# Innovation and Dividend Smoothing

Dimitrios Gounopoulos*

*School of Management, University of Bath*

Winifred Huang†

*School of Management, University of Bath*

Min Yang‡

*School of Management, University of Bath*

First draft: December 2019

This draft: December 2021

* Email: D.Gounopoulos@bath.ac.uk. The School of Management, University of Bath. Claverton Down, Bath, BA2 7AY, United Kingdom.

† Email: W.Huang@bath.ac.uk. The School of Management, University of Bath. Claverton Down, Bath, BA2 7AY, United Kingdom.

‡ Email: M.Yang4@bath.ac.uk. The School of Management, University of Bath. Claverton Down, Bath, BA2 7AY, United Kingdom.

**Abstract**

In this study, we examine the relationship between innovation and dividend smoothing, finding that more innovative firms tend to have higher dividend smoothing. This relationship continues to hold after correcting the endogeneity bias and replacing ex-post measures of innovation with the ex-ante R&D intensity. We further introduce the financial constraints, finding that instead of encouraging dividend smoothing, financial constraints alleviate dividend smoothing in the innovative companies. Our study also demonstrates that innovative firms with low cash holdings tend to have higher dividend smoothing, while it is especially attractive to those without sufficient cash reserve. Finally, we show that innovative firms covered by more analysts show less dividend smoothing than those with fewer analysts. Overall, this study provides novel empirical evidence on the relationship between innovation and dividend smoothing.

***JEL classification***: G35; O32; O33; O34;
***Keywords***: Dividend Smoothing; Innovation; Patents; Citations

## 1. Introduction

Dividend Smoothing, indicating that variation in dividends responds slowly to change in earnings, is universal and pervasive (Guttman, Kadan, and Kandel, 2010; Baker, Mendel, and Wurgler, 2016; Larkin, Leary, and Michaely, 2017). As documented by Brav et al. (2005) and Larkin, Leary, and Michaely (2017), managers and financial executives are trying to maintain a smoothed dividend stream. Several studies have proposed the explanations of dividend smoothing, including mitigating information asymmetry, limiting agency costs, external financing costs, as well as managerial career concerns (Aivazian, Booth, and Cleary, 2006; Guttman, Kadan, and Kandel, 2010; Lambrecht and Myers, 2012; Wu, 2018). However, the relationship between innovation and dividend smoothing remains undocumented.

Dividends constitute one of the most important activities for firms as an informed manager should allocate earnings between investment and dividends, for the intrinsic value and the short-term price (Guttman, Kadan, and Kandel, 2010). Private information such as total earnings and investment is unknown to investors, while observed dividends could convey superior information about the unexpected change in earnings and persistent change in future economic income (Chen and Wu, 1999; Chemmanur et al., 2010; Ham, Kaplan, and Leary, 2020). Except for the earnings, another important determinant of dividends is the future growth opportunity (Miller and Modigliani, 1961; Décamps and Villeneuve, 2007). Firms will cut dividends when they experience or anticipate higher growth, as this growth requires higher investment expenditures and sufficient cash flows. Thus, with good investment opportunities, firms are very likely to postpone their dividend distributions.

Firms are reluctant to cut dividends, even when internal funds are insufficient to cover good investment opportunities (Chemmanur et al., 2010). Managers with unobservable earnings tend to retain enough to prevent falling short next period (Baker, Mendel, and Wurgler, 2016), while dividends will increase by 30% of the increase in earnings (Garrett and Priestley, 2000). Michaely and Roberts (2006) argue that investors’ reaction is one critical reason for dividend smoothing. Stockholders, as well as market, tend to put a premium on stability or gradual growth in dividend rate, while market can penalize firms with dividend cutting (Lintner, 1956; Mantripragada, 1976; Gugler, 2003; Guttman, Kadan, and Kandel, 2010). As a consequence, cutting dividends can lead to the drop in the employees, expenditures of fixed assets, R&D expenditures, as well as the decrease of the firm’s growth options (Jensen, Lundstrum, and Miller, 2010). Lintner (1956) proposes the dividend smoothing, indicating that changing dividends upward is not always the optimal decision as there are always concerns that whether firms have abilities to sustain dividends in the future.

Prior studies have summarized several explanations related to dividend smoothing. Information asymmetry model suggests that dividend smoothing is more prevalent in firms with highly asymmetric information, as signaling for the credible information about earnings is the frequently cited motivation for dividends (Michaely and Roberts, 2012). Under this model, dividend smoothing should be more attractive to firms who can benefit from such a signal, especially opaque firms with more growth opportunities and fewer tangible assets. Limiting the agency costs of free cash flows is another determinant of dividend smoothing, especially for those with greater susceptibility to free cash flow problems (Guttman, Kadan, and Kandel, 2010; Leary and Michaely, 2011).

Innovation, representing non-financial or soft information, conveys a positive signal to investors, indicating that firms are currently operating well and are focusing on the long-run development (Griffin, Hong, and Ryou, 2018). Previous studies have confirmed that innovation is the main engine of growth and it contributes to the economic benefits of firms (Aghion, Van Reenen, and Zingales, 2013). However, innovation is also a major contributor to information asymmetry and insider gains (Aboody and Lev, 2000; Brown and Martinsson, 2019). First, outsider can obtain little or no information about the productivity and value of R&D by observing other firms. Thus, R&D activities are not comparable. Second, organized market for R&D is limited, and therefore, asset price can convey little information. Finally, R&D expenditure is immediately expensed in financial statements under the accounting method and financial reporting rule, and therefore, unlike other physical investment, information about R&D is insufficient. Innovative firms are also sensitive to the free cash flow problems, as the investment in innovative activities and the R&D expenditures are sometimes confidential. In addition, agency cost is usually higher in innovative projects, as they are risky, unpredictable, long-term and multi-stage, labor intensive, as well as idiosyncratic (Holmstrom, 1989; Block, 2012). However, dividend smoothing can provide a solution to information asymmetry and reduce the free cash flows in hands of managers and the waste of free cash flows (Chemmanur et al., 2010; Javakhadze, Ferris, and Sen, 2014). This raises several interesting questions. Are innovative firms more likely to smooth their dividends? If so, is this relationship more pronounced in firms with higher or lower financial constraints? As cash can be an insurance against uncertainty, is dividend smoothing more attractive to firms without sufficient cash reserves? Can analyst coverage change the relationship between innovation and dividend smoothing?

To address these questions, we choose the dividend smoothing in the period of 2005 to 2018 and require firms with at least 10 years of continuous non-missing data in deriving the dividend smoothing. The proxies of innovation in this study include the patent count, patent value and forward citation, generated during the ten-year window before the period of dividend smoothing. We measure the dividend smoothing using the most classic speed of adjustment proposed by Lintner (1956) and two alternative proxies (alternative speed of adjustment and relative volatility) proposed by Leary and Michaely (2011).

In this study, we first conduct the baseline regression, using three different proxies of innovation, including patent count, patent value and forward citation. The results of baseline regression indicate that more innovation can encourage the degree of dividend smoothing. This result is significant both economically and statistically. With a one standard deviation increase of patent count and forward citation, firms tend to increase their dividend smoothing by 26.0 percent and 25.6 percent (see footnote 1 and 2 for the detailed calculation), respectively.

To augment this study, we further perform a series of additional analyses. Financial constraints can be harmful for innovative activities, as those without sufficient financing are very likely to discontinue their innovative projects (Hyytinen and Toivanen, 2005; Li, 2011). However, the effects of financial constraints on dividend smoothing are mixed. Our results prove that financial constraints can alleviate dividend smoothing by demonstrating that innovative firms with financial constraints are less likely to smooth their dividends, which is generally analogous to Leary and Michaely (2011).

In addition, we further show the impact of cash holdings, which serve as the insurance against uncertainty and risk (Denis and Sibilkov, 2010; Jiang and Lie, 2016). We find that innovative firms with low cash holdings are more likely to smooth their dividends, indicating that dividend smoothing is especially attractive to those without sufficient cash reserves. Finally, we are also interested in the role of analysts, finding that positive relationship between innovation and dividend smoothing is only significant in firms with low analyst coverage, suggesting that firms with more analyst coverage tend to reduce their degree of dividend smoothing.

In the robustness tests, we address the endogeneity concerns, using instrumental variables and treatment effect model. Our results demonstrate that the positive relationship between innovation and dividend smoothing remains unchanged after correcting the endogeneity bias. Using the ex-ante proxies of innovation (R&D intensity), keeping innovation and dividend smoothing during the same period and limiting the innovative observations only can also generate similar results.

Our study contributes to existing literature in several ways. First, we provide novel empirical evidence on the relationship between innovation and dividend smoothing. Numerous studies have proposed the determinants of dividend smoothing, such as information asymmetry, agency costs, financial costs, managerial social capital, managers' career concerns, and investment opportunities (Rozeff, 1982; Aivazian, Booth, and Cleary, 2006; Guttman, Kadan, and Kandel, 2010; Lambrecht and Myers, 2012; Wu, 2018l; García-Feijóo, Hossain and Javakhadze, 2021). However, to date, direct relationship between innovation and dividend smoothing remains unexplored, thus, we seek to fill this void. In this study, we find that innovation can significantly increase firms' tendency to smooth their dividends. To the best of our knowledge, this is the first study to provide the effects of innovation on dividend smoothing.

Second, our study supports theories of information asymmetry and agency problems related to dividend smoothing (Leary and Michaely, 2011; Lambrecht and Myers, 2012), from the dimension of innovation. Information-based arguments yield that dividend smoothing should be more pervasive when information environment is opaque, while agency-based arguments propose that firms with higher sensitivity and susceptibility to free cash flows can benefit more from dividend smoothing (Javakhadze, Ferris, and Sen, 2014). Innovative firms are intuitively associated with asymmetric information and agency costs (Holmstrom, 1989; Aboody and Lev, 2000; Brown and Martinsson, 2019), and firms tend to keep the innovation inputs and process confidential unless they have enjoyed some success in the prior innovativeness (Hyytinen, Pajarinen, and Rouvinen, 2015). This also provides a solution for those who want to minimize information asymmetry and agency costs. Finally, our study also offers some guidance to managers, regarding the analyst following. Despite some pressure brought by analysts, the information effect in innovative firms is more overwhelming than the pressure effect. For innovative firms, one positive effect of analyst following is that it could alleviate firms' concern of the unsustainable dividends.

The remainder of this study is organized as follows. We summarize the literature about dividend smoothing and innovation and propose the hypothesis in Section 2. Section 3 describes the sample and data source. Section 4 performs the baseline regression and some additional analysis. Robustness tests including endogeneity and alternative measures of innovation appear in Section 5. We also provide a discussion of our results in Section 6. Finally, Section 7 concludes this study.

## 2. Literature Review and Hypothesis Development

### 2.1 Dividend Policy and Dividend Smoothing

Dividend policy, a consequence of the separation of ownership and control, could reduce the information asymmetry and agency costs, limit the private benefits to insiders, and convey the well-being of firms and the confidence of managers (Easterbrook, 1984; Gugler, 2003; Aivazian, Booth, and Cleary, 2006; Guttman, Kadan, and Kandel, 2010; He et al., 2017; Jiraporn and Lee, 2018). For one, higher dividends can reduce the cash flows in managers' hands, limiting the investment on negative net present value (NPV) projects. For another, high dividends increase the need to seek outside funds, and therefore, increase the effectiveness of monitoring. Dividend reduction, the 'last resort' for a firm, indicates the managerial pessimism about the current and future prospects, as well as the insufficient earnings to meet the existing dividend targets (Lintner, 1956; Miller and Modigliani, 1961; Jensen, Lundstrum and Miller, 2010).

Dividend smoothing, proposed by Lintner (1956), refers that variation in dividends cannot fully reflect change in cash flows, and it is especially important and necessary for firms with volatile earnings (Guttman, Kadan, and Kandel, 2010). There are two main explanatory models for dividend smoothing: one is information asymmetry model, and another is agency-based model. Under the information asymmetry model, dividend smoothing serves as a signal for future cash flows (Lintner, 1956; Guttman, Kadan, and Kandel, 2010). If dividend smoothing is a positive indicator for future, it should be prevalent in firms who need and can benefit more from such a positive signal, such as opaque firms with more growth opportunity, fewer tangible assets and minor insider ownership (Jensen, Solberg, and Zorn, 1992; Aivazian, Booth, and Cleary , 2006; Javakhadze, Ferris, and Sen, 2014).

The second model associated with dividend smoothing is agency-based model, focusing on minimizing agency costs of free cash flows (Leary and Michaely, 2011; Javakhadze, Ferris, and Sen, 2014). One function of dividends is to reduce the free cash flows in the hands of managers and to minimize the inefficient investment (Chemmanur et al., 2010), while shareholders desire regular dividends to limit agency costs (Lambrecht and Myers, 2012). Institutional investors, performing the monitoring functions, are more likely to hold dividend-smoothing stocks than retail investors and tend to impose penalties in response to dividend cut, forcing managers to smooth their dividends (Javakhadze, Ferris, and Sen, 2014; Larkin, Leary, and Michaely, 2017). Besides, Javakhadze et al. (2014) explain the international dividend smoothing by comparing the agency-based model and the asymmetric information theories, finding that agency problems, instead of information effects, are more powerful to explain dividend smoothing. Regarding this explanation, dividend smoothing is more pronounced in firms with greater susceptibility to free cash flow problems (Leary and Michaely, 2011).

### 2.2 Innovation in Corporations

Innovation is a strong positive predictor for future returns (Hirshleifer, Hsu, and Li ,2013). The difficulty in evaluating the economic implications of innovative activities gives rise to the undervaluation of innovation and high future returns. Besides, they are more profitable, with higher return on assets. Innovation is also critical to survival rate (Hyytinen, Pajarinen, and Rouvinen, 2015). It can foster survival-enhancing attributes and capabilities by providing competitive market power and cost efficiency, however, innovative firms face more liabilities than non-innovative firms, especially for newness and smallness. Therefore, entrepreneurs should not regard innovation as an insurance against failure. Some characteristics, such as high probability of failure, unpredictable outcomes, and the impossibly foreseeable contingencies, bring the concerns about information asymmetry and agency costs in innovative activities (Holmstrom, 1989; Chemmanur and Fulghieri, 2013).

As one of the main engines of growth, innovation contributes to the economic benefits of firms (Aghion, Van Reenen, and Zingales, 2013). However, information asymmetry and agency costs have brought some concerns and conflicts between patenting firms and outside investors, as well as in the relationship between financial intermediaries and entrepreneurs (Long, 2002; Chemmanur and Fulghieri, 2013; Czarnitzki, Hall, and Hottenrott, 2014). Information asymmetry gives entrepreneurs the motivation to implement the poor projects as soon as possible, to limit the risk of cancellation of poor projects once the bad news is released. Therefore, firms with innovative activities desire a positive signal to convey information to investors and intermediaries and to reduce information asymmetry and agency costs, while dividends can effectively play such a role.

### 2.3 Hypothesis Development

Dividend smoothing is prevalent in opaque firms, especially for those with growth prospects and few tangible assets (Javakhadze, Ferris, and Sen, 2014), while innovation is positively associated with the future performance and it is indeed the engine of growth (Aghion, Van Reenen, and Zingales, 2013). Besides, innovative activities are very likely to suffer from information asymmetry, not only in the process, but also for the inputs and outputs. Therefore, dividend smoothing can provide a solution to the information asymmetry in the innovative firms and we propose our first hypothesis:

*H1: Innovation can encourage dividend smoothing.*

Financial constraints can influence the degree of dividend smoothing. If smoothing dividends is for preserving financial flexibility, it should be more pronounced in firms with high financial constraints. However, Learyand and Michaely (2011) document that firms with high financial constraints are less likely to smooth dividends. Borrowing from Easterbrook (1984), they propose an explanation that low-cost access to the capital market forces firms to use it by imposing smoothed but higher dividends. Besides, with the moderator of innovation, the impact of financial constraints on dividend smoothing can also be different. This is because financial constraints are also crucial to innovation activities, making firms discontinue their R&D projects and hold back innovation and growth (Hyytinen and Toivanen, 2005; Li, 2011). Information asymmetry, complexity and uncertainty in the innovative activities make the financial constraints more salient, leading higher costs of external financing (Hottenrott and Peters, 2012). It is very likely that financial constraints discourage innovation, and therefore, reduce the degree of dividend smoothing. Thus, we formulate following hypotheses:

*H2: Financial constraints can mitigate the dividend smoothing in innovative firms.*

Operating and competitive circumstance require firms to hold cash, especially for innovative firms, whose R&D are difficult to finance (He and Wintoki, 2016). Being a commitment device to invest in innovation, cash holdings are also necessary to firms whose product markets are uncertain (Lyandres and Palazzo, 2016). Thus, corporate cash holdings, serving as the insurance against uncertainty and riskiness, should be valuable, especially when external financing are insufficient (Denis and Sibilkov, 2010; Jiang and Lie, 2016). Companies want to make their dividends stable and predicative, however, they are very likely to cut payouts during external financing shocks if without sufficient cash holdings. Thus, we assume that firms with low cash holdings have more tendency to signal the persistent earnings through smoothed dividends, and propose the following hypothesis:

*H3: The positive relationship between innovation and dividend smoothing is more pronounced in firms with low cash holdings.*

Analyst coverage, exerting pressure on managers for short-term goals, can impede firm's investment in innovative projects and make firms generate fewer patents and patents with low impacts (He and Tian, 2013). However, through the information effects, analysts can mitigate the information asymmetry between managers and market, through acquiring, understanding and interpreting information. In addition, cutting wasteful resources under the discipline of analysts makes better innovation (Guo, Pérez-Castrillo and Toldrà-Simats, 2019). Regarding dividend payout, we assume the existence of analyst coverage can mitigate the information asymmetry between market and insiders, and limit the wasteful use of cash flows, thus, using dividend smoothing to mitigate information asymmetry and agency costs is no longer necessary. We formulate the following hypothesis:

*H4: Innovative firms covered by more analysts could have less dividend smoothing.*

## 3. Data

### 3.1 Sample Selection

Our sample starts with all firms in both CRSP and COMPUSTAT from 2005 to 2018. Following Leary and Michaely (2011), we exclude financial firms (SIC 6000-6999) and remove all non-dividend-paying firms in this period. This sample also requires the firms with at least 10 years of continuous non-missing data relevant to dividend smoothing, including dividend per share (*DPS*), earnings per share (*EPS*) and share adjustment factor. Our final sample includes 863 observations, which is generally comparable to García-Feijóo, Hossain and Javakhadze (2021).

### 3.2 Dividend Smoothing

The main measure of dividend smoothing in our study is speed of adjustment (Leary and Michaely, 2011; Chemmanur et al., 2010; Javakhadze, Ferris, and Sen, 2014), which is from the partial adjustment of Lintner (1956):

$$\Delta D_{it} = \alpha + \beta_1 D_{it-1} + \beta_2 E_{it} + \varepsilon_{it} \quad (1)$$

Where $D_{it}$ is the dividend in year $t$ and $\Delta D_{it}$ is the difference of the dividends in year $t$ and year $t-1$. $E_{it}$ represents the earnings in year $t$. To control scale effects and the stock splits, we adjust both earnings and dividends according to the common share outstanding for each firm. Speed of Adjustment (*SoA*) is $-\widehat{\beta_1}$ in the above equation.

According to Leary and Michaely (2011), there are two concerns when using the speed of adjustment (*SoA*) as a proxy of dividend smoothing. For one, small-sample bias makes the cross-sectional differences unclear. For another, Lintner (1956) assumes that there is a dividend policy and target payout ratio for each firm, and the actual payout ratio tends to be consistent with the target in the long run. However, target payout ratio seldom exists in recent period, while only a small proportion of firms have a clear target payout ratio. Therefore, we follow Leary and Michaely (2011) to construct two alternative proxies of dividend smoothing. The first alternative is from a two-step procedure, while the first step is to construct the deviation from the target payout ratio, and the alternative speed of adjustment (*SoA_alt*) is the estimated coefficient of the deviation, according to the following equations:

$$\Delta D_{it} = \alpha + \beta * dev_{it} + \varepsilon_{it} \quad (2)$$

Where

$$dev_{it} = TPR_i * E_{it} - D_{it-1} \quad (3)$$

Total payout ratio ($TPR_i$) is the firm median payout ratio over the sample period, which is common dividends divided by net income, and the alternative measure of dividend smoothing (*SoA_alt*) is the $\hat{\beta}$ from the above equations. This alternative improves the precision of the estimate, by reducing the dependence of the bias on the true speed of adjustment (Leary and Michaely, 2011).

Consistent with Leary and Michaely (2011), the second alternative proxy of dividend smoothing in our study is relative volatility (*Rel_Vol*), which is from a model-free non-parametric estimation. The spirit of this approach lies in that dividend smoothing refers changes in dividends are not exactly the changes in cash flows (Guttman, Kadan, and Kandel, 2010), and thus, the relative volatility is the ratio of dividend volatility and earnings volatility. Following Leary and Michaely (2011), we construct relative volatility as the ratio of the root mean squared errors from the following two equations:

$$AdjDPS_{it} = \alpha_1 + \beta_1 * t + \beta_2 * t^2 + \varepsilon_{it} \quad (4)$$

$$TPR_i * AdjEPS_{it} = \alpha_2 + \gamma_1 * t + \gamma_2 * t^2 + \eta_{it} \quad (5)$$

To control the effects of dividend level on relative volatility, we first generate the scaled, split-adjusted earnings series, which is the firm median payout ratio times each year's earnings. We then regress the above two equations, with the quadratic time trend. These two alternatives are complementary as they reflect two different dimensions of dividend smoothing, and both can mitigate the concerns from the small sample bias and the specific dividend policy.

**3.3 Innovation Proxy**

To measure the innovation level for each firm, we use the patents as the proxy of innovation, which can reflect the intangible assets and market prospects, as well as the exclusive right to use some competitive and unique knowledge for obtaining market power. The mandatory disclosure required by patent office, as well as the difficulty to manipulate patents for the short-term financial reporting purpose, can help investors and lenders to know more about the technological discoveries and the potential value of innovative activities, as well as to weigh the cash flows and the risk consequences (Czarnitzki, Hall, and Hottenrott, 2014; Hsu et al., 2015). The value of patents is the incremental economic benefits due to the right to exclude others from exploiting the invention, beyond what would be obtained if nothing has been granted (Farre-Mensa, Hegde, and Ljungqvist, 2017).

We measure the innovation level, including the quantity and quality, in the ten-year window prior to our sample period of dividend smoothing. In the robustness tests, we also measure innovation and dividend smoothing in the same period. Compared to the grant year, application year can efficiently reflect the true innovation and can avoid potential anomalies due to the time lag between application date and the grant date (Griliches, Pakes, and Hall, 1986; Fang, Tian and Tice, 2014; Sapra, Subramanian, and Subramanian, 2014). We obtain patent data from Kogan et al (2017) and Stoffman, Woeppel, and Yavuz (2018).

Our first proxy of innovation is patent count, which is the number of patents applied in this ten-year window. Our second measure of innovation is patent value, provided by Kogan et al. (2017) and Stoffman, Woeppel, and Yavuz (2019). Decomposing the idiosyncratic stock return into components related to patents and components unrelated to patents, they construct the estimated patent value as the product of the patent related return and market capitalization. However, one shortcoming of patents is that they cannot distinguish groundbreaking innovation from incremental technology discoveries (Fang, Tian, and Tice, 2014). Thus, forward citation, the count of later patents that cite a patented invention, is another proxy to capture the quality and the influence of innovation (Moser, Ohmstedt, and Rhode; 2017). Patents are influential if they can receive some citations, as more citations suggest higher influence on the following technology development and higher economic values. Thus, our final proxy of innovation is the total number of forward citations of all patents for each firm. All innovation proxies are highly skewed; thus, we use the natural logarithm of these measures in the following empirical analysis and add one to avoid losing observations (Fang, Tian and Tice, 2014).

### 3.4 Control Variables

Leary and Michaely (2011) provide a series of proxies of market frictions relevant to dividend smoothing. We consider firm size and age, which are proxies of firm maturity. Firm size is the natural logarithm of book assets, while firm age is the difference between founding year and the beginning of sample period. We also control for the asset tangibility and market-to-book ratio, to measure the nature of firm assets. To reflect the risk, we further consider the volatility of earnings and stock returns. We also include the stock turnover to represent investors' horizon and clientele. In addition, we control for the dispersion and accuracy of analysts' forecasts to reflect the information gap between insiders and outsiders. Firms that are cash cows are more likely to suffer from agency problems, thus following Leary and Michaely (2011), we classify firms with high profitability, high credit rating and low P/E as cash cows. Finally, we control for payout ratio and firm leverage. We use the median characteristics of each firm in the period of 2005 to 2018.

Table 1 provides the descriptive statistics for the dividend smoothing (speed of adjustment, alternative speed of adjustment and relative volatility), innovation proxies (patent count, patent value and citation) and other control variables which can systematically affect the dividend smoothing, as discussed above. On average, the speed of adjustment in our sample is 0.45, which is comparable to García-Feijóo, Hossain, and Javakhadze (2021). The average alternative speed of adjustment proposed by Leary and Michaely (2011) is lower than speed of adjustment, with a less dispersion. The distribution of relative volatility is more dispersed than speed of adjustment.

## 4. Empirical Analysis

### 4.1 Baseline Regression

In this section, we conduct regressions to examine the detailed relationship between innovation and dividend smoothing according to the following equation:

$$Dividend\ Smoothing_i = \alpha + \beta * Innovation_i + \gamma * X_i + \eta_k + \varepsilon_i \tag{6}$$

Consistent with previous discussion, dividend smoothing in the period between 2005 and 2018 is the dependent variable. We use three proxies to represent the dividend smoothing, including speed of adjustment (*SoA*), alternative speed of adjustment (*SoA_alt*) and relative volatility for dividends and earnings (*Rel_Vol*). The interest variable in these regressions is the innovation. As discussed earlier, our innovation proxies include patent count, patent value and forward citation. $X_i$ represents a set of control variables which can affect the dividend smoothing under the theories of information asymmetry and agency problems, including market-to-book ratio, asset tangibility, firm maturity, volatility, dispersion and accuracy of analyst forecast, the cash cow indicator, stock turnover, firm leverage and payout ratio. We use the heteroscedasticity-robust standard errors and consider the fixed effects of different industries and the countries of firm headquarters.

We present our results in Table 2, using the speed of adjustment (*SoA*) as the dependent variable. In panel A, we use the patent count as the proxy of innovation. We see from column (1) that more patent count tends to generate high dividend smoothing (low speed of adjustment). Column (2) controls for market-to-book ratio and asset tangibility, which are two measures for the nature of firm assets. Higher tangibility is easier for outsiders to observe, while it is difficult to value growth opportunity (Leary and Michaely, 2011). Market-to-book ratio is positively related to speed of adjustment (*SoA*), which is consistent with García-Feijóo, Hossain, and Javakhadze (2021). We further gradually incorporate additional control variables in column (3) to (10). After controlling for all relevant variables, we still observe that patent count can encourage the dividend smoothing, as indicated by the negative coefficient in column (10). The results are significant both statistically and economically. With a one standard deviation increase of patent count, firms tend to increase their dividend smoothing by 26.0 percent[1].

Panel B presents the regression results when using the patent value as the independent variable. Consistent with Panel A, firms with more valuable patents tend to increase their dividend smoothing (low *SoA*). Including all control variables generates similar results, with the statistical significance at 1%. In Panel C, we use the number of forward citations received by patents as the proxy of innovation, capturing the quality and the influence of innovation. Similarly, our results yield that firms with more patent citations tend to have high dividend smoothing (low *SoA*), while the coefficients are statistically significant at 1%. Besides, the economic significance is also sizeable. With a one standard deviation increase of forward citation, firms will increase their dividend smoothing by 25.6 percent[2].

In Table 3, we present the results using two alternative proxies of dividend smoothing proposed by Leary and Michaely (2011). The dependent variable in panel A is alternative speed of adjustment (*SoA_alt*). Consistent with the results in Table 2, we observe that all innovation measures, including patent count, patent value and patent citation, are negatively related to alternative speed of adjustment, confirming that firms with more innovation tend to have high dividend smoothing (low *SoA_alt*). Unfortunately, we cannot see any impact of innovation on relative volatility, as shown in Table 3 Panel B. Thus, in this section, we find that firms with more innovation, measured by patents, usually smooth their dividends heavily than those with fewer patents.

### 4.2 Effects of Financial Constraints

As discussed in the literature review, financial constraints are crucial to innovative activities, while availability of financing also provides an explanation for dividend smoothing. With the limitations of financial constraints, firms are very likely to discontinue their innovative projects. Financial constraints can prevent innovative firms from commercializing their research activities, and thus, hinder innovative success. This is mainly because that unanticipated cost could prevent firms appropriating necessary complimentary assets (Howell, 2016). In addition, financial constraints can also affect the payout ratio, as well as cash management, as those with limited capital market access tend to retain high portion of cash (Luo, 2011). Therefore, in this section, we wish to emphasize the role of financial constraints, and

[1]We calculate the economic significance as the coefficient of patent count (-0.045, Table 2 Panel A Column 10) times the standard deviation of patent count (2.614, Table 1), all divided by the mean of the speed of adjustment (0.452, Table 1), resulting 26.0%.
[2]We calculate the economic significance as the coefficient of citation (-0.033, Table 2 Panel C Column 10) times the standard deviation of citation (3.503, Table 1), all divided by the mean of the speed of adjustment (0.452, Table 1), resulting 25.6%.

detect whether it could change the relationship between innovation and dividend smoothing. Following Li (2010) and Luo (2011), we use KZ index to measure financial constraints and construct it according to the following linear combination:

$$KZ_{it} = -1.002\, CF_{it}/A_{it-1} - 39.368 DIV_{it}/A_{it-1} - 1.315 C_{it}/A_{it-1} + 3.139 BLEV_{it} + 0.283 Q_{it} \quad (7)$$

where $CF_{it}/A_{it-1}$ is the cash flow over lagged assets; $DIV_{it}/A_{it-1}$ is the cash dividends over lagged assets; $C_{it}/A_{it-1}$ is the cash balance over lagged assets; $BLEV_{it}$ reflects the leverage, calculated as total debt divided by the sum of total debt and equity; $Q_{it}$ is calculated as the market value of equity plus assets minus book value of equity, all divided by total assets. We winsorize the components of KZ index at 1% and 99% before constructing KZ index.

Evidence from financial constraints appears in Table 4. We see that firms with high financial constraints tend to have higher dividend smoothing, as indicated by the negative and significant coefficients of KZ index. This suggests that firms are reluctant to increase their dividends when they realize that obtaining external financing is costly. However, we observe that coefficients of interactions between innovation and KZ index are positive, at the conventional level (5%). This suggests that innovation can change the relationship between financial constraints and dividend smoothing, while innovative firms with financial constraints are less likely to smooth their dividends. Thus, we conclude that instead of encouraging dividend smoothing, financial constraints alleviate the dividend smoothing in the innovative firms.

**4.3 Effects of Cash Holdings**

Corporate cash holdings, the insurance against various factors, are important for firms with greater risk and valuable when sources of funds for capital are insufficient (Denis and Sibilkov, 2010; Jiang and Lie, 2016). Besides, strategic cash reserve is also crucial to R&D firms, especially for those with difficulty to obtain external funding due to uncertainty, as well as those in competitive industries (He and Wintoki, 2016). Thus, innovative firms tend to strategically maintain high cash holdings. (Lyandres and Palazzo, 2016). Therefore, in this section, we detect the role of cash holdings. In the spirit of Harford, Mansi, and Maxwell (2008) and Graham and Leary (2018), we construct cash holdings as the log of cash and cash equivalents to total sales.

Dividing our sample into three groups based on their cash holdings, we present the related results in Table 5. The dependent variable is speed of adjustment (*SoA*). We observe that the positive relationship between innovation and dividend smoothing is more pronounced and significant in firms with low cash holdings, with a higher magnitude, suggesting that dividend smoothing is especially attractive to those without sufficient cash reserves. Firms without sufficient cash holdings could rely on the dividend smoothing to signal the persistent earnings. This also supports Bliss, Cheng, and Denis

(2015), who argue that companies with low cash holdings are more susceptible to the external financing shocks, and thus, more likely to cut payout.

### 4.4 Effects of Analyst Coverage

The role of analyst coverage lies in two aspects: information effects and pressure effects. The information effects explain that analyst can mitigate the information asymmetry between managers and market, through acquiring, understanding and interpreting information. The pressure effects of analyst coverage refer to the disciplinary role when firms fail to meet the analyst forecast (Guo, Pérez-Castrillo and Toldrà-Simats, 2019). In consistence with information effects, Guo, Pérez-Castrillo, and Toldrà-Simats (2019) find analyst coverage makes firm generate more future patents and citations. However, He and Tian (2013) provide evidence of the adverse consequence of analysts, finding that firms covered by more analysts tend to generate fewer patents, as well as patents with less influence. They interpret this as analysts tend to exert too much pressure on managers, forcing them to focus on the short-term profits, instead of long-run development. Based on these two roles of analyst coverage, we emphasize how analyst coverage can change the correlation between innovation and dividend smoothing in this section.

We present the results related to analyst coverage in Table 6. We divide our sample into two groups, based on their number of analysts. We see that the positive association between innovation and dividend smoothing is only significant in firms with low analyst coverage, indicating that firms with more analysts tend to reduce the degree of dividend smoothing, while those followed by few analysts are more likely to make dividends stable and predicative. This supports the information effects of the analysts. Analysts can mitigate the information asymmetry by acquiring, understanding and interpreting information (Guo, Pérez-Castrillo and Toldrà-Simats, 2019), thus, using the dividend smoothing to reduce the information asymmetry is no longer necessary.

## 5. Robustness Tests

### 5.1 Endogeneity Concerns

We augment our study with several robustness tests. Although the window of innovation is prior to the window of dividend smoothing in our study, we are aware that above relationship between innovation and dividend smoothing is not necessarily random, as there are some omitted variables affecting the dividend smoothing and appearing in the error terms. Besides, firms have their own preference about whether to apply their patents and make their discoveries public, generating the self-selection bias. Therefore, in this section, we mitigate the endogeneity concerns, using instrumental variables (IVs) and the treatment effects model.

We choose three instrumental variables. The first one is the pendency, which is the average period between the application year and the grant year. Another instrumental variable is the intellect, which is proxied by the number of employees in each firm, after the logarithm transformation (Griffin, Hong and Ryou, 2018). Koch and Simmler (2020) proxy R&D with patent, thus, we also use the R&D intensity as an instrumental variable. Our overidentification test indicates that these variables are valid, at the same time, the test of endogeneity suggests that innovation, measured by patent, is indeed endogenous.

We present the two stage least square (2SLS) regression in Table 7 Panel A. Column (1) presents the results of first stage, while the patent application pendency, the number of employees and the R&D intensity are all positively related to the number of patents. We further report the results of second stage in column (2) to (4), where the dependent variables are the proxies of dividend smoothing, including speed of adjustment, alternative speed of adjustment and relative volatility. Consistent with the findings in our baseline regression, the coefficients of patent count are still negative, and statistically significant. We notice that after performing regressions with instrumental variables, the coefficient of relative volatility is also significant.

Another endogeneity bias lies in the self-selection problems. Firms have their own preference about whether to apply their patents and make their discoveries public. There is also a possibility that firms with innovation do not have applied patents. Unlike Heckman model, treatment effects model aims to address the self-selection bias when the outcome variables are fully observable. In our study, no matter whether firms have innovation outputs, we can always observe their dividend smoothing outcomes. Treatment effects model requires that the treatment variable is an indicator variable, so we test whether innovation, an indicator variable, can motivate firms to smooth their dividends. The indicator variable, innovation, equals one if firms have at least one successful patent and zero otherwise. In the treatment equation, we choose firm employee, R&D intensity, as well as the average patent number in each industry as the determinants to patent application. We add the industry average patents as the determinant because McGahan and Silverman (2006) demonstrate that market value depends on the patented information by competitors, while Tang (2006) also argues firms' perception of competitive environment is crucial for innovation. Thus, we assume firms in the industry with high patent behavior are more likely to seek patent protection once they have discoveries.

Results of treatment effect model appear in Table 7 Panel B. The dependent variables in this table are the proxies of dividend smoothing, while the explanatory variable of primary interest is an indicator variable (*Innovation*), representing firms with patents. The significant lambda in this table indicates that the self-selection can indeed generate some endogeneity biases. Consistent with the results of 2SLS regression, the coefficients for the speed of adjustment and alternative speed of adjustment are negative and significant at 1% after correcting the self-selection bias, confirming that innovation can indeed increase the dividend smoothing. The coefficient of relative volatility is also negative and significant at

5%. Therefore, we can confirm and conclude that innovation can positively affect firms' degree of dividend smoothing.

### 5.2 Alternative Proxies of Innovation

In the baseline regression, we choose the innovation outputs as our independent variables. In this section, we investigate whether the relationship between innovation and dividend smoothing remains unchanged if we use ex-ante proxy of innovation. Prior studies have documented the ex-post and ex-ante measure of innovation. When analyzing the relationship between innovativeness and startup survival rate, Hyytinen, Pajarinen, and Rouvinen (2015) find that the correlation is negative and significant when using ex-ante measure, however, the ex-post measure of innovativeness makes this relationship positive and insignificant. The difference between ex-post and ex-ante measure of innovation lies in the fact that ex-post measure of innovation can indicate a level of success, while the ex-ante measure of innovation can mirror the inherent uncertainty (Hyytinen, Pajarinen, and Rouvinen, 2015). In this section, we aim to test different effects from ex-ante and ex-post proxies of innovation. In the spirit of Sapra, Subramanian, and Subramanian (2014), we define the ex-ante measure of innovation as R&D intensity, which is the ratio of a firm's R&D expenditure to sales.

Table 8 presents regressions using ex-ante proxy of innovation. As was discussed, the dependent variables are still three measures of dividend smoothing: speed of adjustment and two alternative measures. Results in this table corroborate our baseline findings. Like patent and citation, R&D intensity can still reduce the speed of adjustment, and increase the dividend smoothing. The speed of adjustment will decrease by 19.9[3] percent when R&D intensity increases by one standard deviation. Therefore, we can conclude that the effects of R&D intensity on speed of adjustment and alternative speed of adjustment are statistically significant and economically sizeable, suggesting that ex-ante proxy of innovation can also promote firms' tendency to smooth their dividends.

### 5.3 Different Period for Innovation

Previously, we measured the innovation using ten-year window prior to our dividend smoothing sample period, suggesting the previous innovation outcome is an important determinant for dividend smoothing. In this section, we emphasize the relationship between innovation and dividend smoothing, using the innovation in the same period as dividend smoothing. We see from Table 9 that using generated innovation and dividend smoothing during same period also produces similar results, while coefficients in column (1) and (2) are still negative, as well as statistically significant. This suggests that dividend

[3]We calculate the economic significance as the coefficient of R&D intensity (-2.388, Table 8 Column 1) times the standard deviation of R&D intensity (0.0377, untabulated), all divided by the mean of the speed of adjustment (0.452, Table 1), resulting 19.9%.

smoothing is not only relative to the previous innovation outcome, but also depends on the synchronous innovation.

### 5.4 Innovative Sample

In our previous baseline regression, we employ all firms, including innovative firms and non-innovative firms, as long as they have observable measures of dividend smoothing. In this section, we examine whether the relationship between innovation and dividend smoothing still holds if we limit our sample within innovative firms only. Results of this section appear in Table 10. We observe that coefficients of innovation, including patent count, patent value and patent citation are still negative, indicating that limiting innovative firms only can still generate similar results, and better performance in patents and citations can motivate firms to undertake higher dividend smoothing.

## 6. Discussion

We document that innovative activities can motivate dividend smoothing. In this section, we attempt to discuss why innovation can affect dividend smoothing. One mutual factor for dividends and innovation is that both can serve as signals to the outsiders. Dividend, representing the observable parts of earnings and investment, can convey the firms' future prospects and managers' confidence. Innovation, representing the soft information, indicates the firms are currently running well and competitive in the product market. Market will put premium on the steady dividends and the higher innovation outputs (Lintner, 1956; Mantripragada, 1976; Guttman, Kadan, and Kandel, 2010; Gugler, 2003; Hirshleifer, Hsu, and Li ,2013; Baker, Mendel, and Wurgler, 2016).

Innovative activities are very likely to suffer from information asymmetry, as they require a substantial amount of initial investment over a long period of time, however, the probability of success is highly uncertain (Acharya and Xu, 2017). Dividend smoothing is more prevalent in firms with higher information asymmetry, and a stable dividend payment conveys the information of earnings persistence. (Wu, 2018; García-Feijóo, Hossain and Javakhadze, 2021). The uncertainty and riskiness in the innovation process make dividend smoothing especially desirable. Besides, innovative activities, which are risky, unpredictable, long-term and multi-stage, labor intensive, as well as idiosyncratic, introduce further agency costs (Holmstrom, 1989). Dividend smoothing could also mitigate agency problems in firms with greater susceptibility to free cash flows (Leary and Michaely, 2011), thus, it is also attractive to innovative companies.

Despite all significantly positive relationship, we notice that there are variations in the economic significances of different innovation proxies. Especially, R&D, the initial invention and development stage, is not as powerful as patents and citations in explaining the dividend smoothing. This stands in sharp contrast to our predication as the information asymmetry in the R&D stage is much higher than patents, while publicly disclosed and easily observable patents could reduce the information asymmetry

(Long, 2002). If firms smooth their dividends to reduce information asymmetry, R&D should cause higher degree of dividend smoothing than patents. We propose two reasons. First, patents can mitigate the effects of market uncertainty on investment decision, and thus, improve the R&D investment (Czarnitzki and Toole, 2011). This requires firms to accumulate earnings for future investment instead of making distributions, and explains the higher economic significance for patents and citations. Another reason lies in the missing R&D. We replace missing R&D with zero, however, as indicated in Koh and Reeb (2015), firms with non-reporting R&D tend to have higher patent application and approval, as well as more influential patents than those without any R&D investment. Thus, using R&D with missing value as an innovation proxy can lead underestimation.

## 7. Conclusion

In this study, we predict and confirm the positive relationship between innovation and dividend smoothing, revealing that firms with more innovation tend to have higher degree of dividend smoothing. Replacing ex-post innovation with ex-ante proxy of innovation, which is the R&D intensity, cannot change this relationship. We further document that financial constraints, the limitation to innovation and dividend distributions, can alleviative the dividend smoothing in innovative firms. Furthermore, we detect the role of cash holdings, which are the insurances against the riskiness and uncertainty, documenting that innovative firms with low cash holdings have higher dividend smoothing. Finally, our results also indicate the positive association between innovation and dividend smoothing is more pronounced in firms with low analyst coverage, as those firms have more incentives to make their dividends stable and predicative.

Overall, this study provides a new, but important determinant of dividend smoothing, which is the innovation. Both information asymmetry and agency costs can account for dividend smoothing. Under the theories of information asymmetry, dividend smoothing indicates the persistent earnings, while those benefiting more from such a positive signal are more likely to smooth their dividends, such as opaque firms with growth prospects and few tangible assets. Under the theories of agency problems, dividend smoothing is attractive to firms with susceptibility to free cash flow problems. Innovative firms are very likely to suffer from both information asymmetries and agency problems, while the growth opportunities and the confidential use of cash flows make innovative firms less transparent, giving innovative firms more tendencies and motivation to smooth their dividends.

# References


Aboody, D. and Lev, B., 2000. Information asymmetry, R&D, and insider gains. *The Journal of Finance*, *55*(6), pp.2747-2766.

Acharya, V. and Xu, Z., 2017. Financial dependence and innovation: The case of public versus private firms. *Journal of Financial Economics*, 124(2), pp.223-243.

Aghion, P., Van Reenen, J. and Zingales, L., 2013. Innovation and institutional ownership. *American Economic Review*, *103*(1), pp.277-304.

Aivazian, V., Booth, L. and Cleary, S., 2006. Dividend smoothing and debt ratings. *Journal of Financial and Quantitative Analysis*, *41*(2), pp.439-453.

Almeida, H. and Campello, M., 2007. Financial constraints, asset tangibility, and corporate investment. *The Review of Financial Studies*, *20*(5), pp.1429-1460.

Baker, M., Mendel, B. and Wurgler, J., 2016. Dividends as reference points: A behavioral signaling approach. *The Review of Financial Studies*, *29*(3), pp.697-738.

Bliss, B., Cheng, Y. and Denis, D., 2015. Corporate payout, cash retention, and the supply of credit: Evidence from the 2008–2009 credit crisis. *Journal of Financial Economics*, *115*(3), pp.521-540.

Block, J., 2012. R&D investments in family and founder firms: An agency perspective. *Journal of Business Venturing*, *27*(2), pp.248-265.

Brav, A., Graham, J., Harvey, C. and Michaely, R., 2005. Payout policy in the 21st century. *Journal of Financial Economics*, *77*(3), pp.483-527.

Brown, J. and Martinsson, G., 2019. Does transparency stifle or facilitate innovation? *Management Science*, *65*(4), pp.1600-1623.

Chemmanur, T. and Fulghieri, P., 2013. Entrepreneurial finance and innovation: An introduction and agenda for future research. *The Review of Financial Studies*, *27*(1), pp.1-19.

Chemmanur, T., He, J., Hu, G. and Liu, H., 2010. Is dividend smoothing universal? New insights from a comparative study of dividend policies in Hong Kong and the US. *Journal of Corporate Finance*, *16*(4), pp.413-430.

Chen, R., Guedhami, O., Yang, Y. and Zaynutdinova, G., 2020. Corporate governance and cash holdings: Evidence from worldwide board reforms. *Journal of Corporate Finance*, *65*, p.101771.

Chen, C. and Wu, C., 1999. The dynamics of dividends, earnings and prices: evidence and implications for dividend smoothing and signaling. *Journal of Empirical Finance*, *6*(1), pp.29-58.

Czarnitzki, D., Hall, B. and Hottenrott, H., 2014. Patents as quality signals? The implications for financing constraints on R&D (No. w19947). *National Bureau of Economic Research.*

Czarnitzki, D. and Toole, A., 2011. Patent protection, market uncertainty, and R&D investment. *The Review of Economics and Statistics*, *93*(1), pp.147-159.

Décamps, J. and Villeneuve, S., 2007. Optimal dividend policy and growth option. *Finance and Stochastics*, *11*(1), pp.3-27.

Denis, D. and Sibilkov, V., 2010. Financial constraints, investment, and the value of cash holdings. *The Review of Financial Studies*, *23*(1), pp.247-269.

Easterbrook, F., 1984. Two agency-cost explanations of dividends. *The American Economic Review*, *74*(4), pp.650-659.

Fang, V., Tian, X. and Tice, S., 2014. Does stock liquidity enhance or impede firm innovation? *The Journal of Finance*, 69(5), pp.2085-2125.

Farre-Mensa, J., Hegde, D. and Ljungqvist, A., 2017. What is a patent worth? Evidence from the US patent "lottery" (No. w23268). *National Bureau of Economic Research*.

García-Feijóo, L., Hossain, M. and Javakhadze, D., 2021. Managerial social capital and dividend smoothing. *Journal of Corporate Finance*, *66*, p.101811.

Garrett, I. and Priestley, R., 2000. Dividend behaviour and dividend signaling. *Journal of Financial and Quantitative Analysis*, *35*(2), pp.173-189.

Graham, J. and Leary, M., 2018. The evolution of corporate cash. *The Review of Financial Studies*, *31*(11), pp.4288-4344.

Griffin, P., Hong, H. and Ryou, J., 2018. Corporate innovative efficiency: Evidence of effects on credit ratings. *Journal of Corporate Finance*, *51*, pp.352-373.

Griliches, Z., Pakes, A. and Hall, B., 1986. The value of patents as indicators of inventive activity. *National Bureau of Economic Research*.

Gugler, K., 2003. Corporate governance, dividend payout policy, and the interrelation between dividends, R&D, and capital investment. *Journal of Banking and Finance*, *27*(7), pp.1297-1321.

Guo, B., Pérez-Castrillo, D. and Toldrà-Simats, A., 2019. Firms' innovation strategy under the shadow of analyst coverage. *Journal of Financial Economics*, *131*(2), pp.456-483.

Guttman, I., Kadan, O. and Kandel, E., 2010. Dividend stickiness and strategic pooling. *The Review of Financial Studies*, *23*(12), pp.4455-4495.

Hall, B., Jaffe, A. and Trajtenberg, M., 2001. The NBER patent citation data file: Lessons, insights and methodological tools (No. w8498). *National Bureau of Economic Research*.

Hall, B., Jaffe, A. and Trajtenberg, M., 2005. Market value and patent citations. *RAND Journal of Economics*, pp.16-38.

Ham, C., Kaplan, Z. and Leary, M., 2020. Do dividends convey information about future earnings? *Journal of Financial Economics*, *136*(2), pp.547-570.

Harford, J., Mansi, S. and Maxwell, W., 2008. Corporate governance and firm cash holdings in the US. *Journal of Financial Economics*, *87*(3), pp.535-555.

He, W., Ng, L., Zaiats, N. and Zhang, B., 2017. Dividend policy and earnings management across countries. *Journal of Corporate Finance*, *42*, pp.267-286.

He, Z. and Wintoki, M., 2016. The cost of innovation: R&D and high cash holdings in US firms. *Journal of Corporate Finance*, *41*, pp.280-303.

Hirshleifer, D., Hsu, P. and Li, D., 2013. Innovative efficiency and stock returns. *Journal of Financial Economics*, *107*(3), pp.632-654.

Holmstrom, B., 1989. Agency costs and innovation. *Journal of Economic Behavior & Organization*, *12*(3), pp.305-327.

Hottenrott, H. and Peters, B., 2012. Innovative capability and financing constraints for innovation: more money, more innovation? *Review of Economics and Statistics*, *94*(4), pp.1126-1142.

Howell, A., 2016. Firm R&D, innovation and easing financial constraints in China: Does corporate tax reform matter? *Research Policy*, 45(10), pp.1996-2007.

Hsu, P., Lee, H., Liu, A. and Zhang, Z., 2015. Corporate innovation, default risk, and bond pricing. *Journal of Corporate Finance*, *35*, pp.329-344

Hyytinen, A., Pajarinen, M. and Rouvinen, P., 2015. Does innovativeness reduce startup survival rates? *Journal of Business Venturing*, *30*(4), pp.564-581.

Hyytinen, A. and Toivanen, O., 2005. Do financial constraints hold back innovation and growth? Evidence on the role of public policy. *Research Policy*, *34*(9), pp.1385-1403.

Javakhadze, D., Ferris, S. and Sen, N., 2014. An international analysis of dividend smoothing. *Journal of Corporate Finance*, *29*, pp.200-220.

Jensen, G., Lundstrum, L. and Miller, R., 2010. What do dividend reductions signal? *Journal of Corporate Finance*, *16*(5), pp.736-747.

Jensen, G., Solberg, D. and Zorn, T., 1992. Simultaneous determination of insider ownership, debt, and dividend policies. *Journal of Financial and Quantitative analysis*, *27*(2), pp.247-263.

Jiang, Z. and Lie, E., 2016. Cash holding adjustments and managerial entrenchment. *Journal of Corporate Finance*, *36*, pp.190-205.

Jiraporn, P. and Lee, S., 2018. Do co-opted directors influence dividend policy? *Financial Management*, *47*(2), pp.349-381.

Kaplan, S. and Zingales, L., 1997. Do investment-cash flow sensitivities provide useful measures of financing constraints? *The Quarterly Journal of Economics*, 112(1), pp.169-215.

Koch, L. and Simmler, M., 2020. How important are local knowledge spillovers of public R&D and what drives them? *Research Policy*, *49*(7), p.104009.

Kogan, L., Papanikolaou, D., Seru, A. and Stoffman, N., 2017. Technological innovation, resource allocation, and growth. *Quarterly Journal of Economics*, 132(2), pp. 665-712.

Koh, P. and Reeb, D., 2015. Missing R&D. *Journal of Accounting and Economics*, *60*(1), pp.73-94.

Lambrecht, B. and Myers, S. 2012. A Lintner model of payout and managerial rents. *The Journal of Finance*, *67*(5), pp.1761-1810.

Larkin, Y., Leary, M. and Michaely, R., 2017. Do investors value dividend-smoothing stocks differently? *Management Science*, *63*(12), pp.4114-4136.

Leary, M. and Michaely, R., 2011. Determinants of Dividend Smoothing: Empirical Evidence. *Review of Financial Studies*, 24(10), pp.3197-3249.

Li, D., 2011. Financial constraints, R&D investment, and stock returns. *The Review of Financial Studies*, *24*(9), pp.2974-3007.

Lintner, J., 1956. Distribution of incomes of corporations among dividends, retained earnings, and taxes. *The American Economic Review*, *46*(2), pp.97-113.

Long, C., 2002. Patent signals. *The University of Chicago Law Review*, pp.625-679.

Luo, M., 2011. A bright side of financial constraints in cash management. J*ournal of Corporate Finance*, 17(5), pp.1430-1444.

Lyandres, E. and Palazzo, B., 2016. Cash holdings, competition, and innovation. *Journal of Financial and Quantitative Analysis*, pp.1823-1861.

Mantripragada, K., 1976. An empirical test of the stable dividend hypothesis. *Journal of Business Research*, *4*(4), pp.325-335.

McGahan, A. and Silverman, B., 2006. Profiting from technological innovation by others: The effect of competitor patenting on firm value. *Research Policy*, *35*(8), pp.1222-1242.

Michaely, R. and Roberts, M., 2006. Dividend smoothing, agency costs, and information asymmetry: Lessons from the dividend policies of private firms. *Unpublished Working Paper.*

Michaely, R. and Roberts, M., 2012. Corporate dividend policies: Lessons from private firms. *The Review of Financial Studies*, *25*(3), pp.711-746.

Miller, M. and Modigliani, F., 1961. Dividend policy, growth, and the valuation of shares. *The Journal of Business*, *34*(4), pp.411-433.

Moser, P., Ohmstedt, J. and Rhode, P., 2017. Patent citations—an analysis of quality differences and citing practices in hybrid corn. *Management Science*, *64*(4), pp.1926-1940.

Sapra, H., Subramanian, A., and Subramanian, K., 2014. Corporate Governance and Innovation: Theory and Evidence. *The Journal of Financial and Quantitative Analysis, 49*(4), pp. 957-1003.

Stoffman, N., Woeppel, M. and Yavuz, M., 2019. Small Innovators: No risk, no return. *Kelley School of Business Research Paper,* (19-5).

Tang, J., 2006. Competition and innovation behaviour. *Research policy*, *35*(1), pp.68-82.

Wu, Y., 2018. What's behind smooth dividends? Evidence from structural estimation. *The Review of Financial Studies*, *31*(10), pp.3979-4016.

**Table 1**. Summary Statistics

This table provides the descriptive statistics of all variables in the following empirical analysis, including the measures of dividend smoothing, the innovation proxies and the proxies for market frictions which can affect the dividend smoothing. Speed of Adjustment (*SoA*) is obtained from the following equation:

$$\Delta D_{it} = \alpha + \beta_1 D_{it-1} + \beta_2 E_{it} + \varepsilon_{it}$$

Where $D_{it}$ is the dividends in year $t$ and $\Delta D_{it}$ is the difference of the dividends in year $t$ and year $t-1$. $E_{it}$ represents the earnings in year $t$. Both earnings and dividends are adjusted for the common share outstanding and the stock splits. Speed of Adjustment (*SoA*) can be estimated as $-\widehat{\beta_1}$.

Alternative speed of adjustment (*SoA_alt*) is estimated from the following regression:

$$\Delta D_{it} = \alpha + \beta * dev_{it} + \varepsilon_{it}$$

Where

$$dev_{it} = TPR_i * E_{it} - D_{it-1}$$

Total payout ratio ($TPR_i$) is the firm median payout ratio over the sample period and the alternative measure of dividend smoothing (*SoA_alt*) is the $\hat{\beta}$ from the above equation.

Another alternative of dividend smoothing is relative volatility (*Rel_Vol*), which is measured as the ratio of root mean squared errors from the following two equations:

$$AdjDPS_{it} = \alpha_1 + \beta_1 * t + \beta_2 * t^2 + \varepsilon_{it}$$
$$TPR_i * AdjEPS_{it} = \alpha_2 + \gamma_1 * t + \gamma_2 * t^2 + \eta_{it}$$

Innovation proxies include patent count, patent value and citations, which are obtained from Kogan et al (2017) and Stoffman, Woeppel and Yavuz (2018). Control variables include firm maturity (size and age), natural of asset (asset tangibility and market-to-book ratio), risk (earnings volatility and stock return volatility), investor clientele (turnover), information gap between insiders and outsiders (dispersion and accuracy of analysts' forecast), cash cow indicator, payout ratio and firm leverage. Detailed definitions of each variable can be found in Appendix A.

| | obs | mean | sd | p25 | p50 | p75 |
|---|---|---|---|---|---|---|
| **Dividend Smoothing** | | | | | | |
| SoA | 863 | 0.452 | 0.571 | 0.057 | 0.399 | 0.895 |
| SoA_alt | 863 | 0.326 | 0.372 | 0.035 | 0.179 | 0.574 |
| Rel_Vol | 858 | 1.159 | 3.007 | 0.211 | 0.515 | 0.983 |
| **Innovation** | | | | | | |
| Patent count | 863 | 2.084 | 2.614 | 0.000 | 0.693 | 3.892 |
| Patent value | 863 | 3.515 | 4.049 | 0.000 | 1.820 | 6.695 |
| Citation | 863 | 2.951 | 3.503 | 0.000 | 1.099 | 5.529 |
| **Asymmetric Information & Agency Problems** | | | | | | |
| Size | 863 | 8.161 | 1.953 | 6.841 | 8.222 | 9.564 |
| Age | 863 | 37.224 | 135.810 | 12.000 | 24.000 | 45.000 |
| AssetTang | 863 | 0.339 | 0.248 | 0.136 | 0.256 | 0.524 |
| MA/BA | 863 | 1.767 | 0.995 | 1.175 | 1.476 | 2.047 |
| Earnings_vol | 863 | 0.058 | 0.055 | 0.029 | 0.045 | 0.070 |
| Return_vol | 863 | 0.078 | 0.027 | 0.058 | 0.074 | 0.093 |
| Turnover | 859 | 1.800 | 1.771 | 1.000 | 1.501 | 2.202 |
| FcstDev | 844 | 0.251 | 0.650 | 0.075 | 0.135 | 0.250 |
| FcstDisp | 844 | 0.134 | 0.416 | 0.035 | 0.058 | 0.120 |
| CashCow | 863 | 0.048 | 0.213 | 0.000 | 0.000 | 0.000 |
| PayoutRatio | 863 | 0.425 | 1.137 | 0.125 | 0.246 | 0.469 |
| Leverage | 863 | 0.230 | 0.180 | 0.113 | 0.226 | 0.329 |

**Table 2.** Baseline Regression using Speed of Adjustment

This table provides the results of the baseline regression. The dependent variable is the speed of adjustment (*SoA*) and the independent variable is innovation. Panel A presents the results using patent count as the proxy of innovation. Column (1) displays the results without any control variables, while column (2) controls for the nature of firm assets. In column (3), stock turnover is further included to represent investors' horizon and clientele. Column (4) further controls for the dispersion and accuracy of analysts' forecast. In column (5), we consider whether firms are cash cows. Column (6) controls for firm maturity (size and age). In column (7), return volatility and earnings volatility are included. We further control for firm leverage and payout ratio in column (8) to (9). Column (10) displays the results of baseline regression with all relevant control variables (one proxy for each aspect). Panel B presents the results, using the patent value as the proxy of innovation. Regressions using patent citation appear in Panel C. All regressions control for the industry fixed effects and country fixed effects and use the heteroscedasticity-robust standard errors. Definitions of all variables can be found in Appendix A. Robust t-statistics appear in brackets. The symbols ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

***Panel A: Innovation Proxy-- Patent Count***

| | (1)<br>SoA | (2)<br>SoA | (3)<br>SoA | (4)<br>SoA | (5)<br>SoA | (6)<br>SoA | (7)<br>SoA | (8)<br>SoA | (9)<br>SoA | (10)<br>SoA |
|---|---|---|---|---|---|---|---|---|---|---|
| Patent count | -0.043*** | -0.044*** | -0.044*** | -0.046*** | -0.044*** | -0.025** | -0.034*** | -0.043*** | -0.044*** | -0.045*** |
| | [-4.91] | [-4.96] | [-4.93] | [-5.16] | [-4.50] | [-2.11] | [-3.12] | [-4.75] | [-4.95] | [-4.43] |
| MA/BA | | 0.075*** | 0.072*** | 0.065*** | 0.072*** | 0.060*** | 0.069*** | 0.077*** | 0.076*** | 0.064*** |
| | | [3.78] | [3.67] | [3.44] | [3.66] | [3.08] | [3.22] | [3.67] | [3.76] | [2.90] |
| AssetTang | | 0.134 | 0.129 | 0.212 | 0.129 | 0.129 | 0.097 | 0.136 | 0.116 | 0.198 |
| | | [1.05] | [1.01] | [1.64] | [1.01] | [1.02] | [0.76] | [1.06] | [0.91] | [1.52] |
| Turnover | | | -0.014 | -0.014 | -0.014 | -0.006 | -0.018 | -0.013 | -0.015 | -0.015 |
| | | | [-1.33] | [-1.44] | [-1.32] | [-0.73] | [-1.40] | [-1.37] | [-1.39] | [-1.54] |
| FcstDisp | | | | -0.123 | | | | | | -0.109 |
| | | | | [-1.17] | | | | | | [-1.04] |
| FcstDev | | | | -0.016 | | | | | | -0.025 |
| | | | | [-0.28] | | | | | | [-0.43] |
| CashCow | | | | | 0.021 | | | | | 0.027 |
| | | | | | [0.28] | | | | | [0.35] |
| Size | | | | | | -0.040*** | | | | |
| | | | | | | [-2.68] | | | | |
| Age | | | | | | 0.000 | | | | 0.000 |
| | | | | | | [-1.29] | | | | [-1.18] |
| Return_vol | | | | | | | 1.859* | | | |
| | | | | | | | [1.68] | | | |
| Earnings_vol | | | | | | | 0.395 | | | 0.317 |
| | | | | | | | [1.37] | | | [1.07] |
| Leverage | | | | | | | | -0.205 | | -0.195 |
| | | | | | | | | [-1.64] | | [-1.44] |
| PayoutRatio | | | | | | | | | -0.028* | -0.02 |
| | | | | | | | | | [-1.76] | [-1.30] |
| Constant | 0.733*** | 0.531*** | 0.571*** | 0.586*** | 0.575*** | 0.880*** | 0.288 | 0.593*** | 0.585*** | 0.598*** |
| | [4.36] | [2.74] | [2.94] | [2.76] | [2.99] | [3.69] | [1.19] | [2.94] | [2.97] | [2.66] |
| Industry FE | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Observations | 863 | 863 | 859 | 843 | 859 | 859 | 859 | 859 | 859 | 843 |
| Adj $R^2$ | 0.059 | 0.07 | 0.071 | 0.08 | 0.07 | 0.08 | 0.074 | 0.073 | 0.072 | 0.081 |

***Panel B: Innovation Proxy-- Patent Value***

| | (1) SoA | (2) SoA | (3) SoA | (4) SoA | (5) SoA | (6) SoA | (7) SoA | (8) SoA | (9) SoA | (10) SoA |
|---|---|---|---|---|---|---|---|---|---|---|
| Patent value | -0.028*** | -0.028*** | -0.028*** | -0.030*** | -0.029*** | -0.017** | -0.023*** | -0.027*** | -0.029*** | -0.029*** |
| | [-5.43] | [-5.53] | [-5.51] | [-5.84] | [-5.12] | [-2.23] | [-3.58] | [-5.24] | [-5.60] | [-5.05] |
| MA/BA | | 0.075*** | 0.073*** | 0.066*** | 0.073*** | 0.062*** | 0.069*** | 0.077*** | 0.077*** | 0.065*** |
| | | [3.85] | [3.73] | [3.51] | [3.73] | [3.17] | [3.28] | [3.72] | [3.84] | [2.99] |
| AssetTang | | 0.124 | 0.119 | 0.202 | 0.119 | 0.125 | 0.092 | 0.127 | 0.105 | 0.189 |
| | | [0.98] | [0.94] | [1.57] | [0.94] | [0.99] | [0.72] | [0.99] | [0.82] | [1.45] |
| Turnover | | | -0.014 | -0.015 | -0.014 | -0.007 | -0.018 | -0.013 | -0.015 | -0.015 |
| | | | [-1.38] | [-1.50] | [-1.37] | [-0.84] | [-1.43] | [-1.41] | [-1.45] | [-1.59] |
| FcstDisp | | | | -0.108 | | | | | | -0.095 |
| | | | | [-1.06] | | | | | | [-0.93] |
| FcstDev | | | | -0.023 | | | | | | -0.032 |
| | | | | [-0.42] | | | | | | [-0.55] |
| CashCow | | | | | 0.02 | | | | | 0.026 |
| | | | | | [0.29] | | | | | [0.35] |
| Size | | | | | | -0.035** | | | | |
| | | | | | | [-2.12] | | | | |
| Age | | | | | | 0.000 | | | | 0.000 |
| | | | | | | [-1.18] | | | | [-1.02] |
| Return_vol | | | | | | | 1.655 | | | |
| | | | | | | | [1.49] | | | |
| Earnings_vol | | | | | | | 0.365 | | | 0.281 |
| | | | | | | | [1.26] | | | [0.96] |
| Leverage | | | | | | | | -0.182 | | -0.172 |
| | | | | | | | | [-1.47] | | [-1.29] |
| PayoutRatio | | | | | | | | | -0.030* | -0.022 |
| | | | | | | | | | [-1.91] | [-1.45] |
| Constant | 0.810*** | 0.615*** | 0.656*** | 0.665*** | 0.661*** | 0.892*** | 0.386 | 0.672*** | 0.672*** | 0.676*** |
| | [4.71] | [3.13] | [3.33] | [3.05] | [3.39] | [3.78] | [1.55] | [3.31] | [3.36] | [2.95] |
| Industry FE | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Observations | 863 | 863 | 859 | 843 | 859 | 859 | 859 | 859 | 859 | 843 |
| Adj $R^2$ | 0.063 | 0.074 | 0.075 | 0.085 | 0.074 | 0.08 | 0.077 | 0.076 | 0.077 | 0.086 |

***Panel C: Innovation Proxy-- Citation***

| | (1) SoA | (2) SoA | (3) SoA | (4) SoA | (5) SoA | (6) SoA | (7) SoA | (8) SoA | (9) SoA | (10) SoA |
|---|---|---|---|---|---|---|---|---|---|---|
| Citation | -0.033*** | -0.033*** | -0.034*** | -0.034*** | -0.034*** | -0.021** | -0.027*** | -0.033*** | -0.034*** | -0.033*** |
| | [-5.05] | [-5.14] | [-5.16] | [-5.24] | [-4.76] | [-2.43] | [-3.37] | [-5.03] | [-5.17] | [-4.64] |
| MA/BA | | 0.076*** | 0.074*** | 0.067*** | 0.074*** | 0.061*** | 0.069*** | 0.079*** | 0.077*** | 0.066*** |
| | | [3.87] | [3.75] | [3.54] | [3.75] | [3.15] | [3.27] | [3.77] | [3.85] | [2.98] |
| AssetTang | | 0.132 | 0.127 | 0.209 | 0.127 | 0.125 | 0.094 | 0.134 | 0.114 | 0.193 |
| | | [1.04] | [0.99] | [1.62] | [0.99] | [0.99] | [0.74] | [1.04] | [0.89] | [1.48] |
| Turnover | | | -0.015 | -0.015 | -0.015 | -0.007 | -0.019 | -0.014 | -0.016 | -0.016 |
| | | | [-1.40] | [-1.49] | [-1.39] | [-0.81] | [-1.44] | [-1.45] | [-1.46] | [-1.59] |
| FcstDisp | | | | -0.126 | | | | | | -0.111 |
| | | | | [-1.20] | | | | | | [-1.06] |
| FcstDev | | | | -0.016 | | | | | | -0.025 |
| | | | | [-0.27] | | | | | | [-0.42] |
| CashCow | | | | | 0.011 | | | | | 0.014 |
| | | | | | [0.15] | | | | | [0.20] |
| Size | | | | | | -0.040*** | | | | |
| | | | | | | [-2.67] | | | | |
| Age | | | | | | 0.000 | | | | 0.000 |
| | | | | | | [-1.30] | | | | [-1.21] |
| Return_vol | | | | | | | 1.830* | | | |
| | | | | | | | [1.67] | | | |
| Earnings_vol | | | | | | | 0.406 | | | 0.335 |
| | | | | | | | [1.41] | | | [1.13] |
| Leverage | | | | | | | | -0.217* | | -0.207 |
| | | | | | | | | [-1.75] | | [-1.54] |
| PayoutRatio | | | | | | | | | -0.028* | -0.021 |
| | | | | | | | | | [-1.78] | [-1.34] |
| Constant | 0.743*** | 0.538*** | 0.581*** | 0.601*** | 0.584*** | 0.877*** | 0.299 | 0.603*** | 0.595*** | 0.610*** |
| | [4.60] | [2.85] | [3.06] | [2.93] | [3.09] | [3.75] | [1.25] | [3.06] | [3.10] | [2.78] |
| Industry FE | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Observations | 863 | 863 | 859 | 843 | 859 | 859 | 859 | 859 | 859 | 843 |
| Adj $R^2$ | 0.059 | 0.071 | 0.072 | 0.08 | 0.071 | 0.082 | 0.076 | 0.075 | 0.074 | 0.082 |

**Table 3.** Baseline Regression Using Alternative Proxies

This table provides the regressions when using two alternative measures of dividend smoothing as dependent variables. Panel A displays the results when employing alternative speed of adjustment (*SoA_alt*) as the measure of dividend smoothing, while the interest variables are the measures of innovation, including patent count, patent value and citation. We present the regression without controls and with other characteristics, respectively. Panel B displays the regression results when using relative volatility (*Rel_Vol*) to represent the dividend smoothing. All regressions control for the industry fixed effects and country fixed effects and use the heteroscedasticity-robust standard errors. Definitions of all variables can be found in Appendix A. Robust t-statistics appear in brackets. The symbols ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

***Panel A: Alternative Speed of Adjustment***

| | **Patent Count** | | **Patent Value** | | **Citation** | |
|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| Patent Count | -0.027*** | -0.024*** | | | | |
| | [-4.57] | [-3.53] | | | | |
| Patent Value | | | -0.017*** | -0.016*** | | |
| | | | [-4.92] | [-4.00] | | |
| Citation | | | | | -0.020*** | -0.018*** |
| | | | | | [-4.60] | [-3.77] |
| MA/BA | | 0.077*** | | 0.078*** | | 0.078*** |
| | | [4.49] | | [4.54] | | [4.55] |
| AssetTang | | 0.176* | | 0.17 | | 0.173* |
| | | [1.68] | | [1.63] | | [1.65] |
| Turnover | | -0.012 | | -0.012 | | -0.012 |
| | | [-1.47] | | [-1.50] | | [-1.51] |
| FcstDisp | | -0.025 | | -0.016 | | -0.025 |
| | | [-0.37] | | [-0.25] | | [-0.38] |
| FcstDev | | -0.007 | | -0.011 | | -0.007 |
| | | [-0.20] | | [-0.33] | | [-0.21] |
| CashCow | | -0.013 | | -0.011 | | -0.018 |
| | | [-0.24] | | [-0.20] | | [-0.32] |
| Age | | 0.000 | | 0.000 | | 0.000 |
| | | [0.37] | | [0.42] | | [0.35] |
| Earnings_vol | | 0.16 | | 0.135 | | 0.166 |
| | | [0.69] | | [0.58] | | [0.72] |
| Leverage | | -0.195** | | -0.182* | | -0.201** |
| | | [-2.07] | | [-1.96] | | [-2.14] |
| PayoutRatio | | -0.005 | | -0.006 | | -0.005 |
| | | [-0.34] | | [-0.44] | | [-0.37] |
| Constant | 0.521*** | 0.343** | 0.568*** | 0.385** | 0.527*** | 0.349** |
| | [3.55] | [2.02] | [3.73] | [2.20] | [3.77] | [2.09] |
| Industry FE | YES | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES | YES |
| Observations | 863 | 843 | 863 | 843 | 863 | 843 |
| Adj $R^2$ | 0.083 | 0.124 | 0.087 | 0.128 | 0.083 | 0.125 |

***Panel B: Relative Volatility***

| | Patent Count | | Patent Value | | Citation | |
|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| Patent Count | -0.062* | -0.021 | | | | |
| | [-1.70] | [-0.50] | | | | |
| Patent Value | | | -0.053** | -0.03 | | |
| | | | [-2.04] | [-1.03] | | |
| Citation | | | | | -0.043* | -0.014 |
| | | | | | [-1.69] | [-0.49] |
| MA/BA | | 0.201 | | 0.206 | | 0.201 |
| | | [1.48] | | [1.50] | | [1.49] |
| AssetTang | | 1.483* | | 1.439* | | 1.484* |
| | | [1.79] | | [1.75] | | [1.79] |
| Turnover | | -0.039 | | -0.038 | | -0.04 |
| | | [-0.67] | | [-0.66] | | [-0.68] |
| FcstDisp | | -0.227 | | -0.192 | | -0.23 |
| | | [-0.52] | | [-0.44] | | [-0.53] |
| FcstDev | | 0.218 | | 0.198 | | 0.22 |
| | | [0.90] | | [0.81] | | [0.90] |
| CashCow | | -0.536* | | -0.458* | | -0.547** |
| | | [-1.86] | | [-1.69] | | [-2.00] |
| Age | | 0.000 | | 0.000 | | 0.000 |
| | | [0.82] | | [0.85] | | [0.81] |
| Earnings_vol | | -0.009 | | -0.16 | | 0.007 |
| | | [-0.00] | | [-0.08] | | [0.00] |
| Leverage | | -1.662** | | -1.625** | | -1.668** |
| | | [-2.13] | | [-2.11] | | [-2.13] |
| PayoutRatio | | 0.089 | | 0.085 | | 0.089 |
| | | [1.12] | | [1.06] | | [1.12] |
| Constant | 1.692 | 0.744 | 1.787 | 0.808 | 1.716 | 0.75 |
| | [1.52] | [0.67] | [1.53] | [0.69] | [1.57] | [0.68] |
| Industry FE | YES | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES | YES |
| Observations | 858 | 838 | 858 | 838 | 858 | 838 |
| Adj $R^2$ | 0.033 | 0.035 | 0.034 | 0.036 | 0.032 | 0.035 |

**Table 4.** Effects of Financial Constraints

This table presents whether the relationship between innovation and dividend smoothing is more pronounced in firms with high financial constraints or low financial constraints. We use the KZ index as the proxy of financial constraints, according to the following linear combination:

$$KZ_{it} = -1.002\ CF_{it}/A_{it-1} - 39.368 DIV_{it}/A_{it-1} - 1.315 C_{it}/A_{it-1} + 3.139 BLEV_{it} + 0.283 Q_{it}$$

where $CF_{it}/A_{it-1}$ is the cash flow over lagged assets; $DIV_{it}/A_{it-1}$ is the cash dividends divided by lagged assets; $C_{it}/A_{it-1}$ is the cash balance over lagged assets; $BLEV_{it}$ reflects the leverage, calculated as total debt divided by the sum of total debt and equity; $Q_{it}$ is calculated as the market value of equity plus asset minus book value of equity, all divided by total assets. We winsorize the components of KZ index at 1% and 99% before constructing KZ index. The dependent variables are the proxies of dividend smoothing, including speed of adjustment, alternative speed of adjustment and relative volatility. The interest variables in these regressions are the interactions of innovation and KZ index. All regressions control for the industry fixed effects and country fixed effects and use the heteroscedasticity-robust standard errors. Definitions of all variables can be found in Appendix A. Robust t-statistics appear in brackets. The symbols ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

| | **Speed of Adjustment** | | | **Alternative Speed of Adjustment** | | | **Relative Volatility** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** |
| Patent Count | -0.044*** | | | -0.023*** | | | -0.02 | | |
| | [-4.34] | | | [-3.41] | | | [-0.48] | | |
| Patent Count*KZ index | 0.017** | | | 0.010** | | | 0.026 | | |
| | [2.28] | | | [2.55] | | | [1.09] | | |
| Patent Value | | -0.029*** | | | -0.015*** | | | -0.03 | |
| | | [-4.84] | | | [-3.82] | | | [-1.04] | |
| Patent Value*KZ index | | 0.009** | | | 0.005* | | | 0.017 | |
| | | [2.06] | | | [1.93] | | | [1.13] | |
| Citation | | | -0.032*** | | | -0.017*** | | | -0.013 |
| | | | [-4.52] | | | [-3.58] | | | [-0.44] |
| Citation*KZ index | | | 0.012** | | | 0.006** | | | 0.01 |
| | | | [2.34] | | | [2.11] | | | [0.56] |
| KZ index | -0.075*** | -0.069*** | -0.078*** | -0.047*** | -0.042** | -0.046*** | -0.105 | -0.101 | -0.092 |
| | [-3.42] | [-3.16] | [-3.42] | [-2.76] | [-2.40] | [-2.63] | [-0.69] | [-0.67] | [-0.58] |
| MA/BA | 0.027 | 0.031 | 0.03 | 0.055** | 0.057*** | 0.056*** | 0.159 | 0.168 | 0.159 |
| | [0.99] | [1.11] | [1.08] | [2.56] | [2.64] | [2.64] | [0.83] | [0.87] | [0.84] |
| AssetTang | 0.276** | 0.263* | 0.271** | 0.242** | 0.231** | 0.235** | 1.696* | 1.659* | 1.671* |
| | [2.04] | [1.96] | [2.01] | [2.40] | [2.30] | [2.33] | [1.95] | [1.91] | [1.91] |
| Turnover | -0.012 | -0.013 | -0.014 | -0.011 | -0.011 | -0.012 | -0.037 | -0.036 | -0.037 |
| | [-1.38] | [-1.43] | [-1.47] | [-1.39] | [-1.41] | [-1.44] | [-0.59] | [-0.58] | [-0.60] |
| FcstDisp | -0.108 | -0.103 | -0.11 | -0.024 | -0.021 | -0.026 | -0.224 | -0.203 | -0.23 |
| | [-1.10] | [-1.04] | [-1.10] | [-0.41] | [-0.35] | [-0.41] | [-0.48] | [-0.44] | [-0.50] |
| FcstDev | -0.021 | -0.024 | -0.02 | -0.004 | -0.006 | -0.004 | 0.224 | 0.211 | 0.226 |
| | [-0.38] | [-0.42] | [-0.36] | [-0.14] | [-0.20] | [-0.13] | [0.87] | [0.81] | [0.88] |
| CashCow | 0.002 | 0.01 | -0.01 | -0.027 | -0.019 | -0.03 | -0.585** | -0.495* | -0.586** |
| | [0.02] | [0.14] | [-0.14] | [-0.49] | [-0.34] | [-0.56] | [-1.97] | [-1.79] | [-2.09] |
| Age | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | [-1.38] | [-1.14] | [-1.42] | [0.31] | [0.38] | [0.30] | [0.79] | [0.83] | [0.80] |
| Earnings_vol | 0.126 | 0.093 | 0.155 | 0.028 | 0.009 | 0.044 | -0.276 | -0.439 | -0.227 |
| | [0.39] | [0.29] | [0.47] | [0.13] | [0.04] | [0.20] | [-0.14] | [-0.21] | [-0.11] |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Leverage | 0.002 | 0.009 | -0.013 | -0.077 | -0.072 | -0.084 | -1.451 | -1.449 | -1.445 |
| | [0.01] | [0.06] | [-0.09] | [-0.70] | [-0.66] | [-0.76] | [-1.28] | [-1.28] | [-1.27] |
| PayoutRatio | -0.022 | -0.024* | -0.022 | -0.006 | -0.007 | -0.006 | 0.087 | 0.084 | 0.086 |
| | [-1.59] | [-1.72] | [-1.61] | [-0.47] | [-0.57] | [-0.49] | [1.13] | [1.07] | [1.12] |
| Constant | 0.688*** | 0.738*** | 0.698*** | 0.391*** | 0.415*** | 0.393*** | 0.787 | 0.813 | 0.774 |
| | [3.51] | [3.68] | [3.55] | [2.67] | [2.69] | [2.62] | [0.69] | [0.69] | [0.66] |
| Industry FE | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Observations | 837 | 837 | 837 | 837 | 837 | 837 | 832 | 832 | 832 |
| Adj $R^2$ | 0.096 | 0.097 | 0.096 | 0.139 | 0.139 | 0.137 | 0.034 | 0.035 | 0.033 |

**Table 5.** Effects of Cash Holdings

This table shows whether cash holdings are relevant in explaining the relationship between innovation and dividend smoothing. We divide the sample into three groups based on their cash holdings. Cash holding is defined as the ratio of cash and marketable security to total sales, after log transformation. The dependent variable in this table is the proxy of dividend smoothing, which is the speed of adjustment (*SoA*). The variables of interest are innovation proxies, including patent count, patent value and citation. As prior, we include all variables which are relevant to dividend smoothing. All regressions control for the industry fixed effects and country fixed effects and use the heteroscedasticity-robust standard errors. Definitions of all variables can be found in Appendix A. Robust t-statistics appear in brackets. The symbols ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

| | **Low Cash Holdings** | | | **Medium Cash Holdings** | | | **High Cash Holdings** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** |
| Patent Count | -0.062*** | | | -0.046* | | | -0.045** | | |
| | [-3.35] | | | [-1.89] | | | [-2.44] | | |
| Patent Value | | -0.039*** | | | -0.025* | | | -0.026** | |
| | | [-4.10] | | | [-1.96] | | | [-2.20] | |
| Citation | | | -0.040*** | | | -0.030* | | | -0.034** |
| | | | [-3.20] | | | [-1.81] | | | [-2.47] |
| MA/BA | 0.036 | 0.035 | 0.033 | 0.121** | 0.119** | 0.119** | 0.029 | 0.03 | 0.03 |
| | [0.66] | [0.65] | [0.62] | [2.41] | [2.42] | [2.40] | [0.70] | [0.72] | [0.72] |
| AssetTang | 0.078 | 0.044 | 0.077 | 0.239 | 0.285 | 0.256 | 0.425 | 0.412 | 0.421 |
| | [0.36] | [0.20] | [0.35] | [0.91] | [1.08] | [0.97] | [1.38] | [1.35] | [1.36] |
| Turnover | -0.075** | -0.076** | -0.075** | -0.096** | -0.092** | -0.098*** | 0 | -0.001 | -0.001 |
| | [-2.34] | [-2.38] | [-2.37] | [-2.55] | [-2.45] | [-2.60] | [-0.01] | [-0.07] | [-0.11] |
| FcstDisp | -0.236 | -0.209 | -0.255 | -0.06 | -0.008 | -0.071 | -0.038 | -0.039 | -0.041 |
| | [-0.72] | [-0.63] | [-0.78] | [-0.17] | [-0.02] | [-0.20] | [-0.27] | [-0.28] | [-0.30] |
| FcstDev | 0.049 | 0.039 | 0.058 | 0.021 | -0.015 | 0.021 | -0.13 | -0.126 | -0.129 |
| | [0.27] | [0.22] | [0.32] | [0.10] | [-0.07] | [0.10] | [-1.45] | [-1.42] | [-1.43] |
| CashCow | -0.154 | -0.129 | -0.16 | 0.03 | 0 | -0.002 | 0.155 | 0.14 | 0.141 |
| | [-0.91] | [-0.77] | [-0.93] | [0.20] | [0.00] | [-0.02] | [0.88] | [0.79] | [0.80] |
| Age | -0.000*** | -0.000*** | -0.000*** | -0.000*** | -0.000*** | -0.000*** | 0 | 0.000* | 0 |
| | [-4.24] | [-4.18] | [-4.35] | [-4.23] | [-3.86] | [-4.31] | [1.50] | [1.69] | [1.51] |
| Earnings_vol | 0.935 | 0.891 | 0.861 | 0.235 | 0.255 | 0.285 | 0.645 | 0.619 | 0.698 |
| | [1.56] | [1.49] | [1.46] | [0.23] | [0.24] | [0.27] | [1.09] | [1.04] | [1.16] |
| Leverage | -0.19 | -0.145 | -0.17 | -0.013 | -0.003 | -0.027 | -0.314 | -0.289 | -0.328 |
| | [-0.68] | [-0.53] | [-0.61] | [-0.07] | [-0.02] | [-0.15] | [-0.95] | [-0.86] | [-1.00] |
| PayoutRatio | 0.01 | 0.008 | 0.009 | -0.058*** | -0.059*** | -0.058*** | 0.001 | -0.002 | 0.001 |
| | [0.32] | [0.27] | [0.29] | [-3.33] | [-3.26] | [-3.30] | [0.03] | [-0.12] | [0.05] |
| Constant | 0.609* | 0.581* | 0.600* | 1.522* | 1.477* | 1.505* | -0.034 | 0.045 | -0.019 |
| | [1.93] | [1.80] | [1.90] | [1.92] | [1.83] | [1.85] | [-0.07] | [0.10] | [-0.04] |
| Industry FE | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Observations | 283 | 283 | 283 | 283 | 283 | 283 | 277 | 277 | 277 |
| Adj $R^2$ | 0.04 | 0.058 | 0.034 | 0.163 | 0.159 | 0.158 | -0.055 | -0.058 | -0.054 |

**Table 6.** Effects of Analyst Coverage

This table presents the effects of analyst coverage. We divide our sample into low-analyst group and high-analyst group, based on the number of analysts for each firm. Column (1) to (3) presents the relationship between innovation and dividend smoothing in firms with low analyst coverage, while column (4) to (6) display the results for those followed by more analysts. The dependent variable in this table is the proxy of dividend smoothing, which is the speed of adjustment (*SoA*). The variables of interest are innovation proxies, including patent count, patent value and citation. All regressions control for the industry fixed effects and country fixed effects and use the heteroscedasticity-robust standard errors. Definitions of all variables can be found in Appendix A. Robust t-statistics appear in brackets. The symbols ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

| | **Low Analyst Coverage** | | | **High Analyst Coverage** | | |
|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| Patent Count | -0.073*** | | | -0.024 | | |
| | [-2.66] | | | [-1.60] | | |
| Patent Value | | -0.059*** | | | -0.013 | |
| | | [-2.74] | | | [-1.64] | |
| Citation | | | -0.048*** | | | -0.017 |
| | | | [-2.88] | | | [-1.52] |
| MA/BA | 0.078** | 0.083*** | 0.082*** | 0.039 | 0.039 | 0.039 |
| | [2.50] | [2.74] | [2.64] | [1.18] | [1.20] | [1.18] |
| AssetTang | 0.400* | 0.357 | 0.388* | -0.021 | -0.012 | -0.02 |
| | [1.70] | [1.58] | [1.65] | [-0.11] | [-0.06] | [-0.10] |
| Turnover | -0.006 | -0.006 | -0.008 | -0.025 | -0.025 | -0.024 |
| | [-0.75] | [-0.75] | [-0.99] | [-0.86] | [-0.88] | [-0.85] |
| FcstDisp | -0.618*** | -0.594*** | -0.609*** | 0.407 | 0.427 | 0.409 |
| | [-2.66] | [-2.65] | [-2.62] | [1.46] | [1.53] | [1.47] |
| FcstDev | 0.013 | 0.01 | 0.005 | -0.280* | -0.290* | -0.282* |
| | [0.15] | [0.12] | [0.07] | [-1.70] | [-1.76] | [-1.71] |
| CashCow | 0.047 | 0.056 | 0.01 | 0.032 | 0.023 | 0.025 |
| | [0.30] | [0.37] | [0.06] | [0.36] | [0.27] | [0.28] |
| Age | 0.000*** | 0.000*** | 0.000*** | -0.000** | -0.000** | -0.000** |
| | [2.79] | [3.05] | [2.84] | [-2.27] | [-2.26] | [-2.38] |
| Earnings_vol | -0.105 | -0.181 | -0.061 | 1.008 | 0.992 | 1.026 |
| | [-0.28] | [-0.47] | [-0.16] | [1.54] | [1.51] | [1.56] |
| Leverage | -0.239 | -0.178 | -0.25 | -0.012 | -0.006 | -0.015 |
| | [-1.13] | [-0.82] | [-1.20] | [-0.08] | [-0.04] | [-0.10] |
| PayoutRatio | -0.027 | -0.032 | -0.026 | -0.035** | -0.036** | -0.035** |
| | [-1.18] | [-1.41] | [-1.15] | [-2.26] | [-2.32] | [-2.31] |
| Constant | 0.807** | 1.001*** | 0.778** | 0.375 | 0.406 | 0.377 |
| | [2.45] | [2.97] | [2.34] | [1.54] | [1.62] | [1.54] |
| Industry FE | YES | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES | YES |
| Observations | 431 | 431 | 431 | 412 | 412 | 412 |
| Adj $R^2$ | 0.074 | 0.089 | 0.073 | 0.065 | 0.064 | 0.064 |

**Table 7.** Endogeneity Concerns

This table addresses the endogeneity concerns. Panel A presents the two stage least square regression (2SLS) using the instrumental variables. We use three instrumental variables. The first instrument variable is the number of employees, representing the intellect for each firm. The second one is the pendency, which is the firm's average pendency period between application year and grant year. The final instrument we use is the R&D intensity. We present the first stage in column (1) and the second stage results in column (2) to (4), using the heteroscedasticity-robust standard errors. Panel B shows the treatment effects model for correcting the self-selection problems in reporting patents. The dependent variables are three proxies of dividend smoothing. We treat innovation as an endogenous variable as firms may not make their discoveries public. Innovation is an indicator variable, which equals one for firms with at least one patent and zero otherwise. In the treatment equation, we use the number of employees, industry average patent and R&D intensity to determine whether firms make their innovative discoveries public. All regressions control for the industry fixed effects and country fixed effect. Definitions of all variables can be found in Appendix A. The symbols ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

***Panel A: 2SLS Regression***

| | **Patent Count** | **Speed of Adjustment** | **Alternative Speed of Adjustment** | **Relative Volatility** |
|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** |
| | **First Stage** | **Second Stage** | **Second Stage** | **Second Stage** |
| Employee | 0.485*** | | | |
| | 11.65 | | | |
| Pendency | 0.561*** | | | |
| | [9.84] | | | |
| R&D Intensity | 18.270*** | | | |
| | [8.44] | | | |
| Patent Count | | -0.102*** | -0.058*** | -0.149** |
| | | [-6.45] | [-5.77] | [-2.41] |
| MA/BA | 0.090 | 0.076*** | 0.084*** | 0.223* |
| | [1.31] | [3.36] | [4.94] | [1.70] |
| AssetTang | -0.064 | 0.170 | 0.179* | 1.365* |
| | [-0.15] | [1.37] | [1.91] | [1.71] |
| Turnover | -0.074** | -0.014* | -0.012 | -0.042 |
| | [-2.56] | [-1.71] | [-1.63] | [-0.76] |
| FcstDisp | 0.266 | -0.066 | 0.011 | 0.007 |
| | [0.48] | [-0.58] | [0.16] | [0.02] |
| FcstDev | -0.348 | -0.056 | -0.031 | 0.034 |
| | [-1.10] | [-0.88] | [-0.81] | [0.18] |
| CashCow | 1.804*** | 0.205** | 0.092 | -0.111 |
| | [5.26] | [2.38] | [1.56] | [-0.34] |
| Age | 0.000 | -0.000 | 0.000 | 0.000 |
| | [1.01] | [-0.91] | [0.53] | [1.09] |
| Earnings_vol | -0.947 | 0.080 | -0.129 | -0.815 |
| | [-0.82] | [0.20] | [-0.52] | [-0.33] |
| Leverage | -0.104 | -0.178 | -0.187** | -1.714** |
| | [-0.33] | [-1.42] | [-2.16] | [-2.32] |
| PayoutRatio | 0.026 | -0.023 | -0.007 | 0.074 |
| | [0.67] | [-1.51] | [-0.49] | [1.01] |
| Constant | -2.018** | 0.535* | 0.303 | 0.608 |
| | [-2.19] | [1.95] | [1.52] | [0.47] |
| Industry FE | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES |
| Observations | 834 | 834 | 834 | 829 |
| Adj $R^2$ | 0.675 | 0.044 | 0.090 | 0.041 |

*Panel B: Treatment Effect*

| | (1) | (2) | (3) |
|---|---|---|---|
| | **Speed of Adjustment** | **Alternative Speed of Adjustment** | **Relative Volatility** |
| Innovation | -0.963*** | -0.573*** | -1.861** |
| | [-5.40] | [-5.08] | [-2.14] |
| MA/BA | 0.067*** | 0.079*** | 0.210* |
| | [2.94] | [5.43] | [1.69] |
| AssetTang | 0.178 | 0.185** | 1.371* |
| | [1.28] | [2.09] | [1.81] |
| Turnover | -0.012 | -0.010 | -0.033 |
| | [-1.07] | [-1.40] | [-0.52] |
| FcstDisp | -0.163 | -0.048 | -0.179 |
| | [-1.23] | [-0.57] | [-0.25] |
| FcstDev | 0.009 | 0.008 | 0.156 |
| | [0.13] | [0.19] | [0.40] |
| CashCow | 0.004 | -0.023 | -0.399 |
| | [0.04] | [-0.39] | [-0.84] |
| Age | -0.000 | 0.000 | 0.000 |
| | [-1.08] | [0.87] | [0.49] |
| Earnings_vol | 0.155 | -0.105 | -0.998 |
| | [0.34] | [-0.37] | [-0.40] |
| Leverage | -0.164 | -0.180** | -1.684*** |
| | [-1.45] | [-2.48] | [-2.67] |
| PayoutRatio | -0.027 | -0.009 | 0.067 |
| | [-1.61] | [-0.82] | [0.74] |
| Constant | 0.980** | 0.559** | 1.344 |
| | [2.33] | [2.09] | [0.57] |
| **Innovation** | | | |
| Employee | 0.196*** | 0.196*** | 0.197*** |
| | (6.75) | (6.75) | (6.76) |
| Patent_Industry | 0.411*** | 0.411*** | 0.412*** |
| | (10.59) | (10.59) | (10.59) |
| R&D Intensity | 12.553*** | 12.553*** | 12.379*** |
| | (4.52) | (4.52) | (4.48) |
| Constant | -1.235*** | -1.235*** | -1.234*** |
| | (-11.35) | (-11.35) | (-11.32) |
| **hazard** | | | |
| lambda | 0.519*** | 0.323*** | 1.164** |
| | (4.76) | (4.68) | (2.15) |
| Observations | 834 | 834 | 829 |
| Wald | 233.41 | 272.66 | 169.17 |
| P_value | 0.000 | 0.000 | 0.000 |

**Table 8.** Regression Using Proxy for ex-ante Innovation

This table tests whether the relationship of innovation and dividend smoothing still holds when innovation is measured by ex-ante R&D intensity. The interest variable is R&D intensity, which is the ratio of a firm's R&D expenditure to sales. The dependent variables in column (1) to (3) are speed of adjustment, alternative speed of adjustment and relative volatility, respectively. As prior, we control for all relevant variables. All regressions control for the industry fixed effects and country fixed effects and use the heteroscedasticity-robust standard errors. Definitions of all variables can be found in Appendix A. Robust t-statistics appear in brackets. The symbols ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

| | **(1)** | **(2)** | **(3)** |
|---|---|---|---|
| | **Speed of Adjustment** | **Alternative Speed of Adjustment** | **Relative Volatility** |
| R&D Intensity | -2.388** | -1.297*** | -1.136 |
| | [-2.36] | [-3.46] | [-0.46] |
| MA/BA | 0.071*** | 0.081*** | 0.205 |
| | [3.22] | [4.63] | [1.51] |
| AssetTang | 0.219* | 0.186* | 1.494* |
| | [1.72] | [1.78] | [1.80] |
| Turnover | -0.015 | -0.012 | -0.039 |
| | [-1.50] | [-1.46] | [-0.67] |
| FcstDisp | -0.126 | -0.033 | -0.235 |
| | [-1.29] | [-0.54] | [-0.53] |
| FcstDev | -0.012 | 0 | 0.224 |
| | [-0.22] | [-0.01] | [0.91] |
| CashCow | -0.082 | -0.07 | -0.586** |
| | [-1.22] | [-1.36] | [-2.29] |
| Age | 0.000 | 0.000 | 0.000 |
| | [-1.42] | [0.30] | [0.79] |
| Earnings_vol | 0.383 | 0.191 | 0.018 |
| | [1.27] | [0.83] | [0.01] |
| Leverage | -0.253* | -0.226** | -1.689** |
| | [-1.87] | [-2.34] | [-2.14] |
| PayoutRatio | -0.018 | -0.003 | 0.09 |
| | [-1.17] | [-0.25] | [1.15] |
| Constant | 0.621*** | 0.355** | 0.753 |
| | [3.00] | [2.29] | [0.69] |
| Industry FE | YES | YES | YES |
| Country FE | YES | YES | YES |
| Observations | 843 | 843 | 838 |
| Adj $R^2$ | 0.075 | 0.121 | 0.035 |

**Table 9.** Synchronous Innovation and Dividend Smoothing

This table shows the relationship between innovation and dividend smoothing, while innovation is measured during the same period of dividend smoothing. The dependent variables are the proxies of dividend smoothing, including speed of adjustment, alternative speed of adjustment and relative volatility. The independent variable in our interests is the innovation proxy, measure by the number of patents. We control for all relative variables. All regressions consider the industry fixed effects and country fixed effects and use the heteroscedasticity-robust standard errors. Definitions of all variables can be found in Appendix A. Robust t-statistics appear in brackets. The symbols ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

| | (1) | (2) | (3) |
|---|---|---|---|
| | **Speed of Adjustment** | **Alternative Speed of Adjustment** | **Relative Volatility** |
| Patent Count | -0.045*** | -0.025*** | -0.048 |
| | [-4.23] | [-3.31] | [-1.11] |
| MA/BA | 0.068*** | 0.075*** | 0.268 |
| | [2.63] | [4.10] | [1.61] |
| AssetTang | 0.187 | 0.216* | 1.770* |
| | [1.17] | [1.94] | [1.74] |
| Turnover | -0.037** | -0.033** | 0.019 |
| | [-2.05] | [-2.36] | [0.11] |
| FcstDisp | -0.06 | -0.021 | -0.011 |
| | [-0.52] | [-0.31] | [-0.03] |
| FcstDev | -0.05 | -0.001 | 0.066 |
| | [-0.84] | [-0.03] | [0.31] |
| CashCow | 0.024 | -0.014 | -0.452 |
| | [0.32] | [-0.23] | [-1.57] |
| Age | 0.000 | 0.000 | 0.000 |
| | [-0.92] | [-0.92] | [-0.05] |
| Earnings_vol | 0.398 | 0.227 | -1.585 |
| | [1.15] | [0.86] | [-0.62] |
| Leverage | -0.112 | -0.151 | -1.929** |
| | [-0.81] | [-1.64] | [-2.17] |
| PayoutRatio | -0.032 | 0.003 | 0.001 |
| | [-1.02] | [0.15] | [0.01] |
| Constant | 0.782*** | 0.496*** | 1.903** |
| | [3.65] | [3.41] | [2.30] |
| Industry FE | YES | YES | YES |
| Country FE | YES | YES | YES |
| Observations | 706 | 706 | 704 |
| Adj $R^2$ | 0.083 | 0.146 | 0.08 |

**Table 10.** Innovative Samples Only

This table presents the relationship between innovation and dividend smoothing, using innovative observations only. We define innovative firms as those with at least one successful patent. The dependent variables are dividend smoothing proxies, including speed of adjustment, alternative speed of adjustment and relative volatility. The independent variables are the innovation proxies, measure by the number of patents, patent value and citation, respectively. We include all relative variables shown to be systematically related to dividend smoothing. All regressions control for the industry fixed effects and country fixed effects and use the heteroscedasticity-robust standard errors. Definitions of all variables can be found in Appendix A. Robust t-statistics appear in brackets. The symbols ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

| | **Speed of Adjustment** | | | **Alternative Speed of Adjustment** | | | **Relative Volatility** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** |
| Patent Count | -0.041*** | | | -0.022** | | | -0.022 | | |
| | [-2.72] | | | [-2.39] | | | [-0.43] | | |
| Patent Value | | -0.031*** | | | -0.018*** | | | -0.044 | |
| | | [-3.05] | | | [-2.73] | | | [-1.14] | |
| Citation | | | -0.032*** | | | -0.019*** | | | -0.012 |
| | | | [-2.74] | | | [-2.61] | | | [-0.33] |
| MA/BA | 0.04 | 0.043 | 0.042 | 0.073*** | 0.075*** | 0.075*** | 0.406* | 0.412* | 0.406* |
| | [1.24] | [1.33] | [1.30] | [2.76] | [2.81] | [2.82] | [1.76] | [1.75] | [1.76] |
| AssetTang | 0.357 | 0.358 | 0.358 | 0.218 | 0.217 | 0.216 | 1.554 | 1.51 | 1.562 |
| | [1.31] | [1.32] | [1.31] | [1.33] | [1.35] | [1.33] | [1.19] | [1.18] | [1.19] |
| Turnover | -0.023 | -0.021 | -0.026 | -0.012 | -0.011 | -0.014 | 0.145 | 0.155 | 0.142 |
| | [-1.04] | [-1.02] | [-1.18] | [-0.77] | [-0.69] | [-0.85] | [0.62] | [0.67] | [0.61] |
| FcstDisp | -0.241 | -0.155 | -0.244 | -0.168 | -0.121 | -0.173 | 2.422 | 2.501 | 2.428 |
| | [-0.85] | [-0.56] | [-0.86] | [-0.71] | [-0.51] | [-0.73] | [0.97] | [1.01] | [0.97] |
| FcstDev | 0.019 | -0.017 | 0.008 | 0.062 | 0.042 | 0.056 | 0.208 | 0.152 | 0.205 |
| | [0.14] | [-0.12] | [0.06] | [0.62] | [0.42] | [0.56] | [0.33] | [0.25] | [0.33] |
| CashCow | 0.053 | 0.054 | 0.04 | 0.014 | 0.017 | 0.011 | -0.35 | -0.256 | -0.370* |
| | [0.64] | [0.67] | [0.49] | [0.23] | [0.29] | [0.18] | [-1.51] | [-1.17] | [-1.68] |
| Age | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001** | 0.001** | 0.001** |
| | [0.65] | [0.80] | [0.50] | [1.32] | [1.37] | [1.24] | [2.28] | [2.36] | [2.24] |
| Earnings_vol | 0.276 | 0.178 | 0.296 | 0.17 | 0.107 | 0.17 | 1.203 | 0.82 | 1.252 |
| | [0.63] | [0.41] | [0.68] | [0.47] | [0.29] | [0.48] | [0.49] | [0.33] | [0.51] |
| Leverage | 0.064 | 0.088 | 0.043 | -0.167 | -0.152 | -0.178 | -1.058 | -0.999 | -1.07 |
| | [0.30] | [0.42] | [0.20] | [-1.29] | [-1.24] | [-1.38] | [-1.44] | [-1.42] | [-1.44] |
| PayoutRatio | -0.05 | -0.056 | -0.051 | -0.005 | -0.008 | -0.005 | -0.016 | -0.021 | -0.017 |
| | [-1.37] | [-1.50] | [-1.38] | [-0.22] | [-0.35] | [-0.23] | [-0.09] | [-0.12] | [-0.10] |
| Constant | 0.865** | 0.940*** | 0.875** | 0.638*** | 0.684*** | 0.649*** | -0.424 | -0.226 | -0.436 |
| | [2.41] | [2.67] | [2.44] | [2.95] | [3.18] | [2.99] | [-0.20] | [-0.11] | [-0.20] |
| Industry FE | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Observations | 459 | 459 | 459 | 459 | 459 | 459 | 457 | 457 | 457 |
| Adj $R^2$ | 0.059 | 0.062 | 0.058 | 0.127 | 0.132 | 0.129 | -0.029 | -0.026 | -0.029 |

# Appendix A: Variable Definition

| Variable | Definition |
|---|---|
| ***Dividend Smoothing*** | |
| SoA | Speed of adjustment, which is obtained from the following equation: $$\Delta D_{it} = \alpha + \beta_1 D_{it-1} + \beta_2 E_{it} + \varepsilon_{it}$$ Where $D_{it}$ is the dividends in year $t$ and $\Delta D_{it}$ is the difference of the dividends in year $t$ and year $t-1$. $E_{it}$ represents the earnings in year $t$. Both earnings and dividends are adjusted for the common share outstanding and the stock splits. Speed of Adjustment (SoA) can be estimated as $-\widehat{\beta_1}$. |
| SoA_alt | Alternative speed of adjustment, which is estimated from the following regression: $$\Delta D_{it} = \alpha + \beta * dev_{it} + \varepsilon_{it}$$ Where $$dev_{it} = TPR_i * E_{it} - D_{it-1}$$ Total payout ratio ($TPR_i$) is the firm median payout ratio over the sample period and the alternative measure of dividend smoothing (SoA_alt) is the $\hat{\beta}$ from the above equation. |
| Rel_Vol | Relative volatility, which is measured as the ratio of root mean squared errors from the following two equations: $$AdjDPS_{it} = \alpha_1 + \beta_1 * t + \beta_2 * t^2 + \varepsilon_{it}$$ $$TPR_i * AdjEPS_{it} = \alpha_2 + \gamma_1 * t + \gamma_2 * t^2 + \eta_{it}$$ |
| ***Innovation Proxies*** | |
| Patent Count | The number of patents applied in this ten-year window (1995-2004) prior the dividend smoothing sample period, after natural logarithm, obtained from Kogan et al (2017) and Stoffman, Woeppel and Yavuz (2018). |
| Patent Value | The sum value of each patent for each firm, after natural logarithm, obtained from Kogan et al (2017) and Stoffman, Woeppel and Yavuz (2018). |
| Citation | The natural logarithm of total counts of later patents that cite the patented invention for each firm, obtained from Kogan et al (2017). |
| ***Other Variables*** | |
| Size | Natural logarithm of book assets. |
| Age | The difference between the founding year and the beginning of sample period. |
| AssetTang | Net property, plant and equipment scaled by total assets. |
| MA/BA | The market value of equity plus the book value of assets minus the book value of equity, all divided by the book value of total assets. |
| Earnings_vol | The standard deviation of the ratio of EBITDA to asset over the sample period. |
| Return_vol | The annual standard deviation of monthly stock returns. |
| Turnover | The annual average of the ratio of monthly traded volume of shares to total shares outstanding. |
| FcstDev | The absolute difference between the median analyst forecast and the actual EPS, average over months of the fiscal year. |
| FcstDisp | The standard deviation of analyst forecasts of the current EPS, average over the months of the fiscal year. |
| CashCow | An indicator variable, which equals one for firms with positive profits, A or better debt rating and lower than median P/E ratio. |
| PayoutRatio | Common dividends dividend by net income. |
| Leverage | The sum of short-term and long-term debt divided by book assets. |
| KZ Index | The proxy of financial constraints, according to following equation: $$KZ_{it} = -1.002\, CF_{it}/A_{it-1} - 39.368 DIV_{it}/A_{it-1} - 1.315 C_{it}/A_{it-1} + 3.139 BLEV_{it} + 0.283 Q_{it}$$ where $CF_{it}/A_{it-1}$ is the cash flow over lagged assets; $DIV_{it}/A_{it-1}$ is the cash dividend divided by lagged assets; $C_{it}/A_{it-1}$ is the cash balance over lagged assets; $BLEV_{it}$ reflects the leverage, calculated as total debt divided by the sum of total debt and equity; $Q_{it}$ is calculated as the market value of equity plus asset minus book value of equity, all divided by total assets. We winsorize the components of KZ index at 1% and 99% before constructing KZ index. |

| | |
|---|---|
| Cash Holdings | The ratio of cash and marketable security to total sales, after logarithm. |
| Analyst Coverage | The number of analysts for each firm. |
| Employee | The number of employees, after the logarithm transformation, representing the intellect for each firm. |
| Pendency | The firm's average pendency period between application year and grant year. |
| R&D Intensity | The ratio of a firm's R&D expenditure to sales. |