The Option and Decision to Repurchase Stock

Rohit Sonika[a*$], Nicholas F. Carline[b], and Mark B. Shackleton[c]

[a] XFI Centre for Finance, University of Exeter, Exeter EX4 4ST, U.K.

[b] Birmingham Business School, University of Birmingham, Birmingham B15 2TY, U.K.

[c] Department of Accounting and Finance, Lancaster University, Lancaster LA1 4YX, U.K.

Abstract

Open market repurchase programs provide firms with the flexibility to manage the cash and risk aspects of their operations. This paper therefore aims to determine whether cash and risk matter only at the implementation stage in the sequence of a repurchase program: announcement, implementation, and withdrawal. We do find that temporary cash and risk measures only affect the implementation decision, while partially negating the traditional signaling effect around program announcement. The relevance of the flexibility afforded by the early announcement of a repurchase program is also evidenced by a steadily increasing time-to-event probability of repurchase implementation and program withdrawal.

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[*] *Corresponding Author:* r.sonika@icmacentre.ac.uk

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I. Introduction

Share repurchases typically offer executives greater flexibility over the timing of cash distributions than dividend payments. This is because when a firm announces an authority to repurchase shares, it gains an option to return cash to its shareholders without any commitment to actually doing so. The extant literature has generally modeled the decision to actually implement a repurchase transaction without conditioning on its position in the sequence of events comprising a repurchase program. In particular, by decoupling these two stages and modeling the implementation likelihood conditional on the preceding announcement of an authority, we attempt to embed into the analysis the optionality inherent in a share repurchase program. The aim of this paper is to determine the most important drivers of decision making at each stage of the repurchase sequence from program announcement through program implementation or non-implementation and, finally, to program renewal or withdrawal.[1] By examining how firm financial characteristics, especially those of cash and risk, evolve before, during, and after such a sequence, we offer new insight into the conditions under which these decisions are taken.

Examining the determinants of repurchase decisions in the UK regulatory setting is important. Under Rule 10b-18 of the Securities and Exchange Commission (SEC), firms in the U.S. are not required to obtain shareholder approval in order to initiate a repurchase program. Additionally, it is not mandatory for firms to announce a program initiation to the market, although doing so is a matter of compliance with stock exchange rules.[2] Furthermore, it is only since 2003 that U.S. firms have been required to report their actual repurchase transactions to the SEC on a quarterly basis. Given the limited disclosure of U.S. firms'

[1] See Comment and Jarrell (1991), Ikenberry, Lakonishok, and Vermaelen (1995), Stephens and Weisbach (1998), and Fenn and Liang (2001) for some examples of independent analyses of different repurchase decisions. Dittmar (2000) makes an early attempt to address the importance of the different objectives of open market repurchases in a unified framework.

[2] Irrespective of whether an announcement is made, firms in the U.S. are protected from litigation through safe harbor provisions under the stock price manipulation specifications of the Securities and Exchange Act of 1934.

intentions concerning repurchase programs, it is of no surprise that the prior literature typically relies on signaling models to analyze these corporate payouts. In such a setting, an authority to repurchase shares will only be obtained by firms most likely to execute it. This is because, as Oded (2005) suggests, if a firm has no intention to repurchase (i.e., it signals falsely), then it exposes itself to the negative costs associated with a higher than intended firm valuation.

In contrast, in the UK, a company's board is required to seek shareholder approval at an Annual General Meeting (AGM) or Extraordinary General Meeting (EGM) for a program of specified length (maximum of 18 months) and scale (typically up to 15% of the company's capital). Once the authority has been granted, the firm can exercise this right without further approval from either the shareholders or the board. However, they must report transactions by the next trading day (unlike within a quarter in the U.S.). The authority is typically renewed on an annual basis owing to its limited validity. Jagannathan and Stephens (2003) argue that in this type of setting, the signaling value of repeat announcements will be reduced, thereby limiting the likelihood that a repurchase program will be motivated by firm undervaluation.[3]

The greater restrictions imposed on UK firms have different implications for signaling value at the initiation and implementation stages of a repurchase program. Ikenberry and Vermaelen (1996) argue that the importance of signaling a higher firm value is diminished when there is a longer delay between the initiation and implementation of a repurchase program. Moreover, if a delay is possible, the early announcement of a program has a more diluted effect on firm value when compared to, in particular, fixed price tender offers as studied by Comment and Jarrell (1991). Thus, while Ikenberry and Vermaelen (1996) describe a repurchase program in the U.S. as a free option, in the UK, they are more accurately described as a marginally constrained, but flexible option to repurchase. These

[3] We thank the referee for this valuable suggestion.

differences between the UK and U.S. are more than regulatory in nature as they also allow us to underline points of debate within corporate payout policy.

The UK setting enables us to fully analyze the sequential and conditional phases that comprise a repurchase program. Specifically, UK firms first choose to initiate an authority, which is identified as the first time a firm seeks approval from its shareholders for a repurchase program, conditional upon having no prior authority. However, since renewal of an authority might incrementally indicate a potential change in payout policy, we also analyze the likelihood of all program announcements (i.e., first initiations pooled with renewals). Once an authority is obtained, firms decide whether or not to exercise the authority to repurchase. In contrast to Oswald and Young (2008), we evaluate the likelihood of implementation only among those firms that already have the authority to do so. The final decision of whether to withdraw an authority can occur either post-implementation or without exercising the authority to repurchase. Therefore, we analyze the withdrawal decision conditional upon having obtained an authority to repurchase reflecting the joint probability of withdrawal with or without the exercise of that authority.

Given that signaling theory is less relevant for UK firms announcing repurchase programs, this regulatory setting is expected to provide a stronger test of the flexibility objectives proposed by Ikenberry and Vermaelen (1996) and Jagannathan, Stephens, and Weisbach (2000). In this paper, we are primarily concerned with two major drivers of the flexibility afforded to firms with the option to repurchase shares. First, Jensen (1986) and others have hypothesized that free cash is likely to be an important determinant of share buy backs since they can assist firms in reducing the associated agency costs. In disentangling the effect of free cash, Guay and Harford (2000) and Jagannathan et al. (2000) find that repurchasing firms are more likely to use temporary changes in cash for open market repurchases, while any changes in permanent levels of cash will make it more likely that the

firms will instead resort to increasing dividends. In addition, Grullon and Michaely (2004) suggest that firms use free cash to repurchase in order to reduce the overall risk of the firm, rather than to improve its performance. As such, the level of systematic and idiosyncratic risk may also be an important determinant of repurchase decisions. We analyze the relative importance of these two measures, cash flow permanence and firm risk, in the open market repurchase process described above.

Without properly accounting for the conditional nature of the different decisions comprising a repurchase program, an analysis of the determinants of each phase is likely to be biased. This is also an issue as the relevance of each determinant in the transition between decision points (authority to implementation, and authority to withdrawal) is likely to vary in degree of importance. In this regard, cash flow and firm risk levels are not expected to influence each and every program decision at their conditional points in time. For example, if firms seek the flexibility afforded by a repurchase program, they will not want their cash flow and firm risk levels to provide any signals to the market when initiating an authority to repurchase shares. Consistent with the early adoption hypothesis proposed by Ikenberry and Vermaelen (1996), firms will only undertake a repurchase transaction when their cash flow and/or risk levels justify it. The impact of flexibility on the withdrawal decision is more difficult to disentangle as it reflects the joint probability of either implementation or non-execution. The standalone probability of program implementation, however, aids the withdrawal decision the closer the program is to its completion. Therefore, post-implementation, firms will have weaker incentives to renew their authorities since the cash and risk drivers that enabled them to buy back shares are likely to have now disappeared. Firms that withdraw without having made any actual repurchases will have lower implementation expectations, thus further reducing the impact of the cash and risk drivers in influencing the program withdrawal decision.

Consistent with our expectations discussed above, we find the decision to announce a repurchase program does not appear to be influenced by either cash or risk. However, surplus cash is significant in influencing a firm's decision to implement a repurchase program, which is consistent with most prior findings (Guay and Harford, 2000; Jagannathan et al. 2000; Oswald and Young, 2008). Furthermore, our results also reveal the importance of idiosyncratic risk to the implementation decision, a negative association that is as important economically as surplus cash. The findings on firm risk extend the results of Grullon and Michaely (2004), who only consider the role of share repurchases in reducing overall firm risk. The importance of cash and firm risk are also evident in a time-to-event model. Surplus cash and firm-specific risk are found to be economically important drivers of share repurchases as they increase the hazard rate (probability of event occurring) of implementation, which, in line with the predictions of Ikenberry and Vermaelen (1996), is more likely to occur three to four years after initiation. Post-implementation, lower permanent cash flows (operating and investing) only are found to drive the withdrawal of a repurchase authority.

The remainder of the paper is organized as follows. Section II discusses the theory behind the drivers of the flexibility objective posited for open market repurchase programs. Section III describes the sample and variables used, while also discussing the repurchase decision models and methodology adopted when addressing our research questions. Section IV presents and discusses our findings for the likelihood and time-to-event (survival) models, examining the effect of the cash and risk drivers at each phase of a repurchase program. Finally, Section V provides our conclusions.

II. Drivers for Repurchase Flexibility

There has been much discussion concerning the validity of the different objectives proposed for share repurchases. As discussed in the previous section, repeat announcements, disclosure timing, and the multiplicity of disclosures around announcements reduce the validity of a signaling argument for open market repurchase programs in the UK. Thus, under UK legislation, the discretion afforded to firms when making decisions concerning repurchase programs is expected to provide a more rigorous test of the flexibility objectives proposed by Ikenberry and Vermaelen (1996) and Jagannathan et al. (2000). In addition, the conditionality of repurchase decisions makes the drivers for flexibility important at specific (not all) sequential stages in a repurchase program. In the following two subsections, we explore the validity of the flexibility arguments from the perspectives of agency costs of free cash flow and firm risk.

A. Cash Flow

An often cited objective behind a firm's decision to repurchase shares in the open market is the availability of free cash flow. This objective is likely to be most prominent among firms that are relatively large and with few investment opportunities (Jensen, 1986). Guay and Harford (2000) and Jagannathan et al. (2000) demonstrate that temporary changes in cash flow are likely to motivate firms to repurchase shares, while also indicating that more permanent changes in cash flow are likely to result in dividend payments. Furthermore, Billett and Xue (2007) identify how firms use transitory cash when making open market repurchase decisions.

In the UK setting, Oswald and Young (2008) identify the conditions (incentive alignment and external monitoring) under which management might reduce the agency problem of free cash flow through share repurchases. They consider the impact of cash on share repurchases on the basis of its operational use in a firm. Their flow measure of cash is

synonymous with the normal use of cash for the operating and non-operating activities of a firm. In contrast, their stock measure, which corresponds to current cash and cash equivalents, relates to cash levels in excess of those required by a firm to conduct its normal activities on an ongoing basis. We use these two measures of cash in light of the temporary cash objective of Guay and Harford (2000) and Jagannathan et al. (2000).

While Oswald and Young (2008) only examine implementations, our analysis centers more on the conditional nature of each decision within an open market repurchase program and how cash, as one of the drivers for flexibility, influences the respective transitions. Cash is not expected to be a systematic determinant of each decision stage of a repurchase program. Ikenberry and Vermaelen (1996) suggest that firms that announce a repurchase program do not face any ongoing costs of signaling, especially when the program is repeatedly renewed. Thus, if the objective behind firms announcing programs early is to avoid signaling costs, then temporary cash is unlikely to be the driver of these announcements. In contrast, and consistent with the findings in the extant literature, temporary cash can guide the decision to repurchase stock since repeat announcements of programs will minimize the signaling effect. Similarly, as firms are unlikely to withdraw programs in the presence of significant cash (Billett and Xue, 2007), cash measures are more likely to be negatively or insignificantly related to the probability of program withdrawal. Although it may be a free option, firms may seek to withdraw an authority if they face a difficult business environment and are unable to generate sufficient cash to make payouts to shareholders. DeAngelo and DeAngelo (1990) argue that retaining an authority at a time of distress could potentially have an impact on a firm's reputation.

B. Firm Risk

As an alternative to the free cash flow hypothesis of Jensen (1986), Grullon and Michaely (2004) propose that when free cash flow is used by firms to repurchase shares, it can have a greater effect on mitigating risk than on improving performance. As firms transition from a high growth to a mature phase in their life cycle, their investment opportunity set shrinks leading to lesser risk, a lower cost of capital, and higher free cash flow. This has the potential to lead to over investment by firms. However, Grullon and Michaely (2004) only associate the impact of risk with systematic changes, and not with an idiosyncratic measure. Therefore, we extend their argument by disentangling the effects of market and firm-specific risk on the different decisions involved in a repurchase program.

As for the signaling argument in the dividend payout research, firms are inclined to announce a repurchase program when they are faced with increased systematic risk in an attempt to mitigate their perceived undervaluation. However, as Ikenberry et al. (1995) and Ikenberry and Vermaelen (1996) argue, it is highly unlikely that all firms will find themselves undervalued at the same time. In contrast, changes in idiosyncratic risk will serve as a signal. Because of this, they are unlikely to be a determinant of program initiation. The same holds true for authority renewals since any value from the announcement signal is strongest at the time of first initiation (Jagannathan and Stephens, 2003). Thus, changes in systematic risk, and not idiosyncratic risk, are a possible driver of program announcements. Consequently, a firm's transition from high growth to a mature phase in its life cycle can lead to lower idiosyncratic risk, providing a motive to repurchase shares in order to avoid overinvestment. Alternatively, firms may seek to repurchase shares in order to increase their investment opportunity set (Ikenberry and Vermaelen, 1996). The preceding discussion attests to the potential importance of idiosyncratic risk at the implementation stage only in a repurchase program.

Similarly, the drivers for flexibility can also motivate program withdrawal. Firms may be inclined to withdraw an authority when they face negative systematic and idiosyncratic risks, bringing them close to financial distress. However, the impact of the risk drivers on program withdrawal is more likely to be prominent when firms engage in implementation prior to withdrawal or during the life of the authority. As firms in the UK incur little or no costs in obtaining authorities to repurchase shares, program withdrawals are likely to be rare events. Notwithstanding the potentially long period between initiation and withdrawal of an authority, firms that have a higher implementation probability based on the risk drivers are also likely to see an impact on their withdrawal decisions. In contrast to those firms that implement an authority, repeated renewals in the absence of implementation can lessen the importance of the risk drivers. As such, the risk measures may be positively or insignificantly associated with the withdrawal decision probability for these firms.

We define the proxies for the cash and risk drivers for the flexibility of repurchase programs in the next section.

III. Data and Methodology

A. Sample Selection and Data Sources

As discussed in Section I, in the UK, repurchase authorities are usually obtained through either AGM or EGM notices, the particulars of which are distributed to the shareholders. Additionally, the latest time for firms to disclose their repurchase executions is the trading day following the original repurchase day. Information on this latter decision component, which we use to ascertain the likelihood and speed of repurchase implementation, is not readily available through secondary sources. Thus, to capture the

entire decision process, we independently gather information on repurchase authorities and implementation, as well as program withdrawals, from Perfect Information (PI).[4]

We follow Rau and Vermaelen (2002) in using the Securities Data Company (SDC) database to obtain a list of UK public companies with announcements of repurchase programs.[5] Although the SDC database is prone to some bias toward firms with higher implementation rates (Banyi, Oyl, and Kahle, 2008) and lower announcement period returns (Oswald and Young, 2004), other important control variables, such as firm size, do not depend upon the choice of this database. Using SDC yields a list of 196 UK companies (excluding financials and utilities) who have obtained a repurchase authority from 1990-2010. Through the use of AGM and EGM notices, as well as daily repurchase disclosures that fall within the sample period, we construct two datasets for the sample firms. We first pool all of the firm years from 1990-2010 during which the sample companies are active. This pooled sample comprises 2,762 firm years, which includes 1,923 firm year observations of repurchase authority announcements (including authority renewals). We subsequently identify 10,623 disclosures of daily repurchase executions, which, in order to avoid the use of different time scales and to present a consistent methodology, we aggregate into firm year totals. We obtain accounting and financial information through Datastream/Worldscope (DW). The construction of the cash and risk variables is discussed in the next two subsections. Definitions for all primary and control variables, together with the relevant DW codes, are provided in Table I.

Insert Table I about here.

[4] PI is a database of primary documents released by a firm as part of its legal disclosure to the Regulatory News Services (RNS) in the UK.

[5] SDC incorporates announcements of programs (either completed, pending, status unknown, tentative, or withdrawn), limited to repurchases of at least 5% of a company's total shares outstanding or 3% of a company's shares if the transaction value is $1 million or more.

B. Computing Cash Flow Measures

We follow Oswald and Young (2008) in using two proxy measures for cash. The flow components are intended to capture the use of cash in daily business activities (operating and investing), while a stock measure encapsulates cash levels in excess of operating and investing requirements. We measure the separate flow components as excess cash flow from operating and investing activities. These excesses are computed based on the difference between current scaled cash flow and the average of the lagged and forward-looking measures of scaled cash flow. For the stock measure, we first compute Equation (1) using a standard linear regression framework for each year in the sample period (1990-2010). Surplus (temporary) cash is then estimated for each firm year as the residual (ε_i) from the equation.

$$CCTA_i = \gamma_0 + \gamma_1 LTA_i + \gamma_2 FCF_i + \gamma_3 WC_i + \gamma_4 LEV_i + \gamma_5 RDSL_i + \gamma_6 MTBV_i + \gamma_7 DPDummy_i + \varepsilon_i \quad (1)$$

In Equation (1), cash and cash equivalents ($CCTA_i$) is cross-sectionally regressed on measures of firm size (LTA_i), free cash flow (FCF_i), working capital requirements (WC_i), firm leverage (LEV_i), research and development expenses ($RDSL_i$), investment opportunity ($MTBV_i$), and a dummy variable indicating a dividend paying firm ($DPDummy_i$).

We also construct a dummy variable to control for the agency cost of free cash flow, as generally proposed by Jensen (1986). The *Agency* indicator variable identifies firms that have (operating) free cash above the industry median, while also having investment opportunities below the industry median level. Oswald and Young (2008) stress the importance of agency-based measures in ascertaining the probability of repurchase implementation. However, since we model dependence between successive decisions in

repurchase programs, it is essential, and possible, to consider whether agency issues are persistent for decisions beyond that of obtaining an authority to repurchase shares.

C. Computing Risk Measures

Grullon and Michaely (2004) argue that the rationale for share repurchases may have more to do with managing risk than in utilizing cash to improve firm performance. Therefore, it is important to simultaneously consider how market-related and firm-specific risks influence the probability of successive decisions in repurchase programs. To disentangle the impact of risk, we employ the Fama-French (1993) three-factor model in a panel regression framework as provided in Equation (2).

$$Return_{i,t} - RF_t = \theta_1 RMRF_{i,t} + \theta_2 SMB_{i,t} + \theta_3 HML_{i,t} + \varepsilon_{i,t} \quad (2)$$

In Equation (2), the risk-adjusted firm annual return ($Return_{i,t} - RF_t$) is regressed on the market premium ($RMRF_{i,t}$), the difference in return between small and large firms ($SMB_{i,t}$), and the difference in return between value and growth firms ($HML_{i,t}$).[6]

Systematic risk is then computed as the standard deviation of the explained component of Equation (2), which captures the non-diversifiable component of overall risk. Additionally, unsystematic (idiosyncratic) risk is estimated as the standard deviation of the error term ($\varepsilon_{i,t}$) reflecting the firm-specific drivers of investment and financing decisions not captured by the specification of the three-factor model.

D. Research Methodology

[6] Data on the UK specific factors of the regression were obtained from http://business-school.exeter.ac.uk/research/areas/centres/xfi/research/famafrench/. See Gregory, Tharyan, and Christidis (2009) for a detailed description regarding their computation.

Figure I illustrates the importance of modeling dependence between successive decisions in UK repurchase programs.

Insert Figure I about here.

The initial standpoint from which all subsequent decisions are conditional is the initiation of an authority to repurchase shares in the open market. Firms enter the sample without any authority to repurchase stock. Having obtained such an authority, a firm moves from a state with no authority (*State 1*) to one with authority (*State 2*), as illustrated by *Path 1* in Figure I. This initial transition accounts for 174 observations from the 1,923 total firm years with repurchase authorities. We are primarily interested in these 174 cases of authority initiation, relative to the 839 firm years with no authority.[7] However, we additionally pool initiations and renewals of authority in a similar panel setup with the same control firm years.

We model the likelihood that a firm will obtain an authority using Equation (3).

$$
\begin{aligned}
&Logit(\Pr(AuthAnn.)\,|NoAuth.) \\
&\quad = \beta_1 SCA_{i,t} + \beta_2 ECFO_{i,t} + \beta_3 ECFI_{i,t} + \beta_4 Agency_{i,t} + \beta_5 SRisk_{i,t} \\
&\quad + \beta_6 IRisk_{i,t} + \beta_7 LTA_{i,t} + \beta_8 LEV_{i,t} + \beta_9 MTBV_{i,t} + \beta_{10} DP_{i,t} \\
&\quad + \beta_{11} DPDummy_{i,t} + \beta_{12} EPS_{i,t} + \beta_{13} EPSDummy_{i,t} + \beta_{14} LRET_{i,t} \\
&\quad + \omega_i + \varphi_t + \varepsilon_{i,t} \qquad (3)
\end{aligned}
$$

In Equation (3), the binary decision of authority announcement, conditional upon no prior authority, is regressed against the proxies for surplus cash ($SCA_{i,t}$), excess operating

[7] The 174 initiation firm years are lower than the 196 companies in the sample, owing to left censoring around the year 1990 of companies that were active before the start of the sample period. The 839 firm years with no authority are obtained by subtracting the 1,923 firm years with repurchase authorities from the total 2,762 firm years in the sample period.

cash ($ECFO_{i,t}$) and excess investing cash ($ECFI_{i,t}$), and the indicator variable for firms with potential agency problems linked to free cash flow ($Agency_{i,t}$). The Logit regression also includes the proxies for systematic ($SRisk_{i,t}$) and idiosyncratic ($IRisk_{i,t}$) risk. Finally, we add the standard control variables of firm size ($LTA_{i,t}$), firm leverage ($LEV_{i,t}$), investment opportunity ($MTBV_{i,t}$), dividend payout ratio ($DP_{i,t}$) and a control for its non-linearity ($DPDummy_{i,t}$), earnings per share ($EPS_{i,t}$) and a control for its non-linearity ($EPSDummy_{i,t}$), and three-month lagged firm price returns ($LRET_{i,t}$). The specification also includes firm (ω_i) and year (φ_t) fixed effects.

A firm is not obliged to repurchase shares in the open market during the life of an authority. However, any repurchase transactions that do occur need to be disclosed by the next trading day and, subject to trading restrictions, these executions can occur on a regular basis. This implementation transition is illustrated in Figure I, where a firm in *State 2* (i.e., with an authority) follows *Path 2.1* (implementation) if it chooses to repurchase; otherwise, it follows *Path 2.2* (no implementation).[8] Using Perfect Information, we are able to identify 10,623 repurchase executions for 159 firms in the sample.[9] We use the number of repurchase days (as a proportion of the number of trading days in a calendar year), the number of shares repurchased (as a proportion of the total shares outstanding), and the total value of the shares repurchased (as a proportion of the firm's market value) to annually aggregate the implementation data. We model the implementation transition using Tobit Equation (4), with left censoring at zero.

[8] The decision to implement/not implement is not a state in Figure I, as this decision can be taken at any time during a fiscal year, after which a firm returns to its original state, with authority.
[9] The number of firms that implement is lower than the 176 firms in the sample as some firms choose not to repurchase shares.

$$Tobit(\Pr(Imp.)\,|AuthAnn.)$$

$$= \beta_1 SCA_{i,t-1} + \beta_2 ECFO_{i,t-1} + \beta_3 ECFI_{i,t-1} + \beta_4 Agency_{i,t-1}$$

$$+ \beta_5 SRisk_{i,t-1} + \beta_6 IRisk_{i,t-1} + \beta_7 LTA_{i,t-1} + \beta_8 LEV_{i,t-1}$$

$$+ \beta_9 MTBV_{i,t-1} + \beta_{10} DP_{i,t-1} + \beta_{11} DPDummy_{i,t-1} + \beta_{12} EPS_{i,t-1}$$

$$+ \beta_{13} EPSDummy_{i,t-1} + \beta_{14} LRET_{i,t-1} + \omega_i + \varphi_{t-1} + \varepsilon_{i,t-1} \qquad (4)$$

In Equation (4), we consider the likelihood of implementation conditional upon having initiated an authority in the past by using the restricted sample of 1,923 firm years with a repurchase authority. The specification used here is similar to Equation (3), although the explanatory variables are time lagged. This is because, unlike authority announcements, repurchase transactions can occur over a period of time after their original announcement. Thus, when we aggregate information, which is forward looking, we need to consider the lagged effect of the independent variables.

Since authorities for open market programs entail no commitment, the decision to withdraw depends jointly on implementation or non-implementation. The UK regulatory framework enables us to identify instances when the withdrawal of an authority occurs, which is most often when a firm decides not to renew an existing repurchase authority. This marks the transition from *State 2* to *State 3*, represented by *Path 3*, in Figure I. In our sample, we are able to identify 76 firm years where repurchase authorities are withdrawn.[10] We use the withdrawal firm observations and control for each with the identified firms' announcement years only, resulting in a total of 348 firm year observations. Similar to the decision to obtain an authority, the withdrawal decision is a binary outcome, the likelihood of

[10] This number is lower than the 196 firms present in our sample for two reasons. First, not every firm chooses to withdraw at all during the entire sample period. These firms are right censored in our regression. In addition, some firms choose to withdraw, but later reintroduce an authority within three years of last renewal. We exclude these cases from our subsample.

which we are able to assess in the presence of the cash, risk, and control variables using Logit Equation (5).

$$
\begin{aligned}
&Logit(\Pr(With.)\,|AuthAnn.) \\
&\quad = \beta_1 SCA_{i,t} + \beta_2 ECFO_{i,t} + \beta_3 ECFI_{i,t} + \beta_4 Agency_{i,t} + \beta_5 SRisk_{i,t} \\
&\quad + \beta_6 IRisk_{i,t} + \beta_7 LTA_{i,t} + \beta_8 LEV_{i,t} + \beta_9 MTBV_{i,t} + \beta_{10} DP_{i,t} \\
&\quad + \beta_{11} DPDummy_{i,t} + \beta_{12} EPS_{i,t} + \beta_{13} EPSDummy_{i,t} + \beta_{14} LRET_{i,t} \\
&\quad + \omega_i + \varphi_t + \varepsilon_{i,t} \qquad (5)
\end{aligned}
$$

In addition to the likelihood models described above, the structure of the UK disclosure environment also enables us to consider the survival functions for firms that implement and withdraw their repurchase authorities in our sample period. We utilize the annual renewal process of repurchase programs in the survival models to ascertain whether firms implement or withdraw each year. In the case of implementation, this analysis enables us to incorporate a firm's ability to repurchase shares multiple times, rather than just once, as is the case with a standard discrete-time survival model. In the case of withdrawals, repetitions of such actions are not considered and firms drop out of the sample once an authority is terminated. Thus, the survival functions for both repurchase implementation and program withdrawal are assessed using a semi-parametric Cox proportional hazard model, with intensity $\lambda(t)$, through Equation (6).

$$\lambda(t) = \Pr(t \leq T \leq t+1 | T \geq t)$$
$$= \phi_1 SCA_{i,t} + \phi_2 ECFO_{i,t} + \phi_3 ECFI_{i,t} + \phi_4 Agency_{i,t} + \phi_5 SRisk_{i,t}$$
$$+ \phi_6 IRisk_{i,t} + \phi_7 LTA_{i,t} + \phi_8 LEV_{i,t} + \phi_9 MTBV_{i,t} + \phi_{10} DP_{i,t}$$
$$+ \phi_{11} DPDummy_{i,t} + \phi_{12} EPS_{i,t} + \phi_{13} EPSDummy_{i,t} + \phi_{14} LRET_{i,t}$$
$$+ \omega_i + \varphi_t + \varepsilon_{i,t} \quad (6)$$

In Equation (6), *T* corresponds to the time-to-event, where the event in question is either implementation or withdrawal, and *t* relates to the time of the decision to initiate an authority that all subsequent decisions are conditional upon. The likelihood of implementation or withdrawal is adjudged on the basis of the occurrence of such an event in any given year. The importance of the regressors in the hazard model above will be revealed by their role in increasing the likelihood of implementation or withdrawal in any given time frame. The cash and risk variables, and the standard control factors, are used in the same manner as in Equations (3) and (5).

E. Descriptive Statistics

Table II provides some descriptive statistics for our sample of UK open market repurchase programs.

Insert Table II about here.

Cluster-robust *t*-test and Wilcoxon rank sum test results are also presented for differences in means and medians, respectively, (Wooldridge, 2010) across sample groups that are partitioned according to the different decision paths (announcement, implementation, and withdrawal). The initiation (first authority) and overall announcement (first and renewed

authorities) subsamples compare differences in means and medians between announcement and prior non-announcement firm years. The implementation subsample compares firm years with implementation against those with announcements, but no implementation. Finally, the withdrawal subsample compares firm years with withdrawals against all of those with announcements.

First, we consider differences in means and medians of the cash components across the sample groups. The most prominent and consistent differences are for surplus cash, but only for the implementation and withdrawal subsamples. These differences reveal a significantly higher (lower) value for firms that implement (withdraw). While we also observe similar differences in the excess cash variables, they are not consistently significant across both mean and median. The *Agency* dummy mean and median are also found to be significantly higher (lower) for the implementation (withdrawal) subsample. This suggests that firms that implement are at risk of otherwise overinvesting their excess cash.

Examining the firm risk components across the sample groups yields similar results to those of the cash variables. In contrast to Grullon and Michaely (2004), we find that the implementation (withdrawal) subsample has significantly lower (higher) systematic and idiosyncratic risk. Although we also observe some significance for idiosyncratic risk in the initiations subsample, the univariate findings for cash and risk are broadly in line with our expectation that, in the UK, the motivation behind announcing an open market repurchase program is less about immediate signaling and more about giving firms the flexibility to manage these aspects of their operations at an appropriate point in time. The control variables, with the exception of firm leverage and three-month lagged returns, differ significantly across the sample groups, justifying their inclusion when modeling the likelihood of different repurchase decisions.

IV. Likelihood of Repurchase Decisions

In this section, we present the results for conditional likelihood regressions of firms undertaking announcement, implementation, and withdrawal decisions. Using a conditional regression model in a setup that is multi-path has potential specification issues as conditional probabilities further down the chain can be affected by the marginal probabilities of earlier decisions (Train, 2009). Therefore, we also consider a type-II likelihood model for both implementation and withdrawal decisions. Our tests largely reveal insignificant differences between the two specifications for both decisions.[11]

A. Likelihood of Program Announcement

First, we employ the specification of Equation (3) to analyze the overall sample of firms that make program announcements (Column (1) of Table III). Using a similar specification, we also consider the subsample of firm years for which the announcement is the first time an authority was sought to repurchase shares (Column (2) of Table III).

Insert Table III about here.

Consistent with our univariate results, we do not observe any significance across the temporary and permanent measures of cash in either specification. This suggests that program announcements do not signal the presence of abnormal cash levels in a firm and aligns with our expectation that firms do not necessarily announce intentions to repurchase immediately. Additionally, we find a negative coefficient on the agency dummy in Column (1) indicating an economic and statistical significance of 3.2% lower probability of an authority

[11] We also compute a correlation matrix to capture the univariate relations between the variables in our sample. As expected, the two risk variables are highly collinear. Checking for multicollinearity by separately excluding each risk component does not change the statistical and economic significance of our findings. The same applies for the cash variables. The correlation matrix and modified regression results are available upon request.

announcement for firms with potentially more acute agency problems.[12] However, this variable does not retain significance when considering program initiations alone in Column (2), thus providing further support for the notion that firms first obtain an authority when they are least expected to repurchase.

Also consistent with our expectations, we find that neither the systematic nor idiosyncratic components of firm risk influence the decision to initiate (or announce) an authority. The insignificance of the cash and risk variables emphasizes the flexibility that firms seem to value when considering the adoption of open market repurchase programs. The univariate test results for idiosyncratic risk (Table II) are in contrast to our multivariate findings here indicating the relevance of controlling for other determinants of program announcements.

With respect to the control variables used in the specifications, we find that firm size is significantly related to the decision to obtain an authority. Economically, we find that a one standard deviation increase in firm size increases the probability of program announcement by approximately 24.5%, which is consistent with the agency argument.[13] However, we do not find any statistical significance for the investment opportunity set (proxied by the market-to-book ratio). We also find evidence contrary to the objective, often cited by firms for obtaining an authority to repurchase shares, of improving earnings per share.

B. Likelihood of Repurchase Implementation

Obtaining an authority to repurchase shares in the open market is different from actually buying back stock. While a firm is not obligated to undertake a repurchase transaction, it is essential to condition the implementation decision on the existence of the

[12] All probabilities are computed by multiplying the instantaneous marginal effect coefficients by their respective standard deviations, as shown in Table II.
[13] In a different context, Vermaelen (1981) and Comment and Jarrell (1991) find that small firms are more likely to use tender offers due to the signaling effect.

underlying authority to do so. We use three alternative variables to model the conditional likelihood of the implementation decision as described in Section III. To simplify our analysis, we aggregate the detailed daily information into annual totals. These scaled totals then become the dependent variables in our likelihood analysis using Equation (4). The results are presented in Table IV.[14]

Insert Table IV about here.

Our results for the cash and risk variables are essentially the same across the three different proxies for implementation. Consistent with the flexibility objective, we find that firms choose to implement when they have significant surplus cash and, as such, are more prone to free cash flow agency problems. In economic terms, for a one standard deviation shift in surplus cash, we observe a significant increase in implementation probability by eleven trading days. For an equivalent change in surplus cash, we find a significant increase of 3.7% (3.3%) in the proportional number of (value of) shares repurchased.

The *Agency* dummy captures the importance of free cash in share repurchases when firms have fewer investment opportunities, thus increasing the likelihood of overinvestment. There is a positive and statistically significant correlation between this variable and the likelihood of implementing a repurchase. In terms of economic significance, there is an increase of sixteen repurchase days when a firm is classified as having potential agency problems (*Agency* = 1). This status also leads to a 6.5% (5.2%) increase in the proportional number (value) of shares repurchased. This finding is broadly in line with those of Guay and Harford (2000), Jagannathan et al. (2000), and Oswald and Young (2008). However, our results applies after conditioning the likelihood of implementation on the presence of having

[14] The number of observations used here (1,847) is marginally lower than the total number of announcement firm years (1,923) as some observations fall out of the sample owing to missing data.

an authority to so. Also, we quantify the magnitude of the change in implementation probability relative to changes in the measures of cash.

The agency problem of free cash and the overinvestment issue also imply an increase in repurchase probability when firms have significantly lower idiosyncratic risk. Moreover, Ikenberry et al. (1995) and Grullon and Michaely (2004) argue that an increase in market-related risk, associated with firm cash levels, can lead to firms being potentially misvalued providing them with an incentive to repurchase shares. Our findings in Table IV align with both of these predictions. In terms of economic significance, a one standard deviation increase in idiosyncratic risk leads to twelve fewer repurchase days or a 4.6% (4.1%) reduction in the number (value) of shares repurchased. Furthermore, a one standard deviation increase in systematic risk leads to an equivalent proportional increase in the number and value of shares repurchased. Although the results for systematic risk in Column (1) of Table IV are statistically insignificant, economically it amounts to five extra repurchase days for a one standard deviation change in systematic risk. The findings for idiosyncratic risk are consistent with the univariate results presented in Table II, whereas those for market-related risk are reversed.

With respect to the control variables, we determine that larger firms are more likely to implement repurchases. However, similar to our findings for repurchase announcements, we do not find any statistical significance for the investment opportunities proxy. We also find that implementing firms are under-leveraged suggesting that if a target leverage exists, firms will seek to repurchase shares in order to increase this ratio (Dittmar, 2000). Additionally, our findings do not fully corroborate the notion that firms announce programs with the intention of improving earnings per share (*EPS*). While the EPS variable itself is insignificant, a dummy variable identifying firms with positive EPS (*EPSDummy*) results in 86 fewer repurchase days and a 30.5% lower implementation probability for these firms (based on

repurchase value). Thus, while firms may not initiate authorities based on EPS levels, repurchase implementation seems to occur when EPS turns negative. This finding further highlights the flexibility afforded to firms by having a repurchase authority in place.

C. Likelihood of Program Withdrawal

Unless voluntarily undertaken, firms do not explicitly announce their intention to lapse or withdraw an existing repurchase authority. Nevertheless, the sequential nature of repurchase decisions in the UK means that program withdrawal can be identified as the first year in which an authority is not renewed. As such, the decision to withdraw a repurchase program is conditional upon the joint probability of implementation or non-implementation. However, to permit a more comprehensive analysis, we first consider the overall case of withdrawals conditional upon program announcements, and then the two subsamples based on implementation. We analyze the likelihood of these events using Equation (5). The results are expressed in Table V.

Insert Table V about here.

In the absence of ongoing signaling costs, firms are expected to repeatedly renew their repurchase authorities unless structural changes in their operating environment occur. As observed in Column (1) of Table V, none of the cash and risk variables have any significance in terms of explaining program withdrawal per se. Note that these results differ from the univariate findings in Table II, highlighting the relevance of the control variables. Although we find significance for some of the control variables, only leverage and the dividend payout dummy remain consistent across Columns (1) and (2). The finding for the payout dummy emphasizes the importance of dividends to a firm's overall payout policy. Specifically, the

results indicate that if a firm starts to pay dividends, then the likelihood of program withdrawal drops by 12%.

The motivation behind a decision to withdraw a program post-implementation is likely to be somewhat stronger than if there has been no implementation. Our findings in Columns (2) and (3) of Table V provide support for this conjecture. Post-implementation, we find that only the flow measures of cash have a significant (at the 10% level) influence on the decision to withdraw. This amounts to a 4.7% and 5.6% decline in the likelihood of program withdrawal for a one standard deviation increase in excess operating and investing cash, respectively. The importance of the risk variables is also subdued, with both the systematic and idiosyncratic drivers lacking any significance. Thus, while risk seems to be as relevant a determinant as cash for the implementation decision, only flow measures of cash sustain relevance for the decision to renew or withdraw an authority. In the absence of implementation, the cash and risk drivers do not influence the withdrawal decision. Although the results are robust to different specifications, care is needed in their interpretation as the sample selection process yields a relatively small withdrawal dataset.

D. Hazard Analysis of Repurchase Implementation and Program Withdrawal

To reinforce the findings from the likelihood regressions, we also perform a hazard analysis of program implementation and withdrawal.[15] Using Equation (6), we are able to consider the importance of the cash and risk measures and other control variables that drive a firm to time repurchase decisions following a program announcement. As for the earlier likelihood models, the implementation decision accounts for multiple repurchases during the life of an authority, while program withdrawal is treated as a one-time only decision. Our standard hazard model findings are presented in Table VI.

[15] Also known as a survival function, this analysis evaluates the cumulative probability of a hazard or event not occurring. It is also called a time-to-event analysis.

Insert Table VI about here.

Consistent with the likelihood models in Table IV, in Column (1) of Table VI, we continue to find that surplus cash, the agency dummy, and idiosyncratic risk play a role in guiding the decision to repurchase shares. A one standard deviation increase in surplus cash leads to an 8.2% increase in the probability of implementation, while for those firms classified as having potential agency problems, there is an increase in the same probability by nearly 20%.[16] We also find that the risks associated with over investment are as important as surplus cash in the timing of implementation decisions. A one standard deviation change in idiosyncratic risk reduces the probability of implementation by 20%. The control variables also yield qualitatively similar results to those presented in Table IV.

Panel A of Figure II illustrates the non-implementation survival curve for firms with repurchase authorities. The likelihood that a firm will keep an authority active without implementation remains over 70% until four years after initiating the authority. However, this probability falls sharply after eight years to about 25% and to 20% after ten years. As such, consistent with the early adoption hypothesis of Ikenberry and Vermaelen (1996), firms are more likely to announce their repurchase programs some time ahead of when they plan to actually implement them.

Insert Figure II about here.

Column (2) in Table VI presents our results for repurchase withdrawals in the context of a survival function. Reinforcing our findings for the associated likelihood models (Table

[16] Although the findings have greater economic significance when compared to the equivalent results presented in Table IV, it is important to note that the hazard model uses a dummy variable to account for all implementations within a given year.

V), all of the cash and risk measures have no bearing on the time-to-withdrawal probability of a repurchase authority. The findings for the control variables are also essentially consistent with those in Table V. The one difference we observe is the significance of the continuous dividend payout variable, which indicates a higher withdrawal probability for increases in dividend payouts. This is puzzling in the context of overall payout policy as the importance of permanent cash in dividends (Jagannathan et al., 2000) renders open market programs of secondary importance. Notwithstanding, the dummy indicator of dividend payout continues to imply a negative association with withdrawal probability.

Panel B of Figure II illustrates the non-withdrawal survival function for firms with repurchase authorities. From the smooth trend observed, we infer that firms continue to renew their authorities for an extended period of time. The likelihood that a firm will continue to renew four years after an authority is first initiated is over 80%. This probability only falls to 50% after ten years implying that firms face limited constraints when obtaining authorities to repurchase shares in the open market.

V. Conclusion

Open market repurchase programs provide firms with the flexibility to buy back shares at their discretion without any commitment to do so. This calls into question the signaling ability of program announcements, while giving more credence to the idea that repurchase programs are motivated by the flexibility afforded to firms in managing their cash and risk environment. In addition, a repurchase program entails a sequence of decisions. Firms must first announce their potential to repurchase, before deciding whether to exercise their authority to do so. Finally, they need to decide whether to withdraw the program. The contribution of this paper is to model the likelihood and hazard rates of these sequential and

conditional decisions. This permits us to more robustly examine the extent to which cash and risk are important drivers of each decision comprising a repurchase program.

Consistent with the expectations of Ikenberry and Vermaelen (1996), we find that firms concerned about minimizing the signaling costs associated with program announcements are unlikely to have cash flow levels influencing that decision. However, surplus levels of cash are uniformly found to influence a firm's decision to implement an authority. Additionally, our findings indicate a limited influence of cash in the decision to withdraw an authority, conditional upon whether any implementation was undertaken during the life of a program.

As an alternative to the free cash flow hypothesis, Grullon and Michaely (2004) suggest that firms are driven to repurchase shares in order to reduce their risk exposure rather than to improve their operating performance. Our findings confirm their predictions that firms are more likely to implement (but not announce) programs when exposed to higher systematic risk and lower idiosyncratic risk. The result for idiosyncratic risk is as economically important as the implementation finding for surplus cash. As for the announcement decision, neither component of firm risk appears to influence the decision to withdraw a repurchase program.

The sequential nature of repurchase decisions and the degree of disclosure in the UK also enable us to investigate the time-to-event probability of repurchase implementation and program withdrawal (since initial authority). This analysis is able to directly test the predictions of Ikenberry and Vermaelen (1996), who propose that firms adhere to an early adoption strategy in order to avoid a costly repurchase that would result from an increase in the share price. Their prediction explicitly highlights the importance of a delay in authority implementation. Our findings are consistent with this hypothesis, emphasizing the importance of cash and risk drivers in increasing the chance of implementation three to four years after

initiating an authority. However, the probability of program withdrawal remains relatively low. This is likely a result of the negligible cost involved in obtaining or renewing authorities.

Our findings on the conditional nature of repurchase decisions provide new and richer insight in to the cash and risk drivers extensively documented in the extant literature. Future research might address the significance and consequence of the very different regulatory regimes in the U.S. and UK when analyzing open market repurchase programs within a conditional framework similar to that used in this paper.

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Figure I. Sequential Structure of Open Market Repurchase Decisions

This figure illustrates the sequential nature of an open market repurchase authority in the UK. Excluding left-censored cases, firms begin with no repurchase authority in place (*State 1*). Firms can choose to either obtain an authority (and move to *State 2*) or continue without an authority (*State 1*). The probability of this decision, illustrated as *Path 1*, is tested using Equation (3). Once at *State 2*, firms can choose to buy back shares in the open market, which can be done repeatedly during the life of an authority. This is illustrated by *Path 2.1*. Alternatively, firms can withhold buying back any shares during the life of an authority, and follow *Path 2.2*. The cumulative probability and time-to-event of this decision is tested using Equations (4) and (6), respectively. The decision whether to implement occurs while firms are still in *State 2*. A change of state occurs if, by the next annual general meeting or upon expiration of an authority, firms decide against renewing the authority. Thus, withdrawal of an authority occurs and firms, following *Path 3*, move to *State 3*. The probability and time-to-event of this decision is tested using Equations (5) and (6), respectively.

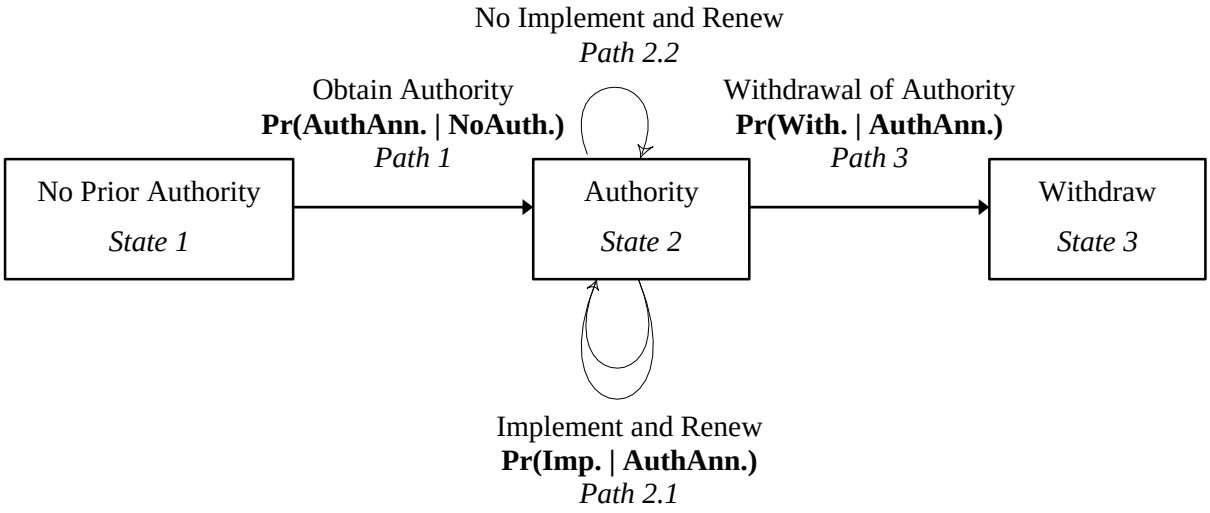
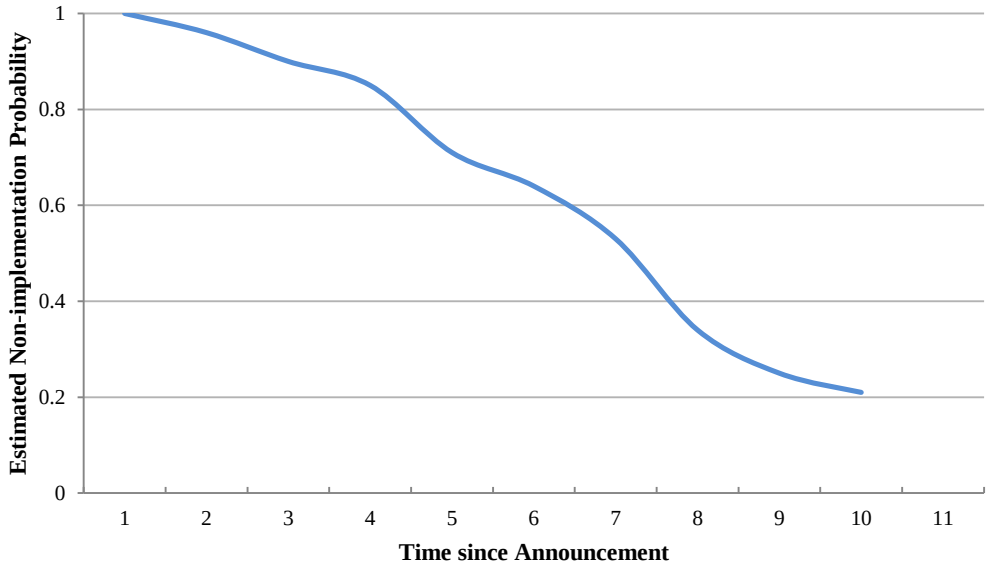


Figure II. Survival Curves of Time to Action of Repurchase Decisions Since Authority Initiation

This figure illustrates the survival curves of the decision to implement (Panel A) and the decision to withdraw (Panel B) a repurchase program, conditional upon having an authority to repurchase in place. The survival curve plots the probability (bounded between zero and one) of a firm continuing with an authority without implementation or withdrawal, plotted against years since first initiation. Both survival curves are obtained based on a discrete time approach, identical to the semi-parametric approach highlighted in Equation (6), the results for which are presented in Table VI. The figure is truncated at Year 10 to enable a comparison across both models, as the withdrawal sample lacks sufficient variability (in a cross-sectional, survival data form) for the model to obtain reliable estimates.

Panel A. Time to Repurchase Implementation



Panel B. Time to Repurchase Withdrawal

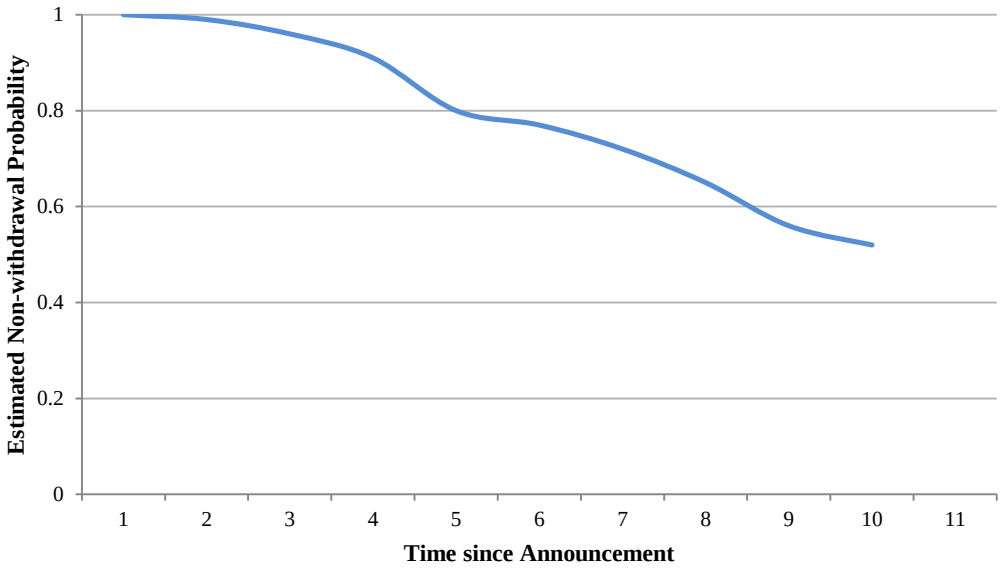


Table I. Variable Definitions

This table describes the explanatory variables used in the likelihood and survival models, in addition to variables used to compute surplus cash (SCA) and systematic (SRisk) and idiosyncratic (IRisk) risk measures. Datastream/Worldscope codes are provided in parentheses, where appropriate.

Explanatory Variable	Description
SCA	Surplus cash measured as the residual from a yearly cross-sectional regression as follows: $CCTA_i = \gamma_0 + \gamma_1 LTA_i + \gamma_2 FCF_i + \gamma_3 WC_i + \gamma_4 LEV_i + \gamma_5 RDSL_i + \gamma_6 MTBV_i + \gamma_7 DPDummy_i + \varepsilon_i$.
ECFO	Excess of cash flow from operating activities computed as the difference between the current scaled measure of cash flow (WC04860) and the average of the lagged and forward looking measures of scaled cash flow from operating activities.
ECFI	Excess of cash flow from investing activities computed as the difference between the current scaled measure of cash flow (WC04870) and the average of the lagged and forward looking measures of scaled cash flow from investing activities.
Agency	Indicator variable equal to one for firm years with free cash (WC04860 scaled by WC02999) above industry median and MTBV below industry median, zero otherwise.
SRisk	Systematic risk computed as the 12-month variance of the predicted component from the Fama-French (1993) Three-Factor Model as follows: $Return_{i,t} - RF_t = \theta_1 RMRF_{i,t} + \theta_2 SMB_{i,t} + \theta_3 HML_{i,t} + \varepsilon_{i,t}$. See Gregory et al. (2009) for data definition and computation.
IRisk	Idiosyncratic risk computed as the 12-month variance from the residual component from the Fama-French (1993) Three-Factor Model as follows: $Return_{i,t} - RF_t = \theta_1 RMRF_{i,t} + \theta_2 SMB_{i,t} + \theta_3 HML_{i,t} + \varepsilon_{i,t}$. See Gregory et al. (2009) for data definition and computation.
LTA	Firm size measured as the log-normalized value of total assets (WC02999).
LEV	Net leverage computed as net debt (total liabilities net of cash holdings: WC03251-WC02001) scaled by net assets (total assets net of cash holdings: WC02999-WC02001).
MTBV	Market-to-book ratio measured as market value (book value of debt: WC02999-WC03501, plus market value of equity: MV) scaled by the book value of assets (WC02999).
DP	Dividend payout computed as dividends per share scaled by earnings per share (WC09504).
DPDummy	Indicator variable equal to one if a firm is a dividend paying firm, zero otherwise.
EPS	Earnings per share computed as the net income available to common shareholders (WC01706) scaled by the number of common shares outstanding (WC05191).
EPSDummy	Earnings per share (EPS) dummy is an indicator variable equal to one if EPS is positive, zero otherwise.
LRet	Log-normalized, 3-month rolling returns computed based on share price (P) information, adjusted for splits and dilution.
CCTA	Cash and cash equivalents (WC02001) scaled by total assets (WC02999).
WC	Working capital computed as total current assets (WC02201) adjusted for cash and cash equivalents (WC02001) and total current liabilities (WC03101), scaled by total assets (WC02999).
RDSL	Research and development expenses (WC01201) scaled by total sales (WC01001).

Table II. Descriptive Statistics

This table presents the summary statistics (mean, median, and standard deviation) of the explanatory variables, grouped by *Cash Components*, *Firm Risk*, and *Control Variables*, used in regression Equations (3)-(6) and presented in Tables III-VI. The sample comprises UK firms (excluding financials and utilities) with a repurchase program from 1990-2010. Definitions of all of the variables are provided in Table I. Summary statistics are presented for all firm years (Overall) and firm year subsamples of program announcements (all and initiations only), implementations, and withdrawals. Statistical significance (two-sided) at the 10%, 5%, and 1% levels are denoted by *, **, and *** respectively, for tests on differences in mean (*t*-test) and median (Wilcoxon rank sum test). Differences in means and medians are computed for the following firm year groups: Overall against Announcement (All), Overall against Announcement (Initiation), Announcement (All) against Implementation (All), and Announcement (All) against Withdrawal (All).

		Cash Components				***Firm Risk***		***Control Variables***							
Sample	**Statistic**	**Surplus Cash** ***[SCA]***	**Excess Operating Cash** ***[ECFO]***	**Excess Investing Cash** ***[ECFI]***	**Agency** ***[AGENCY]***	**Systematic Risk** ***[SRisk]***	**Idiosyncratic Risk** ***[IRisk]***	**Firm Size** ***[LTA]***	**Leverage** ***[LEV]***	**Market to Book** ***[MTBV]***	**Dividend Payout** ***[DP]***	**Dividend Dummy** ***[DPDummy]***	**Earnings per Share** ***[EPS]***	**EPS Dummy** ***[EPSDummy]***	**Lagged Stock Returns** ***[LRet]***
Overall	*Mean*	-0.03	0.02	-0.03	0.37	0.25	0.44	12.17	0.11	0.51	40.03	0.79	0.18	0.96	1.05
Sample	*Median*	-0.06	-0.01	-0.01	0.00	0.18	0.37	11.74	-0.01	0.54	41.22	1.00	0.10	1.00	1.03
(n=2,762)	*Std. Dev.*	1.02	4.89	1.57	0.48	0.24	0.28	2.29	5.83	3.60	26.16	0.40	2.56	0.18	0.23
Announcement:	*Mean*	-0.01	-0.01	0.01	0.36	0.25	0.44	12.47***	-0.01	0.54	41.83***	0.81	0.27*	0.97	1.06
All	*Median*	-0.06	-0.01	-0.01	0.00	0.19	0.37	11.91***	-0.01	0.54	42.81***	1.00	0.12*	1.00	1.03
(n=1,923)	*Std. Dev.*	0.19	0.10	0.22	0.48	0.24	0.27	2.27	3.38	0.29	26.15	0.39	2.74	0.18	0.23
Announcement:	*Mean*	0.05	-0.02	0.03	0.41	0.25	0.48***	11.86**	0.64	0.50	36.95	0.79	0.15	0.98	1.06
Initiation	*Median*	-0.05	-0.01	0.00*	0.00	0.17	0.38***	11.33**	-0.01	0.52	38.44	1.00	0.11	1.00	1.04
(n=174)	*Std. Dev.*	0.31	0.23	0.32	0.49	0.36	0.39	2.18	10.80	0.32	25.75	0.41	0.69	0.13	0.24
Implementation:	*Mean*	0.01*	-0.01	-0.01*	0.41**	0.23**	0.40***	12.73*	-0.09	0.56	44.10*	0.92***	0.38***	0.99***	1.05
All	*Median*	-0.05***	0.00	-0.01	0.00***	0.17***	0.32***	12.26**	-0.01	0.55	44.43*	1.00***	0.16***	1.00***	1.02
(n=495)	*Std. Dev.*	0.21	0.14	0.18	0.49	0.26	0.28	2.41	0.48	0.24	22.16	0.28	3.05	0.08	0.20
Withdrawal:	*Mean*	-0.06*	-0.01	-0.02	0.13***	0.30**	0.57***	11.15***	0.11	0.66***	25.52***	0.39***	-0.56***	0.89*	1.06
All	*Median*	-0.12***	0.00	-0.01	0.00***	0.25**	0.53***	10.68***	-0.01	0.59***	7.39***	0.00***	0.00***	1.00***	1.00
(n=76)	*Std. Dev.*	0.17	0.11	0.22	0.34	0.20	0.29	2.12	1.91	0.48	30.29	0.49	3.68	0.31	0.30

Table III. Likelihood Models of Firms Announcing a Repurchase Program

This table presents the likelihood model (Equation 3) of the decision by UK firms (excluding financials and utilities) to announce a repurchase authority from 1990-2010. Column (1) aggregates the probability of all announcements against prior firm years when no authority existed. Column (2) presents the results for program initiations, which tests the likelihood of first authority only against the same set of prior firm years. All of the variables used in the regressions are defined in Table I. The coefficients capture the marginal effects of an instantaneous change in each independent variable on the probability of obtaining an authority. Cluster-robust *z*-values are reported in parentheses. Statistical significance (two-sided) at the 10%, 5%, and 1% level is denoted by *, **, and ***, respectively.

	(1)	(2)
	All Announcements	**Initiations Only**
Surplus Cash	0.0118	0.0127
[SCA]	(0.36)	(0.30)
Excess Operating Cash	-0.0003	0.0008
[ECFO]	(-0.04)	(0.08)
Excess Investing Cash	0.0058	0.0067
[ECFI]	(0.57)	(0.50)
Agency	-0.0319**	0.0064
[Agency]	(-2.36)	(0.32)
Systematic Risk	0.0286	0.0188
[SRisk]	(0.85)	(0.41)
Idiosyncratic Risk	0.0350	0.0507
[IRisk]	(1.12)	(1.02)
Firm Size	0.1080***	0.1185***
[LTA]	(9.45)	(4.96)
Leverage	0.0004	0.0005
[LEV]	(0.48)	(0.67)
Market-to-Book Ratio	-0.0102	-0.0556
[MTBV]	(-0.41)	(-1.50)
Dividend Payout	0.0001	0.0004
[DP]	(0.32)	(0.66)
Dividend Payout Dummy	-0.0456**	-0.0231
[DPDummy]	(-2.02)	(-0.59)
EPS	0.0059	0.0077
[EPS]	(1.46)	(0.92)
EPS Dummy	-0.0299	0.9597
[EPSDummy]	(-0.42)	(0.02)
3-Month Lagged Returns	0.0166	0.0526
[LRet]	(0.69)	(1.45)
Observations	2,762	887
Implementation Control	Yes	No
Pseudo R-squared	0.2223	0.1080

Table IV. Likelihood Models of Firms Implementing a Repurchase Program

This table presents the likelihood model (Equation 4) of the decision by UK firms (excluding financials and utilities) to implement a repurchase authority from 1990-2010. Column (1) aggregates the measure of repurchase days in a financial year and tests the probability of repurchasing shares against prior firm years with authority, but no implementation. Column (2) presents the results for implementation based on the number of shares repurchased and against the same set of firm years with authority, but no implementation. Column (3) provides the results for implementation based on the value of shares repurchased, conditioned on the same set of firm years as for the other two specifications. All of the variables used in the regressions are defined in Table I. The coefficients capture the marginal effects of an instantaneous change in each independent variable on the individual repurchase measures. Cluster-robust *z*-values are reported in parentheses. Statistical significance (two-sided) at the 10%, 5%, and 1% level is denoted by *, **, and ***, respectively.

	(1)	**(2)**	**(3)**
	Repurchase Days	**Shares Repurchased**	**Repurchase Value**
Surplus Cash	0.2163***	0.1771***	0.1596***
[SCA]	(3.25)	(2.72)	(2.70)
Excess Operating Cash	-0.0029	-0.1026	-0.0708
[ECFO]	(-0.03)	(-1.15)	(-0.88)
Excess Investing Cash	-0.1023**	-0.1118**	-0.0925**
[ECFI]	(-2.20)	(-2.45)	(-2.23)
Agency	0.0660***	0.0646***	0.0518**
[Agency]	(2.81)	(2.82)	(2.50)
Systematic Risk	0.0818	0.1766**	0.1595**
[SRisk]	(1.02)	(2.28)	(2.28)
Idiosyncratic Risk	-0.1712***	-0.1649***	-0.1475***
[IRisk]	(-2.69)	(-2.70)	(-2.65)
Firm Size	0.0410***	0.0113*	0.0139**
[LTA]	(5.77)	(1.65)	(2.21)
Leverage	-0.0096	-0.0154*	-0.0112
[LEV]	(-1.13)	(-1.86)	(-1.51)
Market-to-Book Ratio	0.0778	0.0716	0.0697
[MTBV]	(1.60)	(1.50)	(1.59)
Dividend Payout	-0.0006	-0.0013**	-0.0008
[DP]	(-1.11)	(-2.34)	(-1.63)
Dividend Payout Dummy	0.0840**	0.1491***	0.1251***
[DPDummy]	(2.16)	(4.54)	(4.02)
EPS	-0.0152	0.0129	-0.0017
[EPS]	(-0.61)	(0.52)	(-0.08)
EPS Dummy	-0.3425**	-0.1392	-0.3049***
[EPSDummy]	(-2.15)	(-0.95)	(-6.17)
3-Month Lagged Returns	-0.0228	-0.0222	-0.0193
[LRet]	(-0.49)	(-0.50)	(-0.48)
Observations	1,847	1,847	1,847
Wald Statistic	71.56	49.43	66.88

Table V: Likelihood Models of Firms Withdrawing a Repurchase Program

This table presents the likelihood model (Equation 5) of the decision by UK firms (excluding financials and utilities) to withdraw a repurchase authority from 1990-2010. Column (1) aggregates the probability of all withdrawals against prior firm years when an authority existed. Column (2) presents the results for a subsample of withdrawals that occur post-implementation and tests the likelihood of withdrawal if an authority has been implemented in the past against the same set of prior firm years with authority. Column (3) provides the results for a subsample of withdrawals when no implementation was undertaken, tested against firm years with authority. All of the variables used in the regressions are defined in Table I. The coefficients capture the marginal effects of an instantaneous change in each independent variable on the probability of authority withdrawal. Cluster-robust *z*-values are reported in parentheses. Results for *EPSDummy* are ignored because of its degree of collinearity to *EPS*. Statistical significance (two-sided) at the 10%, 5%, and 1% level is denoted by *, **, and ***, respectively.

	(1)	(2)	(3)
	All Withdrawals	**Withdrawals: Implementation**	**Withdrawals: No Implementation**
Surplus Cash	-0.2229	-0.1077	-5.2062
[SCA]	(-1.16)	(-0.44)	(-1.51)
Excess Operating Cash	0.0386	-0.4264*	3.7140
[ECFO]	(0.21)	(-1.72)	(0.96)
Excess Investing Cash	-0.0992	-0.2526*	12.8410
[ECFI]	(-0.89)	(-1.86)	(1.35)
Agency	-0.0542	-0.0463	-2.4339
[Agency]	(-1.00)	(-0.66)	(-1.16)
Systematic Risk	0.0140	-0.0391	2.1812
[SRisk]	(0.15)	(-0.31)	(1.13)
Idiosyncratic Risk	0.0483	0.0220	-0.7393
[IRisk]	(0.62)	(0.23)	(-0.63)
Firm Size	-0.0640	-0.0341	-2.6483
[LTA]	(-1.62)	(-0.76)	(-1.25)
Leverage	0.1779*	0.2813*	1.0005
[LEV]	(1.70)	(1.94)	(0.63)
Market-to-Book Ratio	0.3456**	0.2067	-0.4949
[MTBV]	(2.09)	(0.88)	(-0.55)
Dividend Payout	0.0015	0.0015	0.0209
[DP]	(1.54)	(1.15)	(1.63)
Dividend Payout Dummy	-0.1242*	-0.1592*	-1.3905
[DPDummy]	(-1.64)	(-1.65)	(-1.47)
EPS	-0.0044	-0.0106	1.3790
[EPS]	(-0.65)	(-1.11)	(1.73)
EPS Dummy	*NA*	*NA*	*NA*
[EPSDummy]	*NA*	*NA*	*NA*
3-Month Lagged Returns	0.0942	0.1893	-2.3876
[LRet]	(1.56)	(2.50)	(-1.59)
Observations	348	285	63
Wald Statistic	0.2925	0.3587	0.7607

Table VI. Hazard Models of Firms Implementing and Withdrawing a Repurchase Program

This table presents the hazard (survival) model (Equation 6) of the decision by UK firms (excluding financials and utilities) to implement or withdraw a repurchase authority from 1990-2010. The hazard model for implementation tests the likelihood of firms implementing an authority during the life of the authority. Similarly, the hazard model for withdrawal tests the likelihood of firms withdrawing an authority during its life. The hazard model for withdrawal requires a firm to withdraw its authority only once during the life of a program, while the implementation model is adjusted to incorporate a firm's ability to repurchase shares multiple times during the life of an authority. All of the variables used in the regressions are defined in Table I. All coefficients are presented as marginal effects, while cluster-robust *z*-values are reported in parentheses. Results for *EPSDummy* are ignored in the withdrawal regression because of its degree of collinearity to *EPS*. Statistical significance (two-sided) at the 10%, 5%, and 1% level is denoted by *, **, and ***, respectively.

	(1)	**(2)**
	Repurchase Implementation	**Repurchase Withdrawal**
Surplus Cash	0.3944*	-0.6454
[SCA]	(1.64)	(-0.98)
Excess Operating Cash	0.0549	0.2438
[ECFO]	(0.27)	(0.94)
Excess Investing Cash	-0.0692	0.1478
[ECFI]	(-0.38)	(1.51)
Agency	0.2188*	-0.2881
[Agency]	(1.79)	(-0.82)
Systematic Risk	0.6161	0.2010
[SRisk]	(1.56)	(0.28)
Idiosyncratic Risk	-0.7155*	-0.5020
[IRisk]	(-1.96)	(-0.91)
Firm Size	0.0716**	-0.1268**
[LTA]	(2.50)	(-2.31)
Leverage	-0.1649*	0.3782
[LEV]	(-1.79)	(0.72)
Market-to-Book Ratio	0.8001***	0.3182***
[MTBV]	(3.09)	(2.96)
Dividend Payout	-0.0036	0.0231***
[DP]	(-1.24)	(3.91)
Dividend Payout Dummy	0.9832***	-1.6131***
[DPDummy]	(3.85)	(-2.82)
EPS	0.0066	-0.1569***
[EPS]	(1.16)	(-6.24)
EPS Dummy	0.0827	*NA*
[EPSDummy]	(0.08)	*NA*
3-Month Lagged Returns	0.0978	1.0604
[LRet]	(0.44)	(1.48)
Observations	1,847	348
Wald Statistic	57.27	4820.76