trends reported in Figure 1 and 2, in the earlier windows an increase in the ratio of active traders decreases the probability of insolvency and at a much lower magnitude. For example, as the ratio increases from 0 to 100 percent, the probability of insolvency decreases from about 20 (40) to less than 10 (5) percent in the 6–12m (12–24m) period. To sum up, the findings of the sensitivity analysis are in line with the regression results presented earlier. The results confirm our earlier suggestion that the impact of insider trading

on the probability of insolvency during the last trading period differs significantly from that in the earlier periods.

5.4. Additional tests

To ensure the robustness of our results, we carried out a series of checks. First, in estimating the likelihood of insolvency we replace the market and accounting variables with the KZ Index, which is generally used in previous research as a proxy for the probability of financial distress and financial constraint (Almeida, Campello and Weisbach 2004; Baker, Stein and Wurgler 2003). The results are not reported separately but they are consistent with our a priori expectations that the relationship between the KZ Index and the likelihood of bankruptcy is positive. The influence of insider trading variables also remains in line with the main findings reported in Table 4.

5.4.1. Type of transaction: purchases vs. sales

In Table 5, we first examine if the positive relation between net purchase ratio (NPR) and the likelihood of insolvency is driven by one type of transaction. To do so we replace NPR with a purchase ratio (PR) in Model 1 and sale ratio (SR) in Model 2. Purchase (sale) ratio is defined as the ratio of total volume of purchase (sale) transactions made by insiders over total aggregated volume of insider purchases and sales. We report only the findings on the insider trading variables for brevity, as the results for the rest of the variables remain qualitatively similar with those provided in Table 4. The results suggest that the positive relation between the transactions in the last period and the likelihood of insolvency is driven by purchase transactions. Specifically, the estimated coefficient of PR in the last trading period is positive and highly significant. In line with the earlier findings, the estimated PR coefficients for the remaining windows are negative and statistically significant. Furthermore, SR does not exert a significant impact in the last trading period. However, the relationship between SR and the likelihood of insolvency is negatively significant in the (12-24m) trading period. To conclude,

it is important to note that while the purchase and sale transactions have the opposite impact on the likelihood of insolvency in the last trading period, we cannot distinguish the two transaction types in the earlier trading periods.

[Insert Table 5 here]

We next perform a similar exercise in Model 3, where we estimate the relation between the number of transactions and the likelihood of insolvency, by distinguishing between number of purchases and sales. We find that the number of sale transactions made by directors exerts a little influence on the likelihood of insolvency. The estimated coefficients are not significant in the first two windows, whilst the coefficient in the last window is negative and significant at the 1 percent level in the 12–24m period. The findings on the number of purchases, however, reveal a highly significant relationship with the likelihood of insolvency, and are also in line with our earlier interpretation of the results with regards to the NPR (in Model 2 of Table 4) and the SR (in Model 1 of Table 5).

5.4.2. Type of director: executive vs. non-executive

As a final robustness test in Table 5, we consider the possibility that the relation between the percentages of directors engaged in trading and the insolvency probability changes depending on whether the trading insider is an executive or a non-executive director. In Model 4, we hence incorporate the percentage of executive and non-executive active trading directors separately. Similar to the findings for other insider trading characteristics, we find an asymmetry with respect to the impact of the percentage of active traders on the likelihood of insolvency across different windows. However, while the estimated coefficients in the 0–6m period for both types of directors are positive, the statistical significance of the estimation on the active non-executive ratio is stronger. More importantly, in the last two periods the estimated impact of the active directors' ratio on the probability of insolvency is significant only for non-executive directors.

Finally, we also recognise that the impact of types of transaction (i.e. sales and purchases) may also vary with the types of directors who trade. To address this possibility we run a number of regressions by further classifying each type of transaction into two groups identified by director type. The results are in line to our earlier findings and hence are not reported separately. Specifically, the impact of sale transactions is insignificant regardless of director type and the significant impact of purchases remains unchanged.¹¹

6. Discussion on the motivations of directors to purchase prior to insolvency

There are two important findings of our analysis. First, we show that the directors of insolvent firms increase their purchases of their own shares as the formal filing for insolvency approaches. Second, we establish that there is clearly a positive association between purchase transactions and the likelihood of insolvency. These findings are not in line with what would normally be expected of the directors of insolvent firms. As we discussed earlier, if insiders are better informed than outsiders they should avoid purchasing stocks prior to insolvency, which leads to a prediction that purchase transactions are negatively associated with the probability of insolvency. This superior information prediction is also supported with the evidence provided by previous research, which shows that the changes in the trading patterns of insiders before major price-relevant corporate announcements are consistent with the subsequent event (e.g. seasoned equity offerings (Karpoff and Lee 1991), dividend initiations and/or cuts (Kose and Lang 1991), stock repurchases (Lee, Mikkelsen and Partch 1992), and mergers and acquisitions (Seyhun 1990)). Accordingly, we conclude that the purchase

¹¹ For robustness purposes, in order to account for the effect of the amount of time (t) between the date of directors' last trading and the date of insolvency filing on the estimated logistic regression associations, we perform additional analysis with the application of proportional Cox hazard model on the single-period data. In this context, the superior feature of the semi-parametric Cox hazard model relates to the treatment of differences in time t between the firms. In particular, the model compares subjects when the values of t are identical, and therefore share the same risk of the event. The results obtained from the Cox hazard model are in line with findings provided by the logistic regression models presented in section 5.2 and hence are not reported separately. However, they are available from the authors upon request.

transactions of directors prior to insolvency are unlikely to be driven by directors' superior information about the imminent insolvency. In the following, we explore several potential reasons for the directors of insolvent firms to trade in their own shares and in particular to increase their purchases notably.

6.1. Signalling motives and litigation risk

One explanation relates to the possibility that insiders may purchase shares in an attempt to affect the market's perception of the firm's financial situation and hence to reduce the probability of insolvency. This is more likely to happen in severe financial distress when the probability of insolvency is significantly high. Managers, compared to other stakeholders in the firm, are known to have stronger incentives to avoid bankruptcy. It is well established in the literature that insolvencies are costly to all the stakeholders of the firm. However, the costs that are born by managers are significantly higher as they also have their human capital invested in the firm (Eckbo, Thorburn and Wang 2012; Gilson 1989). It is therefore reasonable to assume that directors may have incentives to affect the market's sentiment through their purchase activities if doing so is likely to reduce the likelihood of insolvency or delay it. It is also important to note that these incentives are likely to be stronger in the UK for at least two reasons. First, compared to many other bankruptcy codes, in particular to the US code, the UK insolvency code is known to be more favourable to creditors, leading to a greater probability of insolvency when companies are in financial distress (Acharya, Sundaram and Kose 2011; Ozkan 1996). Second, in contrast to the US where under Chapter 11 the incumbent management is allowed to maintain control of the firm's assets and its operations, in the UK the managers of insolvent firms surrender control to insolvency practitioners. Put together, these arguments form the view that it may be reasonable to expect directors to purchase their own shares if there is any scope for avoiding or delaying the insolvency. At least, given the evidence in the literature in favour of the positive short-term reaction of the market to purchase

transactions by insiders, the efforts of directors to impact the market's perception of the firm through purchases can be seen to some extent reasonable and desirable.

Testing the signalling motives of directors to purchase shares prior to insolvency requires a different framework from that adopted in this paper and is also beyond the objective of this paper. However, in Table 6 we provide cumulative abnormal returns (CARs) for up to five trading days following the announcement day. We estimate the market-adjusted abnormal return for firm i on day t as $AR_{i,t} = R_{i,t} - R_{m,t}$, where $R_{i,t}$ is the daily return for the traded share i on day t and $R_{m,t}$ is the return on the value-weighted FTSE All-Share¹² index on the same day (Croci et al, 2010).

[Insert Table 6 here]

We report CARs for five different windows, from CAR(0,1) to CAR(0,5) where, for example, CAR(0,1) gives the cumulative abnormal return on the first trading day following the announcement of insider trading, given as day 0. For purchase transactions made by insiders, the CARs in all of the windows are positive and mostly significant. However, the strongest positive results are observed during the last trading period, 0-6m. We have mixed results for the CARs regarding the sale transactions. They generate lower, and negative, CARs in the last trading period. The CARs for the sale transactions in the earlier periods are positive. The difference in the CARs of insiders' purchases and sales are statistically significant in the 0-6m period, suggesting that the market reaction to purchases and sales differs considerably. This finding is in line with Fidrmuc, Georgen and Renneboog (2006), which also shows that the market reaction to both purchases and sales in poorly performing and financially distressed firms is stronger. Interestingly, the CARs of directors' purchases and sales in earlier periods

¹² FTSE ALL-Share Index represents about 99 percent of UK market capitalization, aggregating of the FTSE 100, FTSE 250 and FTSE Small Cap Indices (http://www.ftse.com/Indices/UK_Indices). Each company in the Index is first weighted using the number of shares-in-issue and the share price. Then, the free float factor is incorporated to arrive at the final weight, considering only the shares available for trading and hence ignoring those shares held by restricted shareholders such as family owners.

are either insignificant or weakly significant in few cases. Moreover, CARs for sales are positive, contrasting our findings for the 0-6m trading period. This result might suggest that the market perceives that transactions made in the verge of insolvency (0-6m window) carry more information than those in earlier periods.

[Insert Figure 4 here]

In an attempt to provide further insights, we present a 22-day moving average plot for the insolvent firms' daily market- adjusted returns across the period of 24 months prior to insolvency. The plotted trend-line clearly shows that the returns of insolvent firms are generally negative and lower than the returns for solvent firms. More importantly, in the period leading up to insolvency the returns first sharply fall and bounce back significantly, possibly due to increased purchase activities observed during the last trading period, which is also in line with the CAR analysis.

The directors of financially distressed firms may also want to reduce their sale and/or increase their purchase transactions before insolvency to minimise the risk of litigation. As we discussed earlier, the relevant risk in the UK in this respect is that of wrongful trading, which can be brought forward against directors if it can be shown that they traded when they knew that there was no reasonable prospect of the company avoiding insolvent liquidation. Also in line with the litigation risk view of insider trading, it is shown in prior studies that insiders, in an attempt to reduce their risk exposure, decrease their timely trades before major events. Specifically, insiders reduce sales and increase purchases ahead of negative and positive news respectively (see, e.g., Chen, Martin and Wang 2013; Seyhun 1992).

6.2. Managerial overconfidence

The above explanations of directors' incentives to purchase prior to insolvency are based on the assumption that directors are generally rational. In that framework, directors act rationally in their own best interest by exploiting the asymmetric information with regard to the likelihood of insolvency, though not necessarily, at the expense of outsiders.

The assumption of rationality may, however, not hold. Directors can be irrational and therefore biased in their perception of the likelihood of insolvency and the future prospects of their firms. One of the behavioural managerial biases affecting their trading behaviour is overconfidence. In particular, in the context of this study, overconfident directors are likely to underestimate the likelihood of insolvency and/or overestimate the expected future returns as a consequence of their illusion of control and the commitment to good outcomes. Overconfident directors of insolvent firms may then choose to purchase shares, with a belief that the firm is undervalued and its chance of survival is significant enough.

The most robust method to proxy the level of managerial confidence was developed by Malmendier and Tate (2005) in their study on the US data exploring behavioural biases of the Chief Executive Officers (CEOs). Building their proxies upon the CEOs behaviour in relation to the exercise of stock options they hold, they claim that the executives who hold their options until the expiration date can be classified as overconfident.

In the UK the life span of the vast majority of managerial stock options is 10 years, with a vesting period of 3 years (Croci et al., 2010). As mentioned above, the trading that we imply can be motivated by managerial overconfidence occurs in the last 6 months of trading of our insolvent firms. During this window, we observe only 51 distinct CEOs in insolvent firms among the insider traders. The average of 3 years tenure of the executives at the time of observation in our sample does not give us an opportunity to test in a robust manner the overconfidence motivation. Still, in order to shed light on the relevance of managerial biases in determining the outcome of severe financial distress, we attempt to provide some preliminary analysis. Following Schrand and Zechman (2012) we employ three CEO

characteristics that might be taken as a proxy for overconfidence. First, we consider CEO's tenure which has been associated with an increase of the perceived controllability which results in optimistic bias (Weinstein and Klein, 1996). Also, Malmendier et al. (2011) and Hirshleifer et al. (2012) find that overconfident CEOs have significantly longer tenures. CEO tenure is normally used to measure managerial ability, so it would not be surprising that ability is associated with confidence. Second, we consider whether the CEO is also the founder or co-founder of the company. A founder CEO holds a formal position in the organizational hierarchy and possesses unique competencies at firm specific level, which might contribute to overconfidence (Galema et al., 2012). As our third measure, we consider the level of education. Education is a measure of expertise which might proxy overconfidence, in the sense that expertise might make individuals to believe that they are better than average at a task (Schrand and Zechman, 2012).

We classify a CEO as overconfident using any (either or) of the following criteria. First, based on CEO's tenure, we choose the top 25 percent, which classifies a CEO with tenure of five years or more as overconfident. CEO tenure is measured as a continuous variable equal to the number of years between the CEO's start date at such position in the company and the year of the insider trade. Second, founder is a dummy variable that equals one if the CEO is also the founder of the company. Third, education is a discrete variable which gives the following values: No college (0); Bachelor's degree (1); Master's degree or Professional Qualification (2); two Master's degrees (2.5); Doctorate degree (3); and classify in the overconfident group those individuals who have a level of education of (2) or more. Using these proxies, we then distinguish between the transactions made by overconfident managers and others. Based on an analysis of 68 purchase transactions made by all CEOs in our sample, we are however unable to provide support for the prediction overconfident CEOs make more purchases than others before insolvency.

7. Conclusion

This paper provides an empirical investigation on the determinants of the likelihood of insolvency. The main objective is to examine if insider transactions performed by company directors before insolvency are associated with the event. To do so, the study distinguishes between purchase and sale transactions made by the directors of a sample of both solvent and insolvent firms in the UK during the period 2000 to 2010. Furthermore, the trading period prior to insolvency is divided into three distinct sub-periods to investigate whether the trading behaviour of directors change nearer the insolvency event.

Our analysis provides clear-cut evidence that insiders increase their purchase transactions significantly in the period leading to insolvency. The results from the logistic regression analysis also support this finding, revealing a positive relationship between net purchase (NPR) and the probability of insolvency only in the six-months trading period before the insolvency. In more distant periods the relation is negative and insignificant. The results hold when the analysis is repeated by incorporating purchase and sale trades in separate estimations. Specifically, there is a positive relation between purchases and the likelihood of insolvency only during the last trading period. However, there is no convincing evidence for the existence of a significant relation between sale transactions and the likelihood of insolvency during the same window of trading. Finally, we find that the relation between insider trading characteristics and the likelihood of insolvency is similar across executive and non-executive directors' dealings.

We also find that board size and independence, and the equity ownership of institutional investors are significant corporate governance characteristics in determining the probability of insolvency. Interestingly, the negative impact of board size and the positive influence of institutional ownership on insolvency are not consistent with what previous corporate governance and corporate bankruptcy studies show. We argue that the differences in the

interplay between these firm-specific governance features and the likelihood of insolvency are due to the specific characteristics of the corporate governance system in the UK.

Overall, the findings of our study point to the importance of insider trading characteristics in determining the probability of insolvency. An avenue for future research is to further distinguish between different directors by focusing on the potential differences regarding the incentives of, for example, firms' CEOs and CFOs. It is also important to incorporate country-specific information in the analysis with regard to insider trading, bankruptcy procedures, and corporate governance characteristics to provide more insights into corporate bankruptcy models.

Finally, the findings of our analysis may partly arise from the biased view of irrational investors. Distinguishing between rational and irrational trading motives of directors is hence important in investigating the relationship between directors' dealings and the likelihood of insolvency. Equally, it is important, though challenging, to test if the increasing efforts of insiders in insolvent firms to influence the market's perception during the period preceding the insolvency are successful for some firms in avoiding bankruptcy. This awaits future research.

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9. Tables and Figures

Table 1
Insolvent and solvent firms by year and industry

<i>Panel A. Number of firms by year</i>				
	<i>Year</i>	<i>Insolvent</i>	<i>Solvent</i>	<i>Total sample</i>
	2000	14	28	42
	2001	11	30	41
	2002	14	49	63
	2003	23	45	68
	2004	7	24	31
	2005	6	8	14
	2006	9	39	48
	2007	11	42	53
	2008	11	37	48
	2009	3	22	25
	2010	8	33	41
	Total	117	357	474

<i>Panel B. Number of firms by industry</i>					
	<i>ICB name</i>	<i>ICB code</i>	<i>Insolvent</i>	<i>Solvent</i>	<i>Total sample</i>
	Basic Materials	1000	6	28	34
	Consumer Goods	2000	33	89	122
	Consumer Service	3000	19	63	82
	Health Care	4000	7	38	45
	Industrials	5000	29	86	115
	Technology	6000	8	5	13
	Telecommunication	9000	15	48	63
	Total		117	357	474

This table presents the distribution of insolvent and solvent (control) firms. Panel A presents the frequency of firms in each group across the years in the sample period. Panel B shows the distribution of firms across the industries on the basis of the Industry Classifying Benchmark (ICB).

Table 2**Characteristics of purchase and sale transactions across insolvent and solvent firms**

		Insolvent			Solvent			Mean-comparison test	
		N	Mean (%)	Mean (£000)	N	Mean (%)	Mean (£000)	Mean (%)	Mean (£)
<i>Panel A. Number and size of transactions</i>									
Purchases	0-6 m	413	0.15	27	914	0.07	30	-7.04***	0.79
	6-12 m	152	0.11	20	823	0.08	25	-1.92*	1.25
	12-24 m	245	0.11	28	1587	0.07	28	-3.32***	0.11
Sales	0-6 m	48	0.31	112	170	0.18	133	-2.79**	0.94
	6-12 m	36	0.21	154	200	0.17	163	-0.97	0.27
	12-24 m	51	0.26	131	432	0.19	136	-1.69*	0.24
<i>Panel B. Number of directors and size of their transactions</i>									
Purchases	0-6 m	298	0.20	37	504	0.12	54	-4.51***	2.10**
	6-12 m	95	0.17	32	480	0.13	43	-1.34	1.53
	12-24 m	177	0.16	39	832	0.14	54	-0.64	1.98**
Sales	0-6 m	33	0.45	164	135	0.23	168	-2.20**	0.11
	6-12 m	26	0.29	213	146	0.23	223	-0.76	0.18
	12-24 m	37	0.36	181	287	0.28	205	-0.85	0.68

This table presents the insider trading characteristics by distinguishing between purchase and sale transactions across both solvent and insolvent firms, made in the three trading periods. Panel A reports the total number of transactions (N) and average transaction size (mean). Panel B reports the average transaction volume per director (mean) and the number of distinct trading directors observed (N). In both panels, the reported mean values are measured in two ways, first as a ratio of the average transaction size to market capitalisation (%) and in sterling values expressed in thousands (£). The significance of mean-differences between solvent and insolvent firms is tested using a *t*-test statistic under the null hypothesis that the mean values of the variables between the two types of firms are equal. ***, **, * indicate that *t*-test is significant at 1%, 5%, and 10% respectively.

Table 3**Descriptive statistics and mean comparisons of the variables used in estimations**

	<i>Full sample</i>		<i>Insolvent</i>	<i>Solvent</i>	<i>t-test</i>
	Mean	Std. dev.	Mean	Mean	
<i>Corporate governance characteristics</i>					
Board size	6.54	2.16	5.70	6.81	4.96***
Board independence	0.51	0.16	0.47	0.52	3.39***
Board ownership	0.13	0.17	0.13	0.13	0.01
Institutional portfolio	0.23	0.30	0.31	0.21	-3.14***
<i>Accounting variables</i>					
Size	17.812	1.892	17.14	18.032	4.5***
Leverage	0.187	0.196	0.279	0.157	-4.98***
Dividend	0.593	0.492	0.342	0.675	6.64***
<i>Market variables</i>					
Return volatility	0.133	0.086	0.171	0.121	-5.67***
Stock return	-0.006	0.598	-0.317	0.096	6.78***
<i>Directors' trading</i>					
NPR <i>0-6m</i>	0.435	0.734	0.703	0.346	-4.66***
NPR <i>6-12m</i>	0.282	0.701	0.238	0.296	0.78
NPR <i>12-24m</i>	0.343	0.773	0.350	0.341	-0.10
No. of trades <i>0-6m</i>	3.259	4.549	3.94	3.036	-1.87*
No. of trades <i>6-12m</i>	2.555	4.283	1.607	2.866	2.78***
No. of trades <i>12-24m</i>	4.884	6.334	2.53	5.655	4.74***
Active insiders <i>0-6m</i>	0.32	0.283	0.513	0.251	-9.46***
Active insiders <i>6-12m</i>	0.24	0.259	0.176	0.256	2.91***
Active insiders <i>12-24m</i>	0.41	0.325	0.321	0.445	3.63***

This table reports the descriptive statistics of the independent variables used in the study. The statistics are provided for the whole sample and insolvent and solvent firms separately. The mean difference t-test compares the mean values of the variables between insolvent and control firms under the null hypothesis that the mean values of the variables across the two sub-samples are equal. ***, **, * indicate that *t*-test is significant at 1%, 5%, and 10% respectively. The definitions of variables are provided in Appendix 1.

Table 4**Logistic regressions: insider trading and the likelihood of insolvency**

	(1)	(2)	(3)	(4)
Board size	-0.218** [0.094]	-0.211** [0.095]	-0.250** [0.105]	-0.280** [0.113]
Board independence	-1.763* [0.970]	-1.843* [0.991]	-1.230 [1.049]	-1.280 [1.138]
Board ownership	-0.140 [0.867]	0.179 [0.906]	0.055 [0.899]	-0.190 [0.957]
Institutional portfolio	1.612*** [0.427]	1.615*** [0.447]	1.785*** [0.463]	1.764*** [0.488]
Size	-0.147 [0.128]	-0.144 [0.130]	-0.180 [0.144]	-0.110 [0.150]
Leverage	3.168*** [0.745]	3.054*** [0.764]	2.982*** [0.800]	2.819*** [0.852]
Dividend	-0.641* [0.333]	-0.723** [0.343]	-0.420 [0.371]	-0.410 [0.389]
Stock return	-1.562*** [0.274]	-1.542*** [0.281]	-1.720*** [0.316]	-1.840*** [0.342]
Return volatility	6.055*** [1.814]	5.796*** [1.936]	6.536*** [2.055]	7.453*** [2.129]
NPR _{0–6m}		0.754*** [0.223]		
NPR _{6–12m}		-0.494** [0.220]		
NPR _{12–24m}		-0.090 [0.202]		
No. of trades _{0–6m}			0.230*** [0.047]	
No. of trades _{6–12m}			-0.170*** [0.057]	
No. of trades _{12–24m}			-0.260*** [0.057]	
Active insiders _{0–6m}				3.604*** [0.623]
Active insiders _{6–12m}				-1.200* [0.657]
Active insiders _{12–24m}				-2.600*** [0.565]
Constant	2.686 [2.121]	2.26 [2.157]	2.669 [2.351]	1.567 [2.445]
N	474	474	474	473
Log-likelihood value	-178.04	-170.38	-153.00	-141.00
Pseudo R ²	0.3279	0.357	0.424	0.465

This table presents the results of the logistic regressions between the dichotomous insolvency variable and the insider trading variables. All models include time and industry dummies. ***, **, * indicate that the estimated coefficient is significant at the 1%, 5%, and 10% levels respectively. Standard errors are reported in brackets. The definitions of variables are provided in Appendix 1.

Table 5**Additional logistic regressions for robustness checks**

	(1)	(2)	(3)	(4)
PR $_{0-6m}$	1.532*** [0.369]	SR $_{0-6m}$ -0.153 [0.436]	No. of purchases $_{0-6m}$ 0.243*** [0.049]	Active Ex $_{0-6m}$ 2.057** [0.809]
PR $_{6-12m}$	-0.765** [0.315]	SR $_{6-12m}$ 0.08 [0.472]	No. of purchases $_{6-12m}$ -0.198*** [0.065]	Active Ex $_{6-12m}$ -0.816 [0.914]
PR $_{12-24m}$	-0.998*** [0.334]	SR $_{12-24m}$ -1.324*** [0.463]	No. of purchases $_{12-24m}$ -0.223*** [0.060]	Active Ex $_{12-24m}$ -1.049 [0.853]
No. of sales $_{0-6m}$				
<i>Constant</i>	1.898 [2.262]	2.541 [2.122]	0.136 [0.156]	Active Non-Ex $_{0-6m}$ 5.317*** [1.038]
N	474	474	-0.008 [0.183]	Active Non-Ex $_{6-12m}$ -2.176* [1.200]
Log-likelihood value	-160.35	-173.02	No. of sales $_{12-24m}$ -0.403*** [0.148]	Active Non-Ex $_{12-24m}$ -3.35*** [1.182]
Pseudo R ²	0.395	0.347	2.727 [2.359]	0.861 [2.451]
			474	474
			-151.4	-144.25
			0.429	0.455

This table presents the results of the additional logistic regressions for robustness purposes. Models 1 and 2 expand Model 2 of Table 4 by distinguishing between the types of transactions. Specifically, in Model 1 NPR is replaced by purchase ratio (PR) defined as the ratio of total volume of purchase transactions made by insiders to total aggregated volume of insider purchases and sales, and in Model 2 sale ratio (SR) is incorporated in a similar manner. Model 3 extends Model 3 in Table 4, also by distinguishing between the types of transactions and includes the number of sales and purchases separately. Finally, Model 4 extends Model 4 in Table 4 by distinguishing between the types of directors, i.e. executive directors (Active EX) proxied by the percentage of active executive trading directors, and non-executive directors (Active Non-Ex) proxied by the percentage of active non-executive trading directors. For brevity, we do not report accounting, market and corporate governance variables that are included in the models as control variables. All models include time and industry dummies. ***, **, * indicate that the estimated coefficient is significant at the 1%, 5%, and 10% levels respectively. Standard errors are reported in brackets. The definitions of variables are provided in Appendix 1.

Table 6**Market reaction to transactions of directors of firms facing insolvency**

	CAR(0;1)	CAR(0;2)	CAR(0;3)	CAR(0;4)	CAR(0;5)
<i>Panel A. Purchases</i>					
0-6m	1.88 ^a	2.27 ^a	1.89 ^b	2.80 ^a	2.95 ^a
6-12m	1.07 ^b	0.85 ^c	0.76	0.55	0.19
12-24m	1.56 ^a	1.34 ^a	2.23 ^a	2.10 ^a	2.26 ^a
<i>Panel B. Sales</i>					
0-6m	-2.05 ^a	-1.71 ^b	-3.13 ^b	-4.90 ^a	-4.80 ^a
6-12m	0.15	1.99	2.73 ^b	2.31 ^c	2.91 ^b
12-24m	0.78	0.05	0.89	0.25	0.24
<i>Panel C. Mean-comparison test</i>					
0-6m	5.25***	3.84***	4.26***	6.39***	6.26***
6-12m	1.46	-0.88	-1.39	-1.24	-1.70*
12-24m	1.33	1.43	1.41	1.84*	1.81*

This table presents mean values of cumulative abnormal returns (CARs) for transactions made by directors of firms facing insolvency. We separately report CARs for purchases (Panel A) and sales (Panel B) across the three periods, i.e. 0-6, 6-12, and 12-24 months prior to insolvency. CARs are estimated for five different intervals, namely CAR(0;1), CAR(0;2), CAR(0;3), CAR(0;4), CAR(0;5) where, for example, CAR(0,3) gives the cumulative abnormal return on the third trading day following the announcement of insider trading, given as day 0. Abnormal returns are estimated on a daily basis in accordance to the procedure outlined in Section 6.2. The mean values presented in both panels (A and B) are tested for significance with application of *t*-statistics, under the null hypothesis that CARs are equal to zero (*a*, *b*, *c*, indicate that *t*-test is significant at 1%, 5%, and 10% respectively). Panel C reports *t*-test on comparison of means under the null hypothesis that the mean values of CARs across purchases and sales in the defined periods are equal (***, **, * indicate that *t*-test is significant at 1%, 5%, and 10% respectively.)

Appendix 1

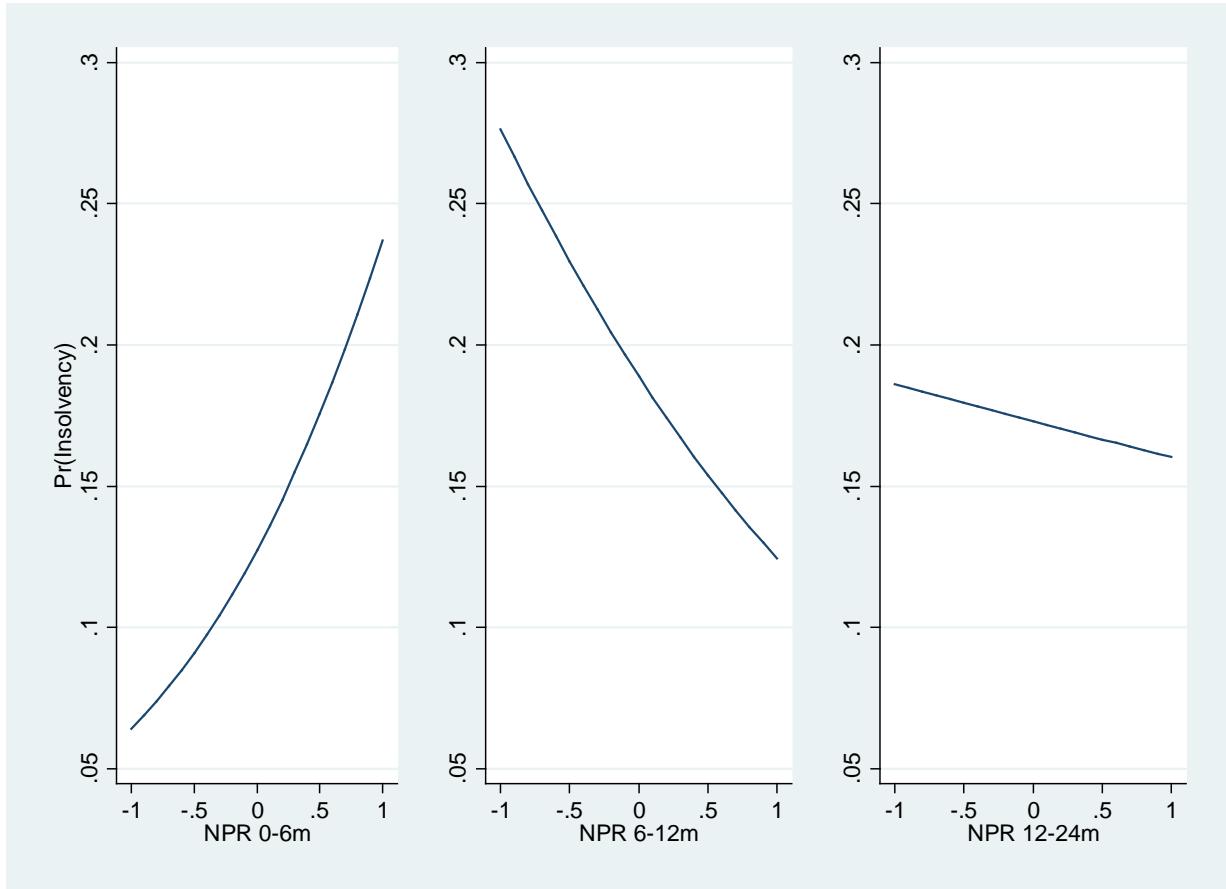
Definitions of variables

Variable name	Definition
<i>Insolvency dummy</i>	Dummy variable that is equal to one if a company enters insolvency procedures and zero otherwise.
Accounting	
<i>Size</i>	Natural logarithm of total assets in constant prices.
<i>Leverage</i>	The ratio of total debt to total assets.
<i>Dividend</i>	Dummy variable that is equal to one if a company pays dividends to its shareholders and zero otherwise.
Market	
<i>Stock return</i>	Aggregated monthly returns minus the aggregated value-weighted monthly FTSE all-share index return in the same year.
<i>Return volatility</i>	Standard deviation of the regression of monthly stock returns in a year on the value-weighted FTSE all-share index for the same year.
Corporate governance	
<i>Board size</i>	Total number of directors on the board.
<i>Board independence</i>	The ratio of non-executive directors to board size.
<i>Board ownership</i>	The percentage holding of executive and non-executive directors.
<i>Institutional portfolio</i>	Average institutional portfolio percentage.
Insider trading	
<i>NPR</i>	Net Purchase Ratio (<i>NPR</i>) is the ratio of the difference between aggregate purchases and sales to the sum of aggregate purchases and sales made by insiders, during: 0–6m six-months period prior to insolvency 6–12m six- to-twelve-months period prior to insolvency 12–24m one- to two-year period prior to insolvency
<i>No. of trades</i>	Total number of purchases and sales made by all insiders during: 0–6m six-months period prior to insolvency 6–12m six- to-twelve-months period prior to insolvency 12–24m one- to two-year period prior to insolvency
<i>Active insiders</i>	The ratio of number of trading directors (who make open market purchases or sales) to board size during: 0–6m six-months period prior to insolvency 6–12m six- to-twelve-months period prior to insolvency 12–24m one- to two-year period prior to insolvency

This table gives the definitions of the variables used in the analysis. The definitions are grouped in four categories, namely accounting, market, corporate governance and insider trading variables.

Figure 1

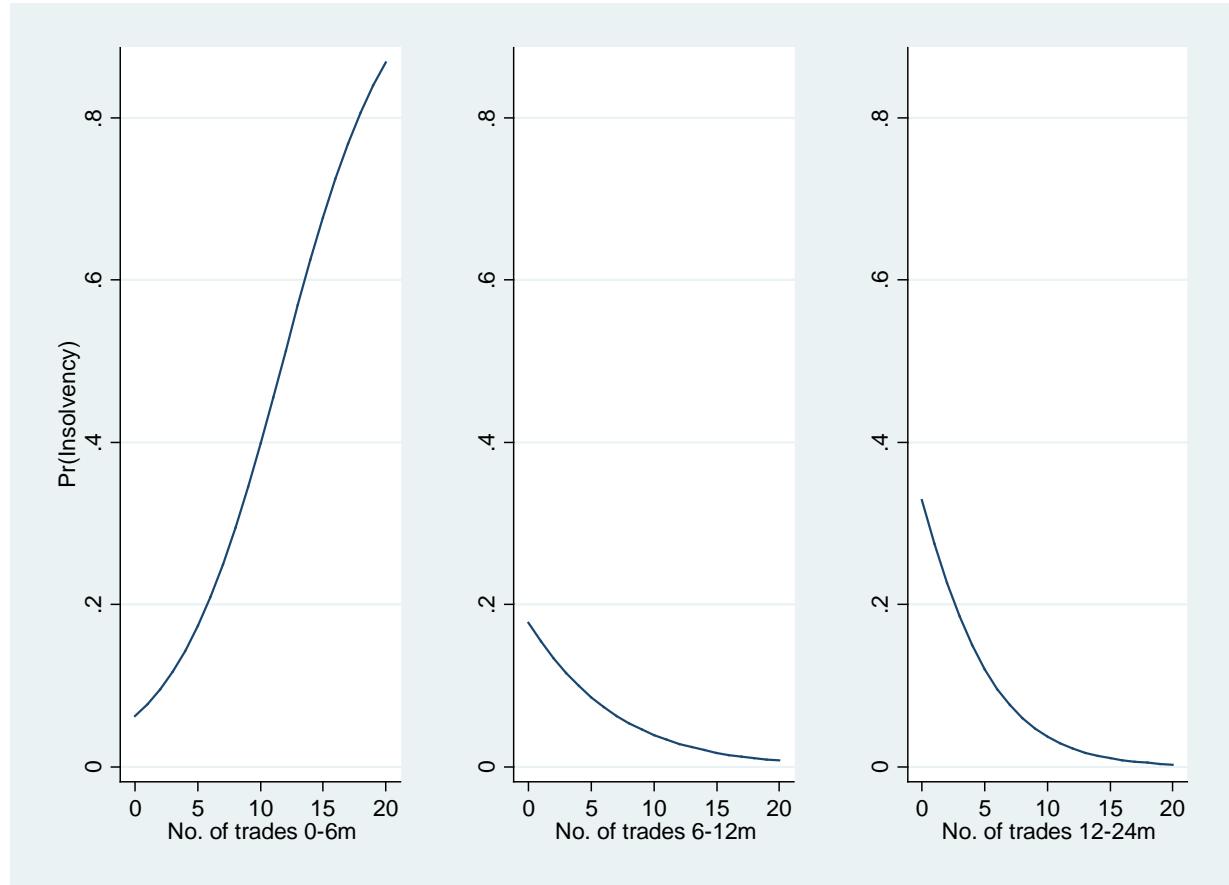
The relationship between probability of insolvency and NPR



The graphs plot the probabilities of insolvency for values of NPR across three windows, i.e. 0–6 months, 6–12 months, and 12–24 months. The probabilities are estimated using the logistic estimates reported in Table 4 (Model 2). The remaining independent variables are evaluated at the sample mean, with the exception of categorical variables (year and industry) that are treated as though they are equally probable. The definitions of all variables are provided in Appendix I.

Figure 2

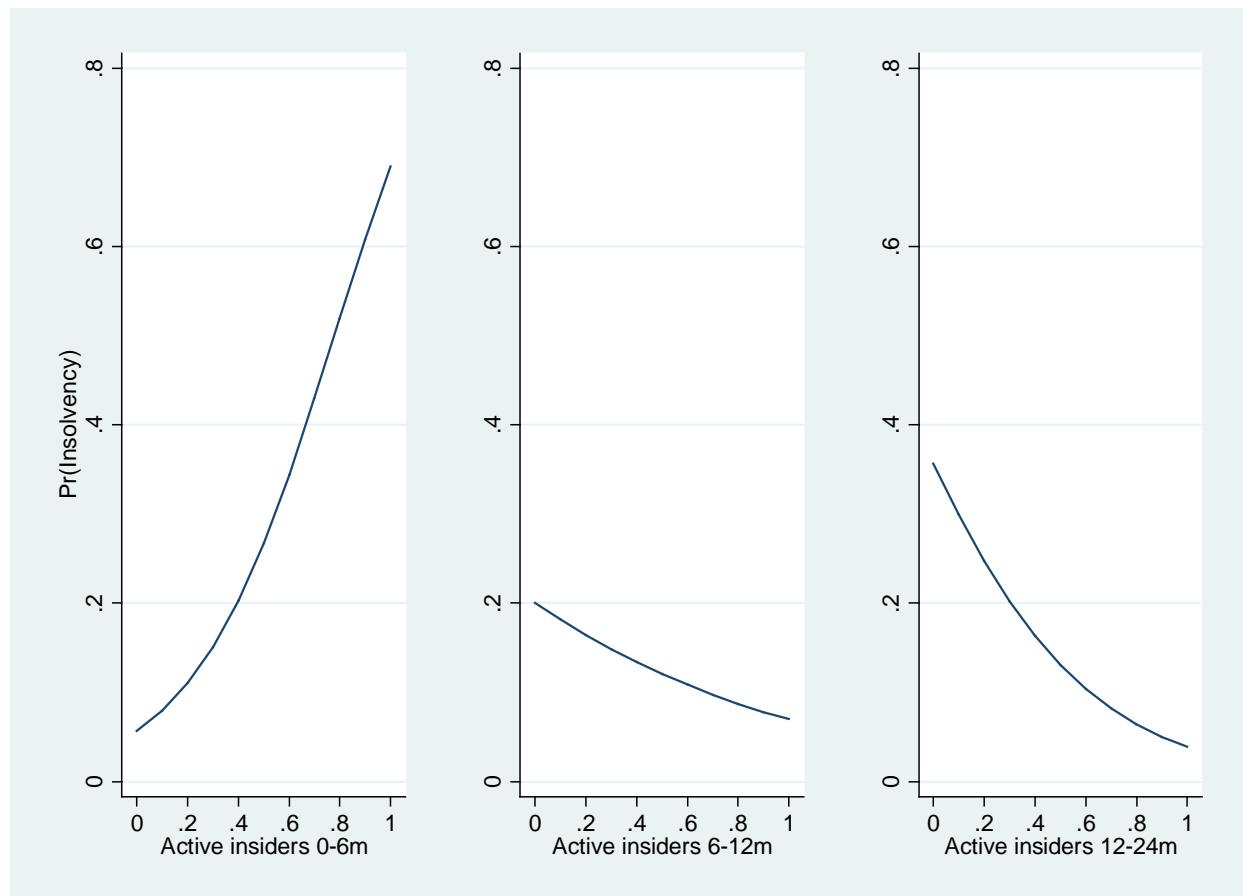
The relationship between probability of insolvency and number of trades



The graphs plot the probabilities of insolvency for values of number of trades across three windows, i.e. 0–6 months, 6–12 months, and 12–24 months. The probabilities are estimated using the logistic estimates reported in Table 4 (Model 3). The remaining independent variables are evaluated at the sample mean, with the exception of categorical variables (year and industry) that are treated as though they are equally probable. The definitions of all variables are provided in Appendix I.

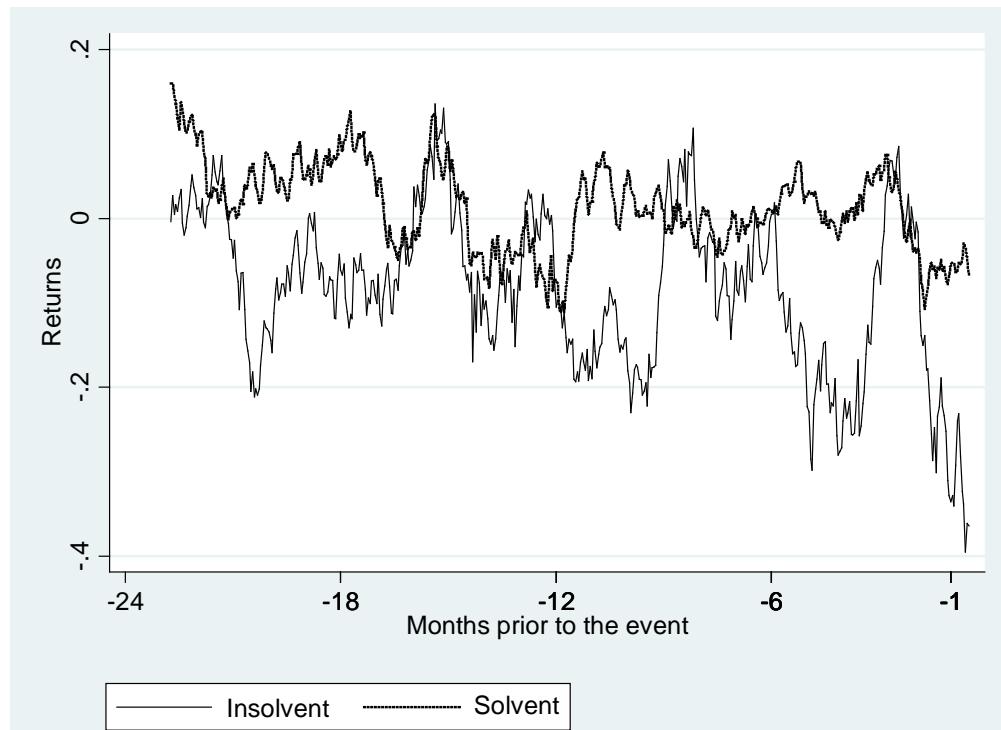
Figure 3

The relationship between probability of insolvency and ratio of active insiders



The graphs plot the probabilities of insolvency for values of active insiders' ratio across three windows, i.e. 0–6 months, 6–12 months, and 12–24 months. The probabilities are estimated using the logistic estimates reported in Table 4 (Model 4). The remaining independent variables are evaluated at the sample mean, with the exception of categorical variables (year and industry) that are treated as though they are equally probable. The definitions of all variables are provided in Appendix I.

Figure 4
Average share price returns of insolvent and solvent firms



This graph reports two trend lines of average market-adjusted returns for the insolvent and solvent firms across the period of 24 months prior to insolvency event. Market adjusted returns are estimated on a daily basis following the procedure outlined in Section 6.1. Each trend line is plotted on the basis of a 22-days moving average. The solid line represents the averaged past returns of insolvent firms. The dotted line plots the averaged past returns of control (solvent) firms in our sample.