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Payout Taxes Matter: The Financing R&D Mechanism

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Abstract. Higher taxes on corporate payouts increase the cost of financing with stock issues. As a result, corporate investments that rely on external equity financing should be particularly sensitive to payout tax rates. A large literature shows that firms rely extensively on stock issues to fund research and development (R&D), suggesting that the financing of R&D is a potentially important microlevel mechanism linking payout taxation with real corporate activity. We document a robust negative association between dividend tax rates and firm R&D investment in a broad sample of developed countries between 2000 and 2019. The negative relation between dividend taxes and R&D is concentrated in equity-dependent firms in high-R&D industries. R&D is more sensitive to dividend tax rates in countries with stock market–based financial systems. Dividend taxes are less important for investment in physical capital than for R&D. Higher dividend taxes are associated with less corporate financing with stock issues, particularly in firms with low internal cash flow. Our study highlights the importance of focusing on equity-dependent activities and firms to evaluate the real consequences of payout taxation.

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Keywords: R&D • dividend taxes • stock issues • innovation • economic growth

1. Introduction

Economists and policymakers have debated the consequences of capital income taxation for decades.[1] Although several studies find that tax rates on corporate payouts affect payout policies and capital structure adjustments, there is mixed and inconclusive evidence on the impact these taxes have on real investment decisions.[2] We contribute to this debate by focusing on how payout taxation affects the equity financing of corporate investment in R&D.

As the literature has long recognized, higher taxes on corporate payouts increase the cost of financing with stock issues, so the real consequences of capital income taxation hinge on whether external equity is the marginal source of funds for new investment (e.g., Poterba and Summers 1984, Auerbach 2002, Chetty and Saez 2010). However, this literature has generally not emphasized the fact that some corporate activities are more equity-dependent than others. In particular, R&D spending is financed extensively with stock issues, in part because equity contracts have advantages over debt when it comes to funding intangible investments with distant and highly variable payoffs (e.g., Stiglitz 1985, Hall 2002, Brown et al. 2009). As a consequence, changes in dividend taxes may matter more for R&D than for fixed capital spending, because R&D-intensive firms who exhaust internal finance at the margin cannot *perfectly* substitute to debt to fund R&D when the cost of external equity increases. Given the importance of R&D for innovation and growth, this "financing R&D mechanism" is a potentially important channel linking corporate payout taxation with the real economy.

We study the effects of payout taxes on corporate R&D in a broad international sample of Organisation for Economic Co-operation and Development (OECD) countries over the period 2000 to 2019. Our identification approach focuses on the differential impact of changes in dividend tax rates across firms with varying dependence on external financing (e.g., Rajan and

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Zingales 1998 (RZ)). Focusing on within-country differences across different types of firms is attractive because it flexibly controls for other factors that could be correlated with dividend tax reforms and broadly important for R&D spending in the same country-year, such as changes in economic growth opportunities. In addition, these tests help establish causality because they are motivated by, and help to pin down, a specific theoretical mechanism through which dividend tax reforms affect real activity (e.g., Roberts and Whited 2013), namely, a relatively stronger R&D response in firms that are more dependent on external finance at the margin.

We document a strong, negative association between dividend tax rates and corporate R&D investment in sectors with a higher dependence on external financing. Moreover, these effects are driven by the firms within external finance–dependent industries that depend most on stock issues to fund investment (i.e., small firms, firms that generate less internal cash flow, and firms with low dividend payouts). These findings are robust to alternative measures of industry external finance dependence, alternative sampling approaches, and directly controlling for the possible confounding effects that changes in economic conditions (e.g., gross domestic product (GDP) growth) and other tax policies (e.g., R&D tax credits) might have on R&D spending in equity-dependent firms.

We explore several additional heterogeneity tests to shed more light on the financing R&D mechanism. First, following Billings et al. (2018), we explore whether dividend taxes have a relatively stronger effect on R&D investment in more R&D-intensive industries. We find no significant differential relation between dividend taxes and R&D in high- versus low-R&D industries. In addition, directly controlling for the interaction between dividend taxes and the Billings et al. (2018) indicator of a high-R&D sector has no impact on our baseline estimate of a strong differential effect in external finance–dependent industries. However, when we include the triple interaction between dividend taxes, industry R&D intensity, and industry external finance dependence, we find that the negative consequences of higher dividend taxes for R&D are concentrated in industries that are both R&D intensive *and* external finance dependent. Drilling down even further, we show that the results are entirely driven by the equity-dependent firms in these industries.

Next, we explore differences across countries based on the structure of their financial markets. To the extent that external stock issues are central to the financing R&D mechanism, we expect R&D to be relatively more sensitive to dividend taxes in countries where external equity financing is more prevalent (e.g., Brown et al. 2013). Consistent with this idea, we find that the link between dividend taxes and R&D is substantially stronger in countries with more developed stock markets.

We also provide contrasting evidence on the link between dividend taxes and fixed capital spending in our sample. In sharp contrast to the findings for R&D, the association between dividend taxes and capital spending is typically insignificant and is not robust to alternative measures of external finance dependence. This evidence is consistent with mixed and inconclusive findings on dividend taxes and capital spending in previous studies (e.g., Becker et al. 2013, Yagan 2015, Isakov et al. 2021, Moon 2022).

We conclude by testing the connection between dividend tax rates and new stock issues at the firm level. The financing R&D mechanism hinges on the idea that changes in dividend tax rates affect the actual *use* of external equity financing. Consistent with the equity financing mechanism, we find a significant negative relation between dividend tax rates and new equity issues in firms located in industries that depend more on external financing. Notably, as with the findings for R&D, the strong stock issue response is driven by firms within external finance–dependent industries with a higher ex ante dependence on external finance. This evidence supports the financing mechanism and is consistent with the idea in Becker et al. (2013) that lower dividend taxes facilitate the reallocation of equity capital to firms with less internal cash flow.

Our study makes a number of contributions and is relevant for an active public policy debate on the effects of capital income tax policy. Most notably, our work directly connects payout taxes with the real investments that drive corporate innovation, technological change, and economic growth over the long run (e.g., Romer 1990, Aghion and Howitt 1992, King and Levine 1993, Grossman and Helpman 1994, Aghion and Howitt 1996). This evidence contributes to an influential literature on the economic effects of payout taxation, including the "new view" and "traditional view" debates about whether these taxes will have any real effects at all (see Auerbach (2002) for a survey of this literature). Our study provides robust support for the traditional view prediction that payout taxes will affect real investment by changing the cost of external equity financing. In so doing, we highlight differences in the effects of payout taxes for both (i) intangible versus tangible corporate investment spending and (ii) equity-dependent versus non-equity-dependent firms.

Our focus differs from most other efforts to understand how the cost of capital consequences of payout taxation influence real activity. For example, Becker et al. (2013) show that as payout tax rates increase, fixed investment shifts away from firms that depend on external equity at the margin, and to firms with high internal cash flow. Similarly, Alstadsaeter et al. (2017)

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study a payout tax reform in Sweden and document allocation effects for fixed investment in a broad sample of unlisted firms. Our work highlights a different implication of the equity financing distortion that accompanies payout taxation: relatively less R&D spending in equity-dependent firms. Similarly, the dynamic general equilibrium model in Gourio and Miao (2010) focuses on the impact of dividend taxes on capital allocation across firms, and estimates from their simulations suggest that lower payout taxes can increase aggregate productivity by enabling previously constrained firms to increase capital investment. Our study also points to a potential connection between payout taxes and productivity growth, but our findings suggest this connection works through investments in R&D rather than physical capital accumulation.

Our findings complement those of Yagan (2015), who evaluates the economic effects of the 2003 U.S. dividend tax cut. Exploiting the fact that the U.S. dividend tax cut applied to some corporations (those with "C" status) but not others ("S" status), Yagan (2015) finds no evidence that the 2003 dividend tax cut affected either capital spending or employee compensation. Similarly, Isakov et al. (2021) study a dividend tax cut in Switzerland in 2011 and find no effect on either capital spending or total investment (capital spending plus R&D), suggesting that retained earnings is the marginal source of funds for the firms in their sample.[3] On the other hand, Moon (2022) documents significant increases in corporate capital spending following a unique capital gains tax reform in Korea. Our contribution is to show that dividend taxes have an economically important effect on R&D investment in equity-dependent firms, a mechanism this prior work does not explicitly study.

Two related studies that do focus on R&D are those by Ma (2016) and Billings et al. (2018). Both studies focus on changes in corporate R&D spending around the 2003 U.S. dividend tax cut. Ma (2016) shows theoretically and empirically that changes in payout taxation can affect innovative activity by altering the intensity of agency conflicts between shareholders and risk-averse owner/managers (e.g., Chetty and Saez 2010, Cheng et al. 2023). Although the financing mechanism we focus on and the agency mechanism are not mutually exclusive, including a proxy for cross-industry differences in managerial incentives in our baseline specification does not change our finding of a strong (negative) differential relation between dividend taxes and R&D.[4]

Billings et al. (2018) find that the U.S. 2003 tax reform is associated with *less* R&D spending in firms in less R&D-intensive industries and firms facing high levels of financial constraints. A key insight from their work is that dividend tax cuts can, in some circumstances, encourage firms to shift resources away from real activity, essentially offsetting the benefits of a lower cost of equity capital. In contrast, our study highlights a *positive* real effect of dividend tax cuts on R&D in equity-dependent firms located in more R&D-intensive industries.

Our work contributes to the literature on the determinants of innovation, particularly the branch of this literature that studies of how financial factors and tax policies affect corporate R&D spending. Most of this work focuses either on the effectiveness of R&D tax credits (e.g., Mansfield 1986, Hall 1993, Bloom et al. 2002, Wilson 2009, Thomson 2017), the R&D response to changes in corporate income taxes (e.g., Atanassov and Liu 2020), or the sensitivity of R&D to the availability of internal and external finance (e.g., Himmelberg and Petersen 1994; Brown et al. 2009, 2012; Aghion et al. 2012).[5] We contribute to this literature by showing that tax policies affecting the cost of external equity financing have an important impact on corporate R&D spending, over and above the effects of the broader institutional environment.

Finally, our findings are relevant for evaluating alternative tax systems and understanding the mechanisms through which these systems affect the real economy (e.g., Slemrod 1990). Our work highlights a negative real consequence of tax systems that favor debt over equity financing. In addition, our work shows that these real effects also depend on the broader institutional environment; in particular, taxes affecting the cost of external equity financing matter more in environments where stock issues are a viable source of external funding. These insights are germane for discussions on the optimal rate at which to tax dividends and capital gains (e.g., Chetty and Saez 2010).[6]

2. Dividend Taxes, Stock Issues, and Investment in R&D

Although questions about the real consequences of capital income taxation continue to generate extensive interest and debate, the financing distortion that arises from payout taxation is uncontroversial: higher taxes on corporate payouts make external equity (stock issues) more expensive than internal cash flow. This "wedge" between the cost of internal and external equity finance reduces the incentive for firms with high cash flow and low investment opportunities to pay out capital and limits access to equity capital for firms that rely on external finance at the margin (Poterba and Summers 1984, Chetty and Saez 2010, Becker et al. 2013). However, although it is clear that the capital tax wedge affects the allocation of equity capital across different types of firms, the extent to which it matters for real activity depends on the importance of stock issues as the marginal source of funds.

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This insight motivates an influential debate in the literature on the economic effects of payout taxation. The "old view" or traditional view is that payout taxation will influence real investment because external equity is the marginal source of funds for new investment (e.g., Harberger 1966, Feldstein 1970). On the other hand, the new view argues that payout taxation will not matter because internal equity (retained earnings) is the marginal source of funds (e.g., King 1977, Auerbach 1979, Bradford 1981). Moreover, even among firms that exhaust internal funds and depend on external finance at the margin, the capital tax wedge will only matter if firms cannot (perfectly) substitute to debt when the cost of financing with stock issues increases.

We extend the insights from this literature by focusing on the economic effects of payout taxation in the firms and real activities that are most equity dependent at the margin. There is substantial theoretical and empirical evidence indicating that R&D-intensive firms use less leverage and rely more on stock issues compared with other firms (e.g., Titman and Wessels 1988, Hall 1992, Aghion et al. 2004, Brown et al. 2013).[7] Notably, compared with traditional investments in fixed capital, R&D has less collateral value and more uncertain, longer-horizon payoffs (Hall 2002, Brown et al. 2009, Rajan 2012, Hsu et al. 2014). If so, stock issues are more likely to be the marginal source of funds for R&D, and R&D the more responsive real investment to changes in the cost and availability of external equity financing. In this sense, whereas the new view perspective on payout taxes may be perfectly reasonable in a world characterized by tangible fixed investment in mature firms with high cash flow, the traditional view is potentially more appropriate for understanding the consequences of payout taxation in modern innovative firms that often rely extensively on external equity to fund high levels of R&D spending (Brown and Petersen 2009).

3. Sample and Variable Definitions

3.1. Data

To identify country-level changes in payout taxes, we use information from the OECD on each country's yearly net top statutory tax rate on dividend income, after accounting for tax credits and allowances at the shareholder level (see table 2.4 in the OECD Tax database). We also use the OECD data to estimate "event study" regressions that focus on the time period surrounding the major dividend tax reforms that took place during our sample period. Specifically, we build an indicator variable (in a similar way as Acharya and Subramanian 2009) that starts at zero and decreases (increases) by one unit in the year a country cuts (raises) the corporate dividend tax rate by at least five percentage points *and* does not subsequently reverse the change within $t-3$ to $t+3$ years around the reform. One advantage of the event study approach is to check for pretrends in R&D spending prior to major tax reforms. Another advantage is to isolate the reforms that are most likely to be perceived by corporations as long lasting.[8]

We merge the country-level data on dividend taxes with firm-level data on investment and financing from the Compustat Global and North America databases.[9] For most of our sampled countries, Compustat has sparse coverage of R&D spending in the 1990s. We thus focus on the 20-year period 2000 to 2019. We focus on the sample of firms in Compustat that report at least three nonmissing R&D observations over the sample period (given that we scale R&D by lagged assets and focus on within-firm regressions, we need at least three observations per firm). We show that our findings are robust to alternative approaches to sample construction, including an approach that assumes all missing R&D values are equal to zero.

3.2. Sensitivity to Changes in the Cost and Availability of External Equity

3.2.1. Measuring External Finance Dependence. Our tests focus on cross-firm differences in sensitivity to changes in the cost of external equity financing. Our baseline approach follows Rajan and Zingales (1998), who use data from U.S. firms to identify the industries whose growth should be most sensitive to financial market development. The key assumption is that reliance on external finance by U.S. firms captures an industry's fundamental or technologically determined need for external capital. Our empirical tests will then focus on whether dividend tax rates have relatively stronger effects on firms in industries with greater dependence on external finance.

To proxy for an industry's external finance dependence, we start with a measure in the spirit of Rajan and Zingales (1998), who focus on the share of new investment that is not financed with internal cash flow. Specifically, for each U.S. firm with coverage in the Compustat North America database, we sum total investment spending (R&D plus capital expenditures), internally generated cash flow, and total assets over the 1990s (the decade prior to the start of our regression sample). Using these summed values, we measure each firm's reliance on external finance as the difference between total investment spending and internally generated cash flow. We then find the median external finance–to–total assets ratio across firms in each industry and consider this value the industry's external finance dependence (*EFD*).[10] Our findings are similar if we measure industry external finance dependence over the 2000–2019 sample period rather than the 1990s (*EFD 2000s*), or if we base the measure on financing and investment activity in non-U.S. firms (*EFD Global*).

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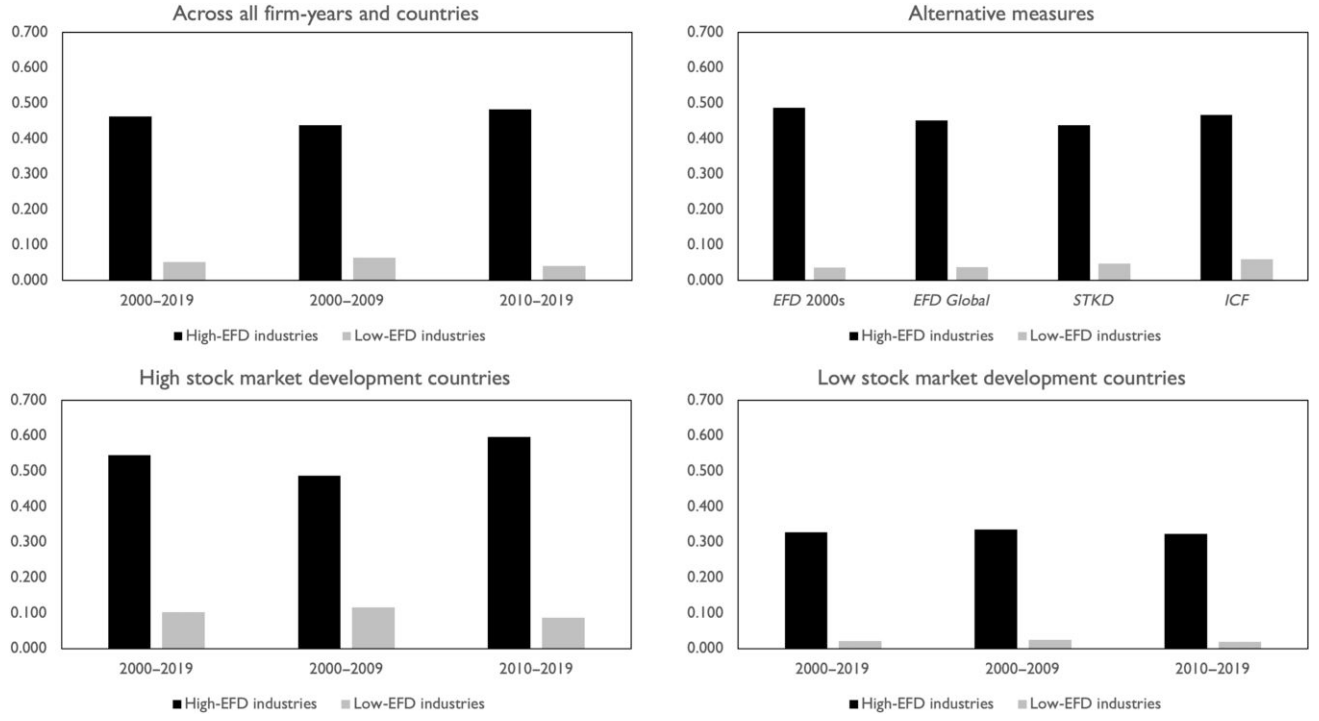
Our findings are also similar if we measure industry external finance dependence with the median firm's stock issues–to–assets ratio (*STKD*) or internal cash flow–to–assets ratio (*ICF*), though of course in the latter case it is the industries with lower values of *ICF* that should be more sensitive to changes in payout tax rates.

3.2.2. Stock Issues in a Global Sample: Differences Across Industries with High and Low External Finance Dependence. Figure 1 shows how the industry external finance dependence measures, most of which are based on the financing and investing activity in U.S. firms in the 1990s, relate to net stock issues in our global sample of firms in the 2000–2019 period. The panel on the top left of Figure 1 shows the pooled sample average stock issues–to–assets ratio in high-*EFD* (top quartile) and low-*EFD* (bottom quartile) industries. There are two key takeaways. First, the firms in our sample located in industries in the top quartile of *EFD* (high-*EFD* industries) issue substantially more external equity than firms in the bottom quartile of *EFD* (low-*EFD* industries). For example, over the full time period (2000–2019), the average stock issues–to–assets ratio is 0.46 in the high-*EFD* industries and only 0.05 in the low-*EFD* sectors. Second, the differing reliance on stock issues across high- and low-*EFD* sectors is stable across the sample period. There is slightly more use of stock issues during the second half of the sample period, but the sizable *gap* in stock issues across high- and low-*EFD* industries is highly persistent over time.

The top right panel in Figure 1 shows that the alternative proxies for industry external finance dependence capture similar differences in actual use of stock issues in our sample of firms. Note that firms in low-cash-flow industries rely much more extensively on stock issues compared with firms in high-cash-flow industries, as expected. The stability and robustness of new equity financing across the different measures of external finance dependence is consistent with the argument in Rajan and Zingales (1998) that some industries have a relatively greater technological need for external financing.

The bottom two panels in Figure 1 show how the use of new equity financing in our sample differs across countries with high and low stock market development. Comparing the two panels, there is significantly more stock market financing by firms in countries with high (above median) stock market development. For example, across the full sample period, the average stock issues–to–assets ratio in high-*EFD* industries is almost twice as large in countries with deeper stock markets (0.55 versus 0.33).

Figure 1. Stock Issues Across Industries Based on External Finance Dependence



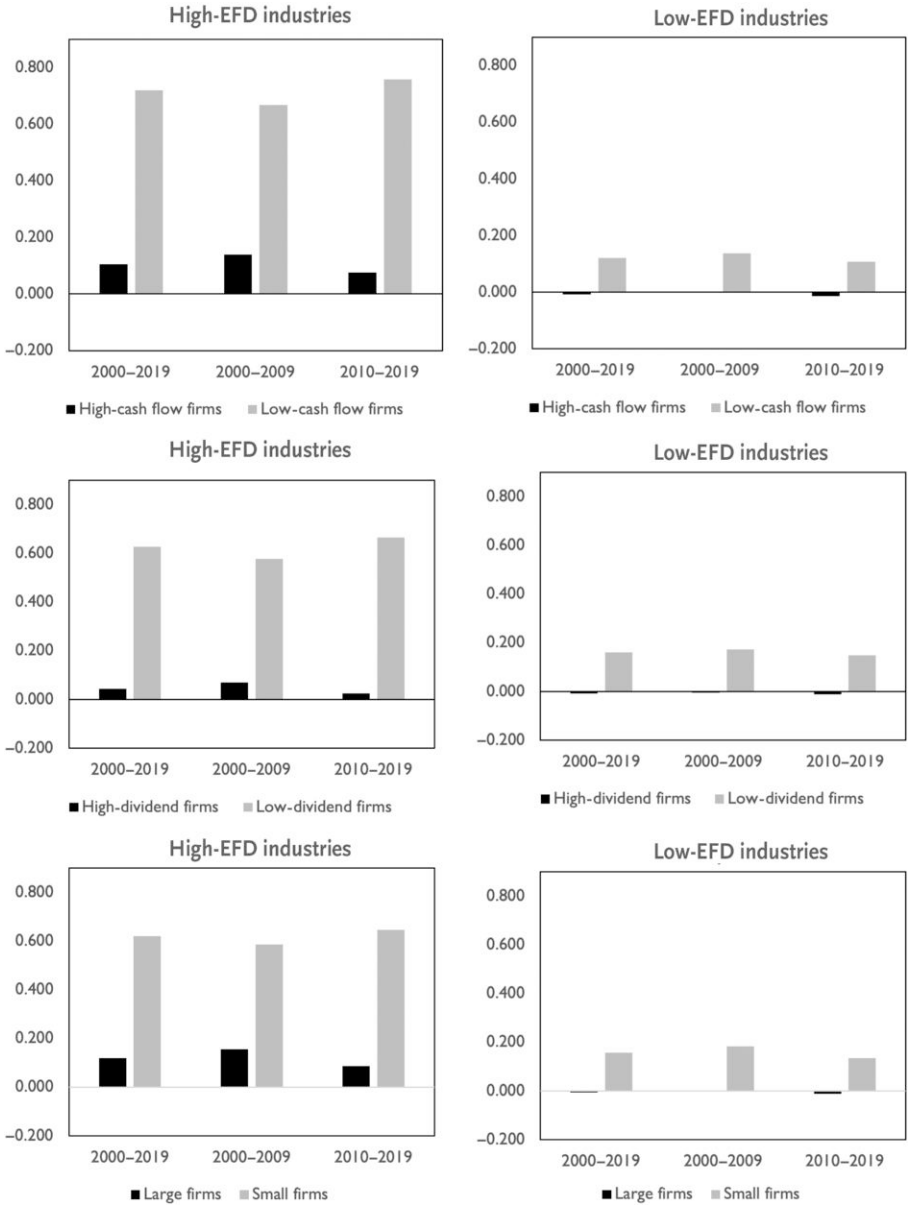
Notes. Figure 1 displays average stock issues–to–assets for firms in high-*EFD* (top quartile in *EFD*) and low-*EFD* (bottom quartile in *EFD*) industries. The top left graph reports average stock issues to assets in three time periods: 2000–2019 (full sample), 2000–2009, and 2010–2019. The top right panel shows differences across top and bottom quartile industries for the four alternative EFD sector measures (*EFD 2000s*, *EFD Global*, *STKD*, and *ICF*). The bottom panels show differences for high (left) versus low (right) stock market development countries measured as above and below the median in stock market capitalization to GDP during 1999–2003.

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3.2.3. New View vs. Traditional View Firms: Cross-Firm Differences in Stock Issues. The disaggregated nature of our data allows us to explore firm-level differences in external finance dependence. This provides another potential "difference" that we can exploit in the empirical tests: some firms within high-*EFD* industries are relatively more dependent on external financing. We focus on three firm-level characteristics that are widely used in the literature to indicate a (relative) need for external capital: cash flow (e.g., Becker et al. 2013), dividend payout (e.g., Fazzari et al. 1988), and size (e.g., Hadlock and Pierce 2010).[11] This approach is broadly consistent with that of Becker et al. (2013), who distinguish between new view and traditional view firms based on firm-level external finance dependence. We expect firms with low cash flow, low dividend payouts, and small size to be traditional view firms who rely more on external equity at the margin and, as a consequence, are more sensitive to changes in dividend tax rates.

In Figure 2, we report the sample average stock issues–to–assets value for subsamples of firms with

Figure 2. Stock Issues by Industry External Finance Dependence and Firm Characteristics



Notes. Figure 2 displays average stock issues to assets for firms in high (top quartile in *EFD)* and low (bottom quartile in *EFD)* EFD industries. The top two panels show average stock issues to assets for high- and low-cash-flow firms in high (left) and low (right) EFD industries. The middle two panels show average stock issues to assets for high- and low-dividend firms in high (left) and low (right) EFD industries. The bottom two panels show average stock issues to assets for large and small firms in high (left) and low (right) EFD industries.

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high/low cash flow, high/low dividends, and large/small total assets. We report these stock issue averages separately for high (top quartile) and low (bottom quartile) industry *EFD*. There are three key takeaways. First, firms with low cash flow, low dividends, and small size use substantially more external equity than their counterparts with high cash flow, high dividends, and large size. These patterns hold in both high- and low-*EFD* industries. Second, it is the low-cash-flow, low-dividend, and small firms located in high-*EFD* industries that are particularly dependent on stock issues as a source of funding (the classic traditional view firms). For example, the average stock issues–to–assets ratio for low-cash-flow firms in high-*EFD* industries is around seven times larger than the corresponding value for low-cash-flow firms in low-*EFD* industries. Finally, the patterns and magnitudes in the use of stock issues is very stable over the two decades we study.

3.3. Summary Statistics

Table 1 reports key summary statistics (mean, median, 25th and 75th percentiles, and standard deviation) for the variables we use in this study. We report detailed variable definitions and data sources in Table A.1. Table 2 shows the characteristics of the OECD countries we sample. There is substantial cross-country variation in the (average) tax rate on dividends, which varies from an average of 10% in Mexico to over 46% in Ireland. There is also substantial cross-country variation in corporate tax rates and R&D tax credits. The evidence at the bottom of Table 2 shows that country dividend tax rates are largely uncorrelated with the other country characteristics; in particular, dividend tax rates and corporate taxes are *negatively* correlated across the countries in our sample.

Table 1. Summary Statistics

Variable name	Mean	25th	Median	75th	St. dev.
R&D	0.083	0.006	0.023	0.081	0.177
Cash flow	0.011	0.024	0.083	0.147	0.521
Sales growth	0.037	−0.083	0.028	0.138	0.401
Total debt	0.236	0.018	0.151	0.313	0.394
Cash holdings	0.259	0.067	0.152	0.311	0.370
log(*Total assets*)	5.479	4.072	5.493	6.941	2.250
Q	2.265	0.959	1.313	2.150	3.887
Stock issues	0.102	−0.012	0.000	0.005	0.513
Fixed investment	0.055	0.011	0.028	0.060	0.092
EFD	0.053	−0.007	0.010	0.074	0.094
EFD2000	0.093	−0.001	0.027	0.181	0.156
EFD Global	0.021	−0.014	0.001	0.012	0.061
EFD_{firm}	0.076	−0.041	−0.013	0.047	0.312
STKD	0.090	0.005	0.041	0.156	0.114
$STKD_{firm}$	0.066	0.000	0.005	0.047	0.160
ICF	0.004	−0.029	0.044	0.068	0.096
ICF_{firm}	0.034	0.021	0.067	0.115	0.191
DivTax	0.251	0.197	0.243	0.306	0.101
PersTax	0.471	0.418	0.463	0.500	0.048
CorpTax	0.291	0.239	0.300	0.350	0.059
RD Credit	0.099	0.060	0.080	0.140	0.075
GDPCAP	10.720	10.591	10.679	10.872	0.156
Gwth Real GDP	1.637	0.960	2.000	2.780	1.793
MCAP	1.049	0.694	1.047	1.419	0.385

Notes. The table reports summary statistics for the firm-years used in the main R&D regression sample. The regression sample conditions on having at least three nonmissing R&D observations and sufficient data on the control variables to estimate the full specification in Equation (1) (114,558 observations). The descriptive statistics for the *Fixed investment* variable are based on the larger sample requiring at least three nonmissing fixed investment observations and sufficient data on the control variables to estimate the full specification in Equation (1) (215,341 observations). Table A.1 provides detailed definitions and data sources for each of the variables.

4. Empirical Approach

Our empirical specification isolates the within-country, across-industry differential effects of changes in payout tax rates. We follow an approach similar in spirit to the classic tests in Rajan and Zingales (1998), although RZ work with a cross-section of observations at the country-industry level, and we use a panel of observations at the firm (i) and year (t) level. We estimate the following regression:

$$Y_{i,t} = \alpha(DivTax_{c,t-1} \times EFD_j) + \beta(Z_{c,t-1} \times EFD_j) + \gamma X_{i,t} + \eta_i + \eta_{j,t} + \eta_{c,t} + \epsilon_{i,t}. \quad (1)$$

Here, $Y_{i,t}$ is the financing or investing outcome of interest for firm i in year t, $DivTax_{c,t-1}$ measures the level of dividend taxation in country c at time period $t-1$, EFD_j is industry j's dependence on external finance, $\mathbf{Z}_{c,t-1}$ is a vector of country-year control variables, and $\mathbf{X}_{i,t}$ is a vector of firm-year control variables. The full specification also includes firm fixed effects (η_i), and full sets of industry-year ($\eta_{j,t}$) and country-year ($\eta_{c,t}$) dummy variables. We cluster standard errors at the country level.

The panel nature of our data permits a much richer fixed effects structure than is possible in the standard cross-sectional RZ-style regression, allowing us to flexibly control for a host of unobserved factors that may confound our inferences on the effects of payout taxation. The firm fixed effects control for any factors common to the same firm over time (such as a country's overall institutional quality and the firm's governance quality or general level of investment opportunities). The industry-year fixed effects account for any time-varying industry-level factors that may drive R&D spending across all firms in a sector, such as changes in industry growth opportunities. The country-year fixed effects account for any time-varying country-level factors that impact investment and financing activity across all firms in a given country-year, such as business cycle effects and financial market developments.

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Table 2. Country Characteristics

Country	Dividend tax rate	Personal tax rate	Corporate tax rate	R&D tax credit	GDP per capita	Gwth real GDP	No. of observations
Panel A: Country average							
Australia	0.248	0.475	0.300	0.115	10.720	2.599	3,851
Austria	0.256	0.477	0.256	0.116	10.812	1.404	453
Belgium	0.213	0.537	0.328	0.126	10.718	1.497	655
Canada	0.314	0.484	0.192	0.161	10.665	2.029	4,576
Denmark	0.426	0.572	0.250	−0.009	10.792	1.200	650
Finland	0.196	0.510	0.242	0.018	10.673	1.439	1,227
France	0.370	0.524	0.362	0.373	10.610	1.276	3,024
Germany	0.257	0.476	0.187	−0.023	10.727	1.346	3,857
Greece	0.114	0.469	0.258	0.047	10.299	−0.816	579
Ireland	0.461	0.469	0.129	0.226	10.971	2.692	243
Italy	0.198	0.468	0.272	0.040	10.561	0.025	1,040
Japan	0.184	0.516	0.278	0.134	10.580	0.729	32,742
Korea	0.367	0.431	0.229	0.048	10.557	3.151	7,807
Mexico	0.109	0.332	0.300	0.051	9.815	1.809	44
Netherlands	0.246	0.520	0.270	0.105	10.811	1.414	639
Norway	0.252	0.403	0.266	0.207	11.000	1.447	674
Portugal	0.255	0.516	0.281	0.389	10.328	0.843	78
Spain	0.230	0.458	0.281	0.347	10.479	1.332	587
Sweden	0.300	0.568	0.244	0.016	10.762	2.055	2,264
United Kingdom	0.307	0.436	0.253	0.097	10.628	1.596	6,802
United States	0.256	0.434	0.338	0.069	10.887	2.058	42,766
Panel B: Correlations							
Dividend tax rate	1.00						
Top personal rate	−0.04	1.00					
Corporate tax rate	−0.14	−0.33	1.00				
R&D tax credits	−0.12	0.32	0.05	1.00			
GDP per capita	0.07	−0.42	0.35	−0.30	1.00		
Gwth real GDP	0.15	−0.24	0.00	−0.12	0.24	1.00	

Notes. Panel A reports the average values of the dividend tax rate (*DivTax*, in column (1)), the (top) personal tax rate (*PersTax*, in column (2)), the corporate tax rate (*CorpTax*, in column (3)), the level of R&D tax incentives (*R&D Credit*, in column (4)), the natural logarithm of GDP per capita (*GDPCAP*, in column (5)), the average annual growth rate in real GDP (*Gwth real GDP*, in column (6)), and the observation count (column (7)) for each sampled country during the time period 2000–2019. Panel B presents correlations for the country measures. Table 1 and Table A.1 provide summary statistics and detailed variable definitions.

Omitted country-year factors remain a potential concern if they are both (i) correlated with the dividend tax rate and (ii) disproportionately important for firms in high-*EFD* industries. Arguably the most important concerns in this regard are that countries systematically change dividend taxes at the same time they make changes to other tax rates, or that countries adopt differing dividend tax policies based on changing economic conditions. We directly control for the potential *differential* effects of these alternative country-year characteristics with the $Z_{c,t-1} \times EFD_j$ interaction term.

The key explanatory variable is the interaction between country *DivTax* and industry *EFD*. The estimate on the interaction term (α) reflects differences in the impact of dividend taxes across firms that differ in terms of their technological dependence on external financing. A negative estimate of α indicates that higher dividend tax rates are associated with a smaller within-country difference in R&D spending across firms with high versus low external finance dependence. Differential evidence of this type permits stronger inferences about the causality of dividend taxation, in part because it is evidence of a specific theoretical (external financing) mechanism through which dividend taxes affect R&D, and also because it flexibly accounts for standard concerns about omitted variable bias and specification error.[12]

5. Dividend Taxes and R&D

5.1. Baseline Estimates

Table 3 reports ordinary least squares (OLS) estimates of Equation (1) with R&D as the dependent variable. We start with specifications that omit the firm- and country-level control variables. The specification in column (1) includes firm and aggregate year fixed effects. In column (2), we replace the aggregate year fixed effects with country-year fixed effects, which absorb the uninteracted *DivTax* variable. In each case, the coefficient estimate on the *DivTax* × *EFD* term is negative and statistically significant at the 5% level. This result indicates that the (negative) effect of country *DivTax* on

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Table 3. Dividend Taxes and R&D Investment

Explanatory variable	(1)	(2)	(3)	(4)	(5)
$DivTax_{c,t-1}$	−0.007				
	(0.017)				
$DivTax_{c,t-1} \times EFD_j$	−0.451**	−0.457**	−0.584***	−0.335***	−0.333***
	(0.176)	(0.186)	(0.123)	(0.065)	(0.065)
$CorpTax_{c,t-1} \times EFD_j$			0.867	0.233	0.161
			(0.734)	(0.284)	(0.259)
$TopPersTax_{c,t-1} \times EFD_j$			−0.283	−0.694	−0.593
			(1.119)	(0.582)	(0.472)
$R\&DTaxCred_{c,t-1} \times EFD_j$			−0.365	−0.210	−0.237
			(0.355)	(0.266)	(0.207)
$GDPCAP_{c,t-1} \times EFD_j$			−2.108***	−0.989***	−0.858**
			(0.627)	(0.341)	(0.309)
$RealGDPGwth_{c,t-1} \times EFD_j$			0.004	0.009**	0.007*
			(0.006)	(0.003)	(0.003)
$Cash\ flow_{i,t}$				−0.067***	−0.067***
				(0.003)	(0.003)
$Sales\ growth_{i,t}$				0.030***	0.030***
				(0.003)	(0.003)
$Total\ debt_{i,t}$				0.008	0.008
				(0.005)	(0.004)
$Cash\ holdings_{i,t}$				−0.044***	−0.044***
				(0.004)	(0.004)
$\ln(Total\ assets_{i,t})$				−0.016***	−0.016***
				(0.001)	(0.001)
$Q_{i,t}$				0.006***	0.006***
				(0.000)	(0.000)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	No	No	No	No
Country × year effects	No	Yes	Yes	Yes	Yes
Industry × year effects	No	No	No	No	Yes
Observations	130,059	130,057	130,057	113,599	113,564
Adjusted R^2	0.640	0.642	0.644	0.721	0.720

Notes. The table reports OLS estimates of Equation (1) with $R\&D_{i,t}$ as the dependent variable. All regressions include firm fixed effects. Column (1) includes year fixed effects, columns (2)–(5) include country-year fixed effects, and column (5) also includes industry-year fixed effects. $DivTax_{c,t-1}$ is the dividend tax rate, and EFD_j measures each industry's external finance dependence as the ratio of total investment minus internally generated cash flow to assets for the median U.S. firm in a given industry over the 1990–1999 period. The firm-level data are from Compustat, and the country-level variables are from the OECD. The sample period is 2000 to 2019. Detailed variable definitions and summary statistics are provided in Table 1 and Table A.1. The standard errors are clustered at the country level.
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

R&D spending is relatively stronger in industries with a high dependence on external finance.

In column (3), we include interactions between *EFD* and several other time-varying country characteristics with the potential to affect R&D. Notably, after controlling for the potential differential effects of corporate and personal tax rates, R&D tax credits, GDP per capita, and GDP growth, we continue to find a significant negative coefficient on the *DivTax* × *EFD* interaction term.[13] In column (4), we include the firm-year control variables, and in column (5), we estimate the full specification with firm, country-year, and industry-year fixed effects. In each case, the coefficient on the *DivTax* × *EFD* interaction term is negative and statistically significant at the 1% level.[14]

We discuss economic magnitudes in more detail in Section 9, but, broadly speaking, we can evaluate the economic significance of the results in Table 3 by estimating how a given change in the dividend tax rate affects the difference in R&D spending across high- and low-*EFD* industries. For example, the results in column (5) of Table 3 indicate that a 10-percentage-point reduction in the dividend tax rate is associated with a 0.003 increase in the *gap* in R&D investment between an industry at the 75th percentile of *EFD* and an industry at the 25th percentile. This differential effect is a little over 3% of the sample average R&D intensity.[15]

5.2. Other Measures of External Finance Dependence

There are several different ways to identify the industries and firms that should be most sensitive to changes in the dividend tax rate. In Table A.2, we report results using several alternative measures of external finance dependence. First, we report the

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results using two alternative samples to compute industry external finance dependence: *EFD 2000s* and *EFD Global*. Both of these measures are constructed the same way as our primary measure of external finance dependence, except that *EFD 2000s* is based on data for U.S. firms over the 2000–2019 sample period, and *EFD Global* is based on non-U.S. firms in our sample. In each case, the key interaction term is negative and statistically significant, consistent with our baseline results.

In column (3), we focus on a measure of external finance dependence that varies by firm (rather than industry). The variable EFD_{firm} is a firm-specific measure of total investment (R&D plus capital expenditures) not financed by internal cash flow over the full sample period. Although this measure is arguably more endogenous than our primary industry measure (*EFD*), it more directly captures each firm's reliance on external financing during our sample period. The coefficient on the interaction term is negative and statistically significant, consistent with our baseline results.

In the next four columns, we focus separately on industry- and firm-level measures of external stock issues and internal cash flow. Firms with higher dependence on stock issues should be more sensitive to changes in dividend taxes. Indeed, the results in columns (4) and (5) of Table A.2 show that the $DivTax \times STKD$ and $DivTax \times STKD_{firm}$ interactions are negative, statistically significant, and similar in magnitude to our baseline results. On the other hand, firms with *less* internal cash flow should be relatively more dependent on external financing and, therefore, more sensitive to dividend taxation. In column (6), we interact the dividend tax rate with industry-level cash flow dependence (*ICF*), and in column (7), we interact the dividend tax rate with the own firm's cash flow ratio (ICF_{firm}). In each case, the coefficient on the cash flow interaction is *positive* and statistically significant, consistent with the R&D financing mechanism.

5.3. Alternative Microlevel Mechanisms

One potential concern is that our baseline results are confounded by the correlation between dividend tax policy and firm-specific factors, such as growth opportunities or financial structure. We provide a series of additional tests in Table A.3 that speak to the most plausible confounding factors. Specifically, we augment the baseline specification with interactions between time-varying firm characteristics and both *DivTax* and *EFD*. The results in columns (1) and (2) show that directly controlling for the potential interactive effects of industry and firm growth rates on R&D has no effect on our main inferences. Similarly, columns (3) and (4) show that both leverage and market value (Tobin's *Q*) are relatively more important for R&D spending in high-*EFD* industries; however, controlling for these differential effects does not impact the baseline finding of a negative effect of dividend taxes on R&D in high-EFD industries. In column (5), we directly control for whether the firm reports under International Financial Reporting Standards (IFRS) standards in a given year. We do this to ensure that changes in R&D reporting standards are not spuriously affecting our findings. The results are almost identical to the baseline results in Table 3.

Dividend taxes can also influence managerial incentives to make productive but risky investments (Chetty and Saez 2010, Ma 2016, Cheng et al. 2023). Although agency conflicts tend to be more severe in high-cash firms with low external finance dependence and operate independent of the cost of capital channel we focus on, they could potentially explain some of our findings. Because agency incentives are a function of managerial ownership, we can at least partially control for the agency mechanism by adding interactions between country dividend taxes and indicators for cross-industry differences in the concentration of inside ownership (*IO*).[16] In column (6) of Table A.3, the estimate on the $DivTax \times EFD$ interaction remains negative and statistically significant, whereas the estimate on the $DivTax \times IO$ term is positive but statistically insignificant. These results show that controlling for agency issues associated with varying levels of inside ownership does not affect our inferences about the relation between dividend taxes and corporate R&D in external finance–dependent firms.

5.4. Alternative Samples and Dependent Variables

Table 2 shows that Japan and the United States account for a large share of firm-level observations in our main sample. In the first column in Table A.4, we exclude both the United States and Japan from the regression sample. This approach reduces the sample size by approximately 66%. Nonetheless, the coefficient estimate on the key interaction term is statistically significant at the 1% level and even larger in magnitude than the baseline estimate in Table 3. Column (2) reports results from a larger sample that sets any missing R&D observations to zero. The coefficient estimate is smaller in magnitude (as is the sample average R&D intensity), but the main finding of a significant negative differential effect holds in the larger sample. In columns (3)–(7) in Table A.4, we report results using alternative scales and transformations of the R&D variable, including log(*R&D*), R&D as a share of total investment ($R\&D_{inv}$), and R&D-to-sales ($R\&D_{sales}$). In each case, the coefficient on the key interaction term is negative and statistically significant, consistent with our baseline approach.

6. Event Study Specifications

Next, we turn to event study regressions that focus on changes in R&D spending around major dividend tax

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reforms. To perform these tests, we need relatively "clean" dividend tax changes in the sense that they are both sizable in magnitude and uncontaminated by subsequent or prior reforms. We thus flag all country years where the country's top dividend tax rate changes by at least five percentage points and has three pre- and postyears of data without reversals. There are 13 of these dividend tax reforms in our sample: tax cuts in the United States in 2003, Japan in 2004, and Canada in 2006, and tax increases in Finland in 2005, Norway in 2006, France in 2011, Ireland in 2011, Italy in 2012, Belgium in 2012, the United States in 2013, Mexico in 2014, Japan in 2014, and Canada in 2016.[17]

We define an *Event* indicator variable that starts at zero and increases (decreases) by one unit in the year of a major dividend tax increase (cut). We include three years before and after each dividend tax reform and pool the data across the 13 events in our sample so that we can use the same difference-in-differences approach that we use in the main tests.

Columns (1) and (2) in Table 4 show the average (differential) effect of a major dividend tax reform in the pooled sample. Whether or not we include the time-varying firm-level controls, the *Event* × *EFD* interaction is negative and statistically significant. Thus, consistent with the prior estimates, large increases (cuts) to the corporate dividend tax rate are associated with a significant differential reduction (increase) in R&D investment in high-*EFD* industries.

One advantage of the event study approach is the ability to test whether the differential effect we focus on shows up prior to the reform. In column (3) of Table 4, we replace the *Event* × *EFD* variable with a series of interaction terms that capture the differential effect two years before the tax reform ($Before^{(-2)} \times EFD_j$), the year before the reform ($Before^{(-1)} \times EFD_j$), the year of the

Table 4. Dividend Taxes and R&D Investment: Large Changes

Explanatory variable	(1)	(2)	(3)	(4)
$Event_{c,t} \times EFD_j$	−0.106***	−0.082***		
	(0.023)	(0.010)		
$Before^{(t-2)} \times EFD_j$			−0.016	
			(0.012)	
$Before^{(t-1)} \times EFD_j$			0.007	
			(0.018)	
$After^{(t\ to\ t+1)} \times EFD_j$			−0.023	
			(0.024)	
$After^{(t+2\ to\ t+3)} \times EFD_j$			−0.071***	
			(0.013)	
$Tax\ Increase_{c,t} \times EFD_j$				−0.088***
				(0.024)
$Tax\ Decrease_{c,t} \times EFD_j$				0.080***
				(0.024)
Firm fixed effects	Yes	Yes	Yes	Yes
Industry × year effects	Yes	Yes	Yes	Yes
Country × year effects	Yes	Yes	Yes	Yes
Country interactions	Yes	Yes	Yes	Yes
Firm controls	No	Yes	Yes	Yes
Observations	67,363	59,946	59,946	59,946
Adjusted R^2	0.672	0.731	0.731	0.731

Notes. The table reports OLS estimates of Equation (1) with $R\&D_{i,t}$ as the dependent variable. *Event* is an indicator variable that starts at zero and increases (decreases) by one unit in the year of a major dividend tax increase (cut). The tests include data three years before and after each dividend tax reform. $Before^{(-2)}$ is an indicator variable taking the value one two years before the tax reform (zero otherwise), $Before^{(-1)}$ takes the value one the year before the reform (zero otherwise), $After^{(t\ to\ t+1)}$ takes the value one the year of the reform and the year after (zero otherwise), and $After^{(t+2\ to\ t+3)}$ takes the value one years $t+2$ to $t+3$ following the reform (zero otherwise). $Tax\ increase_{c,t}$ ($Tax\ decrease_{c,t}$) is an indicator variable that takes on the value one at the year of a large tax increase (decrease) and the three years after (zero otherwise). EFD_j measures each industry's external finance dependence as the ratio of total investment minus internally generated cash flow to assets for the median U.S. firm in a given industry over the 1990–1999 period. All regressions include firm, industry-year, and country-year fixed effects and the following country-year interactions with EFD_j: corporate tax rate, top personal tax rate, R&D tax credits, GDP per capita (in logs), and the real GDP growth rate. Columns (2)–(4) include the following firm control variables: $Cash\ Flow_{i,t}$, $Sales\ growth_{i,t}$, $Total\ debt_{i,t-1}$, $Cash\ holdings_{i,t-1}$, ln($Total\ assets_{i,t}$), and $Q_{i,t}$. The firm-level data are from Compustat, and the country-level variables are from the OECD. The sample period is 2000 to 2019. Detailed variable definitions and summary statistics are provided in Table 1 and Table A.1. The standard errors are clustered at the country level.

*** indicates significance at the 1% level.

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reform and the year after ($After^{(t\ to\ t+1)} \times EFD_j$), and years $t+2$ to $t+3$ following the reform ($After^{(t+2\ to\ t+3)} \times EFD_j$). The estimates show that no differential effects from the tax reforms show up in years prior to the reform, as expected if our findings are not spurious. Moreover, the negative differential effect increases in magnitude in the years *after* the reform, supporting a causal inference (e.g., Bertrand and Mullainathan 2003).

In the last column of Table 4, we replace the *Event* indicator with separate indicators for dividend tax increases (*Tax increase*) and decreases (*Tax decrease*). The coefficients on the interaction terms are similar in magnitude but opposite in sign, showing that large dividend tax increases are associated with less R&D in high-*EFD* industries, whereas large dividend tax cuts are associated with more R&D in high-*EFD* industries.

7. Heterogeneity

7.1. Firm-Level Sorts

As argued above, some (new view) firms likely have sufficient resources to fund R&D internally, whereas other (traditional view) firms depend on external equity at the margin. We have already shown that, within high-*EFD* industries, it is the low-cash-flow, low-dividend, and small firms in our sample that rely most heavily on new stock issues (see Figure 2). We now explore whether the R&D response is most pronounced in these types of firms.

In the first two columns in Table 5, we sort firms into two groups based on the level of internal cash flow that they generate, in the next two columns, we sort firms based on dividend payouts, and in the last two columns, we sort firms based on size. We find negative, statistically significant, and large differential effects for the low-cash-flow, low-dividend, and small firm subsamples. In the high-cash-flow, high-dividend, and large samples, the estimate on the *DivTax* × *EFD* interaction is negative but small and statistically insignificant. In each case, the coefficient estimates for the different subsamples are statistically different at conventional levels. Thus, the effects of dividend tax changes show up in the types of firms where the effects *should be* the strongest if the financing R&D mechanism is operational.[18]

7.2. High- and Low-R&D Sectors

In Table 6, we explore whether there are differences in the effects of dividend taxes across high- and low-R&D sectors. These tests are motivated by Billings et al. (2018), who find that the 2003 U.S. dividend tax cut had a negative impact on R&D investment in low-R&D sectors. Following Billings et al. (2018), we define an indicator variable *HRD* (high-R&D sector) to equal one if the firm operates in one of the following two-

Table 5. Dividend Taxes and R&D Investment: Firm-Level Heterogeneity

	(1)	(2)	(3)	(4)	(5)	(6)
Explanatory variable	High cash flow	Low cash flow	High dividend	Low dividend	Large assets	Small assets
$DivTax_{c,t-1} \times EFD_j$	−0.015	−0.804***	−0.032	−0.532***	−0.061	−0.596***
	(0.141)	(0.158)	(0.119)	(0.174)	(0.138)	(0.151)
Difference (low – high)		−0.789***		−0.500**		−0.535***
(p-value)		(0.000)		(0.018)		(0.009)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × year effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year effects	Yes	Yes	Yes	Yes	Yes	Yes
Country interactions	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	59,144	54,308	57,546	55,894	58,833	54,636
Adjusted R^2	0.760	0.684	0.706	0.693	0.752	0.691

Notes. The table reports OLS estimates of Equation (1) with $R\&D_{i,t}$ as the dependent variable. $DivTax_{c,t-1}$ is the dividend tax rate. EFD_j measures each industry's external finance dependence as the ratio of total investment minus internally generated cash flow to assets for the median U.S. firm in a given industry over the 1990–1999 period. The firm-level data are from Compustat, and the country-level variables are from the OECD. The sample period is 2000 to 2019. High (low) cash flow (dividend) are firms above (below) the median in $Cash\ Flow_i$ ($Dividend_i$) within a given country. Large (small) assets are firms above the median in $Total\ assets_i$ within a given country. $Cash\ Flow_i$, $Dividend_i$, and $Total\ assets_i$ are averaged over all sample years for each firm. All regressions include firm, industry-year, and country-year fixed effects and the following country-year interactions with EFD_j: corporate tax rate, top personal tax rate, R&D tax credits, GDP per capita (in logs), and the real GDP growth rate. All columns include the following firm control variables: $Cash\ Flow_{i,t}$, $Sales\ growth_{i,t}$, $Total\ debt_{i,t-1}$, $Cash\ holdings_{i,t-1}$, ln($Total\ assets_{i,t}$), and $Q_{i,t}$. Columns (1) and (2) include the same control variables except for $Cash\ Flow_{i,t}$; columns (5) and (6) include the same control variables except for ln($Total\ assets_{i,t}$). The difference (low – high) test is a two-sided Wald test of coefficient equality for each firm-level sort. Detailed variable definitions and summary statistics are provided in Table 1 and Table A.1. The standard errors are clustered at the country level.

*** and ** indicate significance at the 1% and 5% levels, respectively.

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Table 6. Dividend Taxes and R&D Investment: High-R&D Sectors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Explanatory variable	All	All	All	High cash flow	Low cash flow	High dividend	Low dividend	Large assets	Small assets
$DivTax_{c,t-1} \times HRD_j$	0.015	0.017	0.030*	0.015	0.042**	0.004	0.064**	0.005	0.060**
	(0.013)	(0.014)	(0.015)	(0.011)	(0.019)	(0.008)	(0.027)	(0.008)	(0.028)
$DivTax_{c,t-1} \times EFD_j$		−0.336***	−0.048	0.000	−0.341***	−0.074	−0.028	−0.141	0.065
		(0.065)	(0.090)	(0.142)	(0.117)	(0.078)	(0.158)	(0.091)	(0.122)
$DivTax_{c,t-1} \times HRD_j \times EFD_j$			−0.403***	−0.023	−0.661***	0.064	−0.688**	0.107	−0.940***
			(0.117)	(0.108)	(0.193)	(0.132)	(0.254)	(0.124)	(0.258)
Difference (low – high)					−0.638***		−0.752***		−1.047***
(p-value)					(0.004)		(0.009)		(0.000)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	113,564	113,564	113,564	59,144	54,308	57,546	55,894	58,833	54,636
Adjusted R^2	0.720	0.720	0.720	0.760	0.684	0.706	0.693	0.752	0.691

Notes. The table reports OLS estimates of Equation (1) with $R\&D_{i,t}$ as the dependent variable. $DivTax_{c,t-1}$ is the dividend tax rate. HRD_j is an indicator variable taking the value one if the firm is in a sector with SIC code 28, 35, 36, or 48 and zero otherwise. EFD_j measures each industry's external finance dependence as the ratio of total investment minus internally generated cash flow to assets for the median U.S. firm in a given industry over the 1990–1999 period. The firm-level data are from Compustat, and the country-level variables are from the OECD. The sample period is 2000 to 2019. High (low) cash flow (dividend) are firms above (below) the median in *Cash Flow*$_i$ (*Dividend*$_i$) within a given country. Large (small) assets are firms above the median in *Total assets*$_i$ within a given country. *Cash Flow*$_i$, *Dividend*$_i$, and *Total assets*$_i$ are averaged over all sample years for each firm. All regressions include firm, industry-year, and country-year fixed effects and the following country-year interactions with EFD_j: corporate tax rate, top personal tax rate, R&D tax credits, GDP per capita (in logs), and the real GDP growth rate. All columns include the following firm control variables: *Cash Flow*$_{i,t}$, *Sales growth*$_{i,t}$, *Total debt*$_{i,t-1}$, *Cash holdings*$_{i,t-1}$, ln(*Total assets*$_{i,t}$), and $Q_{i,t}$. Columns (4) and (5) include the same control variables except for *Cash Flow*$_{i,t}$; columns (8) and (9) include the same control variables except for ln(*Total assets*$_{i,t}$). The difference (low – high) test is a two-sided Wald test of coefficient equality for the triple interaction term for each firm-level sort. Detailed variable definitions and summary statistics are provided in Table 1 and Table A.1. The standard errors are clustered at the country level.

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

digit Standard Industrial Classification (SIC) code industries: 28, 35, 36, or 48.

In the first column in Table 6, we estimate a version of Equation (1) with only the *DivTax* × *HRD* interaction. The estimated coefficient is close to zero and far from statistically significant, indicating no differential effect of changes in dividend taxes across more or less R&D-intensive sectors. In column (2), we include the *DivTax* × *EFD* interaction, and we continue to find a strong negative differential effect of dividend taxes in external finance–dependent industries, but no effect across more and less R&D-intensive industries.

In column (3) of Table 6, we also include the triple interaction *DivTax* × *HRD* × *EFD*. The coefficient on the *DivTax* × *EFD* interaction term remains negative but is much smaller in magnitude and statistically insignificant, whereas the triple interaction term is negative and statistically significant. This result shows that the negative differential effect of dividend taxes on R&D in high-*EFD* industries is driven by firms located in the most R&D-intensive sectors of the economy.

In columns (4)–(9), we report separate results for the sample splits based on firm-level cash flow, dividends, and total assets. As with our other findings, the effect is stronger (economically and statistically) in the low-cash-flow, low-dividend, and small firms. Given the importance of small R&D-intensive firms for innovation and growth, particularly in key high-tech sectors in the economy (see e.g., Brown et al. 2013, 2017a, b), this evidence not only pins down the financing R&D mechanism, but also suggests that this mechanism is economically meaningful.

7.3. Stock Market Development

In Table 7, we explore whether the connection between dividend taxes and R&D is stronger in countries with more developed equity markets. This test follows from the evidence in Figure 1 showing more dependence on stock issues in countries with deeper stock markets. We take the (cross-sectional) measure of equity (*MCAP*) market development at the start of our sample period from La Porta et al. (2008).

We start in column (1) by augmenting Equation (1) with the triple interaction between *DivTax*, *EFD*, and *MCAP*. Note that the two-way interaction between *DivTax* and *MCAP* is absorbed by the country-year fixed effects and thus not included in the specification. The coefficient on the *DivTax* × *EFD* term is negative

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Table 7. Dividend Taxes and R&D Investment: Stock Market Development

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Explanatory variable	All	High cash flow	Low cash flow	High dividend	Low dividend	Large assts	Small assets
$DivTax_{c,t-1} \times EFD_j$	−0.340***	0.023	−0.674***	0.002	−0.443***	−0.013	−0.547***
	(0.090)	(0.102)	(0.113)	(0.098)	(0.127)	(0.072)	(0.117)
$DivTax_{c,t-1} \times EFD_j \times MCAP_c$	−0.358*	0.389*	−1.202**	0.210*	−0.740*	0.552***	−1.055***
	(0.183)	(0.221)	(0.425)	(0.112)	(0.376)	(0.193)	(0.324)
Difference (low – high)			−1.591***		−0.950**		−1.607***
(p-value)			(0.001)		(0.015)		(0.000)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	113,564	59,144	54,308	57,546	55,894	58,833	54,636
Adjusted R^2	0.720	0.760	0.684	0.706	0.693	0.752	0.691

Notes. The table reports OLS estimates of Equation (1) with $R\&D_{i,t}$ as the dependent variable. $DivTax_{c,t-1}$ is the dividend tax rate, $MCAP_c$ is stock market capitalization to GDP averaged over 1999–2003 (taken from La Porta et al. 2008), and EFD_j measures each industry's external finance dependence as the ratio of total investment minus internally generated cash flow to assets for the median U.S. firm in a given industry over the 1990–1999 period. The firm-level data are from Compustat, and the country-level variables are from the OECD. The sample period is 2000 to 2019. High (low) cash flow (dividend) are firms above (below) the median in *Cash Flow*$_i$ (*Dividend*$_i$) within a given country. Large (small) assets are firms above the median in *Total assets*$_i$ within a given country. *Cash Flow*$_i$, *Dividend*$_i$, and *Total assets*$_i$ are averaged over all sample years for each firm. All regressions include firm, industry-year, and country-year fixed effects and the following country-year interactions with EFD_j: corporate tax rate, top personal tax rate, R&D tax credits, GDP per capita (in logs) and the real GDP growth rate. All columns include the following firm control variables: *Cash Flow*$_{i,t}$, *Sales growth*$_{i,t}$, *Total debt*$_{i,t-1}$, *Cash holdings*$_{i,t-1}$, ln(*Total assets*$_{i,t}$), and $Q_{i,t}$. Columns (2) and (3) include the same control variables except for *Cash Flow*$_{i,t}$; columns (6) and (7) include the same control variables except for ln(*Total assets*$_{i,t}$). The difference (low – high) test is a two-sided Wald test of coefficient equality for the triple interaction term for each firm-level sort. Detailed variable definitions and summary statistics are provided in Table 1 and Table A.1. The standard errors are clustered at the country level.

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

and statistically significant, consistent with our baseline results. The triple interaction is also negative and significant, showing that the negative (differential) link between dividend taxes and R&D is even stronger in countries with more developed equity markets. The results in columns (2)–(7) show that the amplifying effect of stock market development robustly appears only in the traditional view firms more likely to rely on external equity at the margin (i.e., low-cash-flow, low-dividend, and small firms).

7.4. Fixed Investment

In Table 8, we report results with fixed capital investment as the dependent variable. As discussed earlier, if tangible investments are less equity dependent at the margin, then physical investment will be less sensitive than R&D to changes in dividend tax rates. Moreover, sharp differences in the effects of dividend taxes across different types of investment help rule out alternative explanations for the strong effects on R&D we have documented, as these alternatives would also have to apply only to one type of investment activity.

In the first column in Table 8, we report results for fixed investment using the baseline R&D sample. The key interaction term is positive but small and statistically insignificant. In column (2), we expand the sample to include all firms with at least three nonmissing fixed investment observations. This fixed investment sample includes firms that never report R&D spending and is roughly twice as large as our main sample. The coefficient on the interaction term is positive and statistically significant, suggesting that lower dividend taxes are associated with slightly *less* fixed investment in external finance–dependent sectors. In the remainder of Table 8, we report results for the various firm splits using the full fixed investment sample. The coefficient estimates on the interaction term are small and (typically) statistically insignificant, and, in sharp contrast to R&D, there are no significant differences across the subsamples.

Table A.5 estimates the fixed investment regression using different measures of industry external finance dependence. For the alternative measures of external finance and stock issue dependence (columns (1)–(5)), the key interaction term is small and typically *positive*, which differs sharply from our findings for R&D but is consistent with the results in the first two columns of Table 8. In column (6), the interaction is negative and statistically significant, also indicating *less* fixed investment in industries with more internal cash flow (higher external finance dependence). The only result that suggests a potential financing fixed investment mechanism is the result in column (7), which shows a positive interaction between firm-level cash flow and

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Table 8. Dividend Taxes and Fixed Investment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	All	High cash flow	Low cash flow	High dividend	Low dividend	Large assets	Small assets
Explanatory variable	Main	Fixed investment sample						
$DivTax_{c,t-1} \times EFD_j$	0.040	0.092**	0.099**	−0.008	0.055	0.121*	0.041	0.118**
	(0.033)	(0.044)	(0.047)	(0.050)	(0.054)	(0.067)	(0.060)	(0.045)
Difference (low – high)				−0.107		0.066		0.077
(p-value)				(0.115)		(0.441)		(0.306)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	112,635	214,661	112,317	102,383	115,744	98,904	114,788	99,845
Adjusted R^2	0.432	0.517	0.593	0.447	0.530	0.506	0.604	0.435

Notes. The table reports OLS estimates of Equation (1) with $Fixed\ Investment_{i,t}$ as the dependent variable. $DivTax_{c,t-1}$ is the dividend tax rate, and EFD_j measures each industry's external finance dependence as the ratio of total investment minus internally generated cash flow to assets for the median U.S. firm in a given industry over the 1990–1999 period. The firm-level data are from Compustat, and the country-level variables are from the OECD. The sample period is 2000 to 2019. The sample in column(s) (1) ((2)–(8)) requires a firm to have at least three nonmissing R&D (fixed investment) observations. High (low) cash flow (dividend) are firms above (below) the median in $Cash\ Flow_i$ ($Dividend_i$) within a given country. Large (small) assets are firms above the median in $Total\ assets_i$ within a given country. $Cash\ Flow_i$, $Dividend_i$, and $Total\ assets_i$ are averaged over all sample years for each firm. All regressions include firm, industry-year, and country-year fixed effects and the following country-year interactions with EFD_j: corporate tax rate, top personal tax rate, R&D tax credits, GDP per capita (in logs), and the real GDP growth rate. All columns include the following firm control variables: $Cash\ flow_{i,t}$, $Sales\ growth_{i,t}$, $Total\ debt_{i,t-1}$, $Cash\ holdings_{i,t-1}$, ln($Total\ assets_{i,t}$), and $Q_{i,t}$. Columns (3) and (4) exclude the cash-flow control. Columns (7) and (8) include the same control variables except for ln($Total\ assets_{i,t}$). "Main" refers to the main sample used in this study with a firm-level requirement of at least three nonmissing R&D observations. "Fixed investment sample" is a sample with a firm-level requirement of at least three nonmissing capital expenditures observations; the $Cash\ flow_{i,t}$ control and sample splits in the fixed investment sample set any missing R&D values to zero. The difference (low – high) test is a two-sided Wald test of coefficient equality for each firm-level sort. Detailed variable definitions and summary statistics are provided in Table 1 and Table A.1. The standard errors are clustered at the country level.

** and * indicate significance at the 5% and 10% levels, respectively.

the dividend tax rate (consistent with Becker et al. 2013). Overall, the findings for fixed investment are weak and inconsistent and suggest little or no relation between dividend taxes and firm fixed investment in the broad international panel we study.

8. Dividend Taxes and Stock Issues

A necessary condition for the financing R&D mechanism is that dividend tax rates impact the actual use of external equity financing. In Table 9, we report estimates of Equation (1) with firm-level stock issues as the dependent variable. In the full sample (column (1)), the coefficient on the $DivTax \times EFD$ interaction term is negative and significant at the 10% level. This result is consistent with main finding for R&D, indicating that lower dividend taxes are associated with a differential increase in stock issues in industries with high EFD.

In columns (2)–(7), we provide subsample estimates for the different firm-level proxies for the need for external finance. In each case, we find a large negative coefficient on the key interaction term in the subset of firms that should (ex ante) depend most on external financing (the coefficient in the small firm subsample is noisy and not statistically significant at conventional levels). These results show that dividend taxes affect the actual use of stock issues in the firms that rely most on external financing and should be most responsive to changes in the marginal cost of issuing external equity capital.

9. Economic Magnitudes

Table 10 summarizes the economic significance of our main difference-in-differences estimates. We quantify our estimates following the approach in Rajan and Zingales (1998). Specifically, we consider how a cut in the country dividend tax rate equivalent to a move from the 75th to the 25th percentile of $DivTax$ (approximately 10 percentage points) affects the *difference* in the financing or investment outcome of interest between industries at the 75th and 25th percentiles of EFD. We then evaluate the magnitude of this differential effect relative to the sample average level of the outcome variable.

We report economic magnitudes for the alternative outcome variables and various subsamples we study. Across the top of Table 10, we report estimated magnitudes for three outcome variables: R&D (columns (1)–(3)), fixed investment (column (4)), and stock issues

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Table 9. Dividend Taxes and Stock Issues

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Explanatory variable	All	High cash flow	Low cash flow	High dividend	Low dividend	Large assets	Small assets
$DivTax_{c,t-1} \times EFD_j$	−0.803*	0.156	−2.886***	0.059	−1.490*	−0.203	−1.135
	(0.448)	(0.284)	(0.821)	(0.203)	(0.715)	(0.184)	(0.810)
Difference (low – high)			−3.042***		−1.549**		−0.932
(p-value)			(0.000)		(0.037)		(0.261)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	113,564	59,144	54,308	57,546	55,894	58,833	54,636
Adjusted R^2	0.458	0.260	0.368	0.312	0.439	0.263	0.443

Notes. The table reports OLS estimates with *Stock Issues*$_{i,t}$ as the dependent variable. $DivTax_{c,t-1}$ is the dividend tax rate, and EFD_j measures each industry's external finance dependence as the ratio of total investment minus internally generated cash flow to assets for the median U.S. firm in a given industry over the 1990–1999 period. The firm-level data are from Compustat, and the country-level variables are from the OECD. The sample period is 2000 to 2019. High (low) cash flow (dividend) are firms above (below) the median in *Cash Flow*$_i$ (*Dividend*$_i$) within a given country. Large (small) assets are firms above the median in *Total assets*$_i$ within a given country. *Cash Flow*$_i$, *Dividend*$_i$, and *Total assets*$_i$ are averaged over all sample years for each firm. All regressions include firm, industry-year, and country-year fixed effects and the following country-year interactions with EFD_j: corporate tax rate, top personal tax rate, R&D tax credits, GDP per capita (in logs), and the real GDP growth rate. All columns include the following firm control variables: *Cash Flow*$_{i,t}$, *Sales growth*$_{i,t}$, *Total debt*$_{i,t-1}$, *Cash holdings*$_{i,t-1}$, ln(*Total assets*$_{i,t}$), and $Q_{i,t}$. Columns (2) and (3) include the same control variables except for *Cash Flow*$_{i,t}$; columns (6) and (7) include the same control variables except for ln(*Total assets*$_{i,t}$). The difference (low – high) test is a two-sided Wald test of coefficient equality for each firm-level sort. Detailed variable definitions and summary statistics are provided in Table 1 and Table A.1. The standard errors are clustered at the country level.

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

(column (5)). Moving down each row, we quantify the effects for the full sample, high- and low-cash-flow firms, high- and low-dividend firms, and firms with large/small total assets.

Focusing on the full sample of firms (top row of the table), our empirical estimate from column (5) in Table 3 suggests that a 10-percentage-point cut in the dividend tax rate is associated with a differential increase in R&D that amounts to just under 4% of the sample average R&D value. The results in columns (2) and (3) show that this R&D response is driven entirely by the high-R&D sectors: the magnitude of the differential effect in high-R&D (low-R&D) sectors is 4.48% (0.51%). Column (4) shows that the *negative* response we document for fixed investment is small in magnitude (−1.48%). Column (5) shows that the magnitude of the (differential) increase in stock issues is around 7% of the sample average.

Table 10. Economic Magnitudes

	(1)	(2)	(3)	(4)	(5)
	R&D			Fixed inv.	Stock issues
Sample	All firms (%)	High-R&D sectors (%)	Low-R&D sectors (%)	All firms (%)	All firms (%)
All firms	3.54	4.48	0.51	−1.48	6.95
High-cash-flow firms	0.16	0.09	0.00	−1.59	−1.35
Low-cash-flow firms	8.55	10.21	3.63	0.13	24.98
High-dividend firms	0.34	0.06	0.79	−0.88	−0.51
Low-dividend firms	5.66	6.94	0.30	−1.94	12.90
Large firms	0.65	0.31	1.50	−0.66	1.76
Small firms	6.34	8.67	−0.69	−1.89	9.82

Notes. The table reports the economic magnitudes for *R&D* across all sectors in column (1) (based on the estimation results in Table 3 (column (5)) and in Table 5), for *R&D* in high- and low-R&D sectors in columns (2) and (3) (based on the estimation results in Table 6), for *Fixed investment* in column (4) (based on the estimation results from columns (2)–(8) in Table 8), and for *Stock issues* in column (5) (based on the estimation results in Table 9). Each value is measured as the predicted difference in the outcome variable for a firm located in an industry at the 75th percentile (*EFD*: 0.074) in the level of *EFD* compared with in an industry at the 25th percentile (*EFD*: −0.007) if a country decreases *DivTax* from a level equivalent to the 75th percentile (*DivTax*: 0.306) to the 25th percentile (*DivTax*: 0.197). This predicted differential is expressed relative to the sample mean in the outcome variable.

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The remaining six rows evaluate the economic magnitude across firms more or less likely (ex ante) to depend on external equity at the margin. For both stock issues and R&D, the economic magnitude of the differential effect in low-cash-flow, low-dividend, and small firms is substantial. For example, a 10-percentage-point cut in the dividend tax rate is associated with a differential increase in R&D in small firms that amounts to 6.34% of the sample average R&D value (8.67% if we focus only on high-R&D sectors). The corresponding value for stock issues in small firms is 9.82%. Beyond demonstrating economic importance, these results also help pinpoint where in the economy dividend tax reform is likely to have the strongest effect on R&D: equity-dependent firms in R&D-intensive industries.

10. Conclusions

We document an economically important negative relation between dividend taxes and corporate investment in R&D. Our analysis is based on two main ideas: (i) taxing corporate payouts raises the cost of capital for firms that depend on external equity at the margin, and (ii) R&D should be particularly sensitive to the equity-financing distortion that results from payout taxation because firms cannot perfectly substitute debt for (costly) external equity when financing risky, intangible activities.

Using a broad cross-country firm-level panel, we find strong evidence that higher taxes on dividends have a negative impact on firm stock issues and corporate R&D spending. Moreover, we find these effects are concentrated in the firms most dependent on external equity at the margin: small, low-cash-flow, and low-payout firms in more R&D-intensive industries. These findings support the traditional view idea that payout taxation affects the real economy by changing the availability of external equity financing.

A key implication of our study is that focusing only on investment in physical assets and/or relying solely on samples of cash-rich firms can understate (or miss entirely) the real effects of taxing capital income. R&D is of interest not only because it is equity dependent in nature, but also because it is a critical driver of innovation, creative destruction, and technological change in modern economies (e.g., Aghion and Howitt 1992). Thus, the negative association between dividend taxes and R&D investment that we document suggests taxes on capital income have broad economic implications. A logical extension of our work is to directly explore how dividend taxation affects longer-run economic outcomes, such as patenting activity and total factor productivity growth.

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Appendix

This appendix collects supplementary material referenced in the main text. Table A.1 provides detailed definitions and data sources for all variables used in the study. Table A.2 reports estimates of the baseline R&D specification using alternative industry- and firm-level measures of external finance dependence, and Table A.3 augments the baseline specification with alternative firm- and industry-level mechanisms. Table A.4 presents robustness tests based on alternative samples and alternative transformations of the R&D variable. Finally, Table A.5 re-estimates the fixed investment specification using the alternative measures of external finance dependence.

Table A.1. Description of Variables

Variable name	Description
Firm-level variables	
R&D	Research and development expenditures (xrd) normalized by lagged book value of total assets (at). Winsorized at 1%. Source: Compustat.
Cash flow	Internal cash flow before spending on R&D and fixed investment (ib + dp + xrd) normalized by lagged book value of total assets (at). Winsorized at 1%. Source: Compustat.
Sales growth	Annual change in log sales (sale). Values are converted into 2015 U.S. dollars. Winsorized at 1%. Source: Compustat.
Total debt	Total debt (dltt + dlc) divided by book value of total assets (at). Winsorized at 1% Source: Compustat.
Cash holdings	Cash holdings and short-term investments (che) normalized by lagged book value of total assets (at). Winsorized at 1%. Source: Compustat.
ln(*Total assets*)	Natural logarithm of total assets (at). Values are converted into 2015 U.S. dollars. Winsorized at 1%. Source: Compustat.
Q	Tobin's Q. Market value of assets (cshoi * prccd + at − ceq) normalized by book value of assets (at). Winsorized at 1%. Source: Compustat.

Table A.1. (Continued)

Variable name	Description
Stock issues	Gross stock issues minus stock repurchases and dividends (sstk − prstkc − dvc) normalized by lagged book value of total assets (at). Winsorized at 1%. Source: Compustat.
Fixed investment	Capital expenditures (capx) normalized by lagged book value of total assets (at). Winsorized at 1%. Source: Compustat.
Cash flow	Internal cash flow net of R&D spending (ib + dp) normalized by lagged book value of total assets (at). Winsorized at 1%. Source: Compustat.
IFRS	Indicator variable equal to one if the firm-year reports under IFRS (acctstd = "DI") Source: Compustat.
$R\&D_{inv}$	Research and development expenditures (xrd) normalized by the sum of research and development expenditures (xrd) and capital expenditures (capx). Winsorized at 1%. Source: Compustat.
$R\&D_{sales}$	Research and development expenditures (xrd) normalized by net sales (sale). Winsorized at 1%. Source: Compustat.
Industry-level variables	
EFD	External finance dependence (*EFD*) is the ratio of total investment (R&D plus capital expenditures) minus internally generated cash flow to assets for the median U.S. firm in a given industry. Total investment (capx + xrd), cash flow (ib + dp + xrd) and assets (at) are summed over the period 1990–1999 prior to computing the ratio. Source: Compustat.
EFD 2000s	External finance dependence over the 2000s (*EFD 2000s*) is the ratio of total investment (R&D plus capital expenditures) minus internally generated cash flow to assets for the median U.S. firm in a given industry. Total investment (capx + xrd), cash flow (ib + dp + xrd), and assets (at) are summed over the period 2000–2019 prior to computing the ratio. Source: Compustat.
EFD Global	External finance dependence (*EFD Global*) based on non-U.S. firms in Compustat Global. It is the ratio of total investment (R&D plus capital expenditures) minus internally generated cash flow to assets for the median global firm in a given three-digit SIC industry. Total investment (capx + xrd), cash flow (ib + dp + xrd) and assets (at) are summed over the period 2000–2019 prior to computing the ratio. Source: Compustat.
EFD_{firm}	External finance dependence EFD_{firm} is the ratio of total investment (R&D plus capital expenditures) minus internally generated cash flow to assets for each firm in the sample. Total investment (capx + xrd), cash flow (ib + dp + xrd) and assets (at) over the sample period prior to computing the ratio. Source: Compustat.
STKD	Stock issues dependence (*STKD*) is the ratio of net stock issues to assets for the median U.S. firm in a given industry, where net stock issues is equal to gross stock issues minus stock buybacks. Both net stock issues (sstk − prstkc) and assets (at) are summed over the period 1990–1999 prior to computing the ratio. Source: Compustat.
$STKD_{firm}$	Stock issues dependence $STKD_{firm}$ is the ratio of net stock issues to assets for each firm in the sample, where net stock issues is equal to gross stock issues minus stock buybacks. Both net stock (sstk − prstkc) and assets (at) are summed over the sample period prior to computing the ratio. Source: Compustat.
ICF	Internal cash flow (*ICF*) is the ratio of cash flows to assets for the median U.S. firm in a given industry. Cash flow (ib + dp + xrd) and assets (at) are summed over the period 1990–1999 prior to computing the ratio. Source: Compustat.
ICF_{firm}	Internal cash flow ICF_{firm} is the ratio of cash flows to assets for each firm in the sample. Cash flow (ib + dp + xrd) and assets (at) are summed over the sample period prior to computing the ratio. Source: Compustat.
$NICF_{firm}$	Internal cash flow $NICF_{firm}$ is the ratio of cash flows to assets for each firm in the fixed investment sample. Missing R&D is set to zero, and cash flow (ib + dp + xrd) and assets (at) are summed over the sample period prior to computing the ratio. Source: Compustat.
HRD	High-R&D sector is an indicator variable equal to one if the firm operates in a two-digit SIC industry with code 28, 35, 36, or 48 and zero otherwise. Source: Compustat.
Ind gwth	Industry sales growth is the median value in *Sales growth* by industry and year. Source: Compustat and authors' own calculations.
Agency	Agency is the industry-level insider ownership rate, measured as the number of shares held by insiders as a percent of total shares outstanding. Insider ownership is measured across U.S. industries in 2000 and mapped to SIC codes. Source: Data Archives on Damodaran Online: "Insider and Institutional Holdings by Industry Sector" (inshold00) and authors' own calculations.
Country-level variables	
DivTax	Personal income tax rates on dividend income. Source: OECD Data Explorer.
PersTax	Top statutory personal income tax rate. Source: OECD Data Explorer.
CorpTax	Corporate income tax rate on profit. Source: OECD Data Explorer.
RD Credit	The implied tax subsidy rates on R&D expenditures for large firms, and is defined as one minus the B-index, a measure of the before-tax income needed by a "representative" firm to break even on USD 1 of R&D outlays. Source: OECD Data Explorer.
GDPCAP	The natural logarithm of GDP per capita (converted into 2015 U.S. dollars). Source: World Bank Development Indicators.
Gwth Real GDP	Growth rate total economy GDP (period on period, chain linked volume, calendar and seasonally adjusted). Source: OECD Data Explorer.

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Table A.1. (Continued)

Variable name	Description
MCAP	Ratio of stock market capitalization to GDP, averaged over 1999–2003. From World Development Indicators. Source: La Porta et al. (2008).
Event	Event is an indicator variable that starts at zero and increases (decreases) by one unit in the year of a major dividend tax increase (cut). Major dividend tax reforms are changes in the dividend tax rate (*DivTax*) of at least five percentage points that are not reversed within the three years before or after the reform. Source: OECD and authors' own calculations.
$Before^{t-2}$	$Before^{t-2}$ is an indicator variable equal to one two years before a major dividend tax reform and zero otherwise. Source: OECD and authors' own calculations.
$Before^{t-1}$	$Before^{t-1}$ is an indicator variable equal to one in the year before a major dividend tax reform and zero otherwise. Source: OECD and authors' own calculations.
$After^{t\ to\ t+1}$	$After^{t\ to\ t+1}$ is an indicator variable equal to one in the year of a major dividend tax reform and the year after the reform and zero otherwise. Source: OECD and authors' own calculations.
$After^{t+2\ to\ t+3}$	$After^{t+2\ to\ t+3}$ is an indicator variable equal to one two and three years after a major dividend tax reform, and zero otherwise. Source: OECD and authors' own calculations.
Tax Increase	*Tax Increase* is an indicator variable equal to one in the year of a large dividend tax increase and the three years after the increase and zero otherwise. Source: OECD and authors' own calculations.
Tax Decrease	*Tax Decrease* is an indicator variable equal to one in the year of a large dividend tax decrease and the three years after the decrease and zero otherwise. Source: OECD and authors' own calculations.

Notes. The table provides the definition and source for each variable used in the study. For variables constructed from Compustat data, we report the Compustat variable names in parentheses.

Table A.2. Alternative Measures of External Finance Dependence

Explanatory variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$DivTax_{c,t-1} \times EFD\ 2000s_j$	−0.234***						
	(0.046)						
$DivTax_{c,t-1} \times EFD\ Global_j$		−0.480***					
		(0.103)					
$DivTax_{c,t-1} \times EFD_{firm}$			−0.296**				
			(0.129)				
$DivTax_{c,t-1} \times STKD_j$				−0.215***			
				(0.054)			
$DivTax_{c,t-1} \times STKD_{firm}$					−0.587***		
					(0.134)		
$DivTax_{c,t-1} \times ICF_j$						0.318***	
						(0.066)	
$DivTax_{c,t-1} \times ICF_{firm}$							0.352**
							(0.132)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	106,517	113,808	113,827	113,564	113,827	113,564	113,827
Adjusted R^2	0.718	0.720	0.720	0.720	0.720	0.720	0.706

Notes. The table reports OLS estimates of Equation (1) with $R\&D_{i,t}$ as the dependent variable. All regressions include firm, industry-year, and country-year fixed effects and the following country-year interactions with EFD_j: corporate tax rate, top personal tax rate, R&D tax credits, GDP per capita (in logs), and the real GDP growth rate. All columns include the following firm control variables: $Cash\ Flow_{i,t}$, $Sales\ growth_{i,t}$, $Total\ debt_{i,t-1}$, $Cash\ holdings_{i,t-1}$, ln($Total\ assets_{i,t}$), and $Q_{i,t}$. Variable $DivTax_{c,t-1}$ is the dividend tax rate. $EFD\ 2000s_j$ measures each industry's external finance dependence as the ratio of total investment minus internally generated cash flow to assets for the median U.S. firm in a given industry over the 2000–2009 period. $EFD\ Global_j$ measures each industry's external finance dependence as the ratio of total investment minus internally generated cash flow to assets for the median non-U.S. firm in a given industry over the 2000–2009 period. EFD_{firm} measures external finance dependence as the ratio of total investment minus internally generated cash flow to assets for each sample firm. $STKD_j$ measures the ratio of net stock issues to assets for the median U.S. firm in a given industry, where net stock issues is equal to gross stock issues minus stock buybacks and dividends over the 1990–1999 period. $STKD_{firm}$ measures the ratio of net stock issues to assets for each sample firm. ICF_j measures the ratio of cash flows to assets for the median U.S. firm in a given industry. ICF_{firm} measures the ratio of cash flows to assets for each sample firm. The firm-level data are from Compustat, and the country-level variables are from the OECD. The sample period is 2000 to 2019. Detailed variable definitions and summary statistics are provided in Table 1 and Table A.1. The standard errors are clustered at the country level.

*** and ** indicate significance at the 1% and 5% levels, respectively.

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Table A.3. Alternative Mechanisms

	(1)	(2)	(3)	(4)	(5)	(6)
Explanatory variable	*Ind gwth*	*Firm gwth*	*Firm Q*	*Leverage*	*IFRS*	*Agency*
$DivTax_{c,t-1} \times EFD_j$	−0.320***	−0.304***	−0.253***	−0.334***	−0.421***	−0.389***
	(0.071)	(0.065)	(0.080)	(0.066)	(0.087)	(0.086)
$DivTax_{c,t-1} \times$	−0.027	0.004	0.000	−0.015	−0.021	0.017
$Characteristic_{i,t-1}$	(0.021)	(0.012)	(0.005)	(0.013)	(0.048)	(0.048)
$Characteristic_{i,t-1} \times$		−0.016	0.019***	0.066***	0.120	
EFD_j		(0.012)	(0.002)	(0.014)	(0.075)	
$Characteristic_{i,t-1}$		0.005**	0.011***	0.005	0.000	
		(0.002)	(0.002)	(0.004)	(0.012)	
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × year effects	Yes	Yes	Yes	Yes	Yes	Yes
Country interactions	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	113,564	113,147	111,423	113,564	113,564	92,585
Adjusted R^2	0.720	0.715	0.746	0.720	0.720	0.727

Notes. The table reports OLS estimates of Equation (1) with $R\&D_{i,t}$ as the dependent variable. All regressions include firm, industry-year, and country-year fixed effects and the following country-year interactions with EFD_j: corporate tax rate, top personal tax rate, R&D tax credits, GDP per capita (in logs), and the real GDP growth rate. All columns include the following firm control variables: $Cash\ Flow_{i,t}$, $Sales\ growth_{i,t}$, $Total\ debt_{i,t-1}$, $Cash\ holdings_{i,t-1}$, ln($Total\ assets_{i,t}$), and $Q_{i,t}$. Variable $DivTax_{c,t-1}$ is the dividend tax rate. EFD_j measures each industry's external finance dependence as the ratio of total investment minus internally generated cash flow to assets for the median U.S. firm in a given industry over the 1990–1999 period. The *Characteristics* in columns (1)–(6) are industry sales growth (*Ind gwth*), firm sales growth (*Firm gwth*), firm-level Tobin's *Q* (*Firm Q*), firm debt to assets (*Leverage*), an indicator variable taking on the value one if the firm-year reports under IFRS standards and zero otherwise (*IFRS*), and the industry-level insider ownership measured as number of shares held by insiders as a percent of total stock outstanding for U.S. corporations in 2000 (*Agency*). The firm-level data are from Compustat, and the country-level variables are from the OECD. The sample period is 2000 to 2019. Detailed variable definitions and summary statistics are provided in Table 1 and Table A.1. The standard errors are clustered at the country level.

*** and ** indicate significance at the 1% and 5% levels, respectively.

Table A.4. Robustness: Alternative Samples and Dependent Variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Explanatory variable	No U.S. or Japan	Missing R&D = 0	Log(*R&D*)	$R\&D_{inv}$	Log($R\&D_{inv}$)	$R\&D_{sales}$	Log($R\&D_{sales}$)
$DivTax_{c,t-1} \times EFD_j$	−0.674***	−0.116**	−0.344***	−0.359**	−0.318**	−7.308*	−0.871*
	(0.175)	(0.048)	(0.070)	(0.139)	(0.127)	(4.126)	(0.440)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	38,323	215,625	113,564	112,332	112,332	113,564	113,564
Adjusted R^2	0.679	0.747	0.681	0.850	0.850	0.605	0.769

Notes. The table reports OLS estimates of Equation (1) with $R\&D_{i,t}$ as the dependent variable in columns (1) and (2), with the inverse hyperbolic sine transformed $R\&D_{i,t}$ in logs as the dependent variable in column (3), with R&D to total investment ($R\&D_{inv}$) as the dependent variable in column (4), with the inverse hyperbolic sine transformed $R\&D_{inv}$ in logs as the dependent variable in column (5), with R&D to sales ($R\&D_{sales}$) as the dependent variable in column (6), and with the inverse hyperbolic sine transformed $R\&D_{sales}$ in logs as the dependent variable in column (7). All regressions include firm, industry-year, and country-year fixed effects and the following country-year interactions with EFD_j: corporate tax rate, top personal tax rate, R&D tax credits, GDP per capita (in logs), and the real GDP growth rate. All columns include the following firm control variables: $Cash\ Flow_{i,t}$, $Sales\ growth_{i,t}$, $Total\ debt_{i,t-1}$, $Cash\ holdings_{i,t-1}$, ln($Total\ assets_{i,t}$), and $Q_{i,t}$. Variable $DivTax_{c,t-1}$ is the dividend tax rate, and EFD_j measures each industry's external finance dependence as the ratio of total investment minus internally generated cash flow to assets for the median U.S. firm in a given industry over the 1990–1999 period. The firm-level data are from Compustat, and the country-level variables are from the OECD. The sample period is 2000 to 2019. Detailed variable definitions and summary statistics are provided in Table 1 and Table A.1. The standard errors are clustered at the country level.

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

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Table A.5. Fixed Investment: Alternative Measures of External Finance Dependence

Explanatory variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$DivTax_{c,t-1} \times EFD\ 2000s_j$	0.053*						
	(0.030)						
$DivTax_{c,t-1} \times EFD\ Global_j$		0.072					
		(0.098)					
$DivTax_{c,t-1} \times EFD_{firm}$			−0.018				
			(0.072)				
$DivTax_{c,t-1} \times STKD_j$				0.096***			
				(0.017)			
$DivTax_{c,t-1} \times STKD_{firm}$					0.066		
					(0.116)		
$DivTax_{c,t-1} \times ICF_j$						−0.101***	
						(0.028)	
$DivTax_{c,t-1} \times NICF_{firm}$							0.084
							(0.066)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	194,690	216,311	216,355	214,661	216,355	214,661	216,412
Adjusted R^2	0.518	0.516	0.516	0.517	0.516	0.517	0.511

Notes. The table reports OLS estimates of Equation (1) with *Fixed investment*$_{i,t}$ as the dependent variable. All regressions include firm, industry-year, and country-year fixed effects and the following country-year interactions with EFD_j: corporate tax rate, top personal tax rate, R&D tax credits, GDP per capita (in logs), and the real GDP growth rate. All columns include the following firm control variables: *Net cash Flow*$_{i,t}$, *Sales growth*$_{i,t}$, *Total debt*$_{i,t-1}$, *Cash holdings*$_{i,t-1}$, ln(*Total assets*$_{i,t}$), and $Q_{i,t}$. Variable $DivTax_{c,t-1}$ is the dividend tax rate. $EFD\ 2000s_j$ measures each industry's external finance dependence as the ratio of total investment minus internally generated cash flow to assets for the median U.S. firm in a given industry over the 2000–2009 period. $EFD\ Global_j$ measures each industry's external finance dependence as the ratio of total investment minus internally generated cash flow to assets for the median non-U.S. firm in a given industry over the 2000–2009 period. EFD_{firm} measures external finance dependence as the ratio of total investment minus internally generated cash flow to assets for each sample firm. $STKD_j$ measures the ratio of net stock issues to assets for the median U.S. firm in a given industry, where net stock issues is equal to gross stock issues minus stock buybacks over the 1990–1999 period. $STKD_{firm}$ measures the ratio of net stock issues to assets for each sample firm. ICF_j measures the ratio of cash flows to assets for the median U.S. firm in a given industry. $NICF_{firm}$ measures the ratio of net cash flows to assets for each sample firm. The firm-level data are from Compustat, and the country-level variables are from the OECD. The sample period is 2000 to 2019. Detailed variable definitions and summary statistics are provided in Table 1 and Table A.1. The standard errors are clustered at the country level.

*** and * indicate significance at the 1% and 10% levels, respectively.

Endnotes

[1] See Harberger (1966), Feldstein (1970), Feldstein (1973), Feldstein (1974), King (1977), Auerbach (1979), Poterba and Summers (1984), Poterba and Summers (1985), Fazzari and Herzon (1996), Auerbach (2002), Gentry et al. (2003), Auerbach and Hasset (2003), Auerbach and Hasset (2007), Desai and Goolsbee (2004), and Korinek and Stiglitz (2009).

[2] For example, whereas Yagan (2015) finds that the large 2003 dividend tax cut in the United States did not increase investment in physical capital, Moon (2022) documents significant increases in corporate capital spending following a unique capital gains tax reform in Korea. For evidence on the link between payout tax rates and capital structure decisions, see Chetty and Saez (2005), Lin and Flannery (2013), Jacob and Jacob (2013), and Faccio and Xu (2015).

[3] Isakov et al. (2021) study a sample of highly mature firms (average age in their sample is 77 years) that do not appear to invest much in R&D (the sample size declines by over 50% when they include R&D in the total investment variable). Together, this likely means there are very few firms in their sample that rely on external equity as the marginal source of funds for new investment.

[4] More broadly, whereas agency issues are typically more severe in cash rich firms (e.g., Jensen 1986), our findings are concentrated in low-cash firms that depend on external stock issues to fund investment.

[5] A related literature studies innovation outcomes, focusing specifically on patenting activity (e.g., Atanassov 2013, Bhattacharya et al. 2017, He and Tian 2018). We keep the focus in this paper on a specific microlevel channel linking payout taxes with real activity: the equity financing of corporate R&D spending.

[6] Our work focuses only on the R&D response to payout taxation, and thus does not address the full implications of capital tax reform. For example, Chetty and Saez (2005) discuss the distributional issues associated with adjusting capital income taxes.

[7] We are not suggesting that R&D is never financed with debt, or that innovation does not benefit from better access to debt financing. Indeed, several studies show that innovating firms with extensive intangible assets are often able to secure debt financing (e.g., Hochberg et al. 2018, Mann 2018), and Atanassov (2016) finds that innovation increases significantly after public offerings of both equity and (arm's-length) debt financing. For the mechanism we emphasize to be operational, all that is necessary is that at least in

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some firms, debt is not a perfect substitute for equity when it comes to funding R&D.

[8] The (expected) time horizon of the tax cut is important because R&D tends to be a long-term investment with high adjustment costs. The long-term nature of R&D should make it less sensitive to transitory changes in payout tax rates. We thank an anonymous referee for drawing our attention to this point.

[9] Numerous studies use Compustat Global for international data on firm fundamentals, including Pinkowitz et al. (2016), Azar et al. (2016), Augustin et al. (2020), Hung et al. (2022), Kuvshinov and Zimmermann (2022), and Hassan et al. (2024). As Pinkowitz et al. (2016) discuss, one advantage of using Compustat Global instead of an alternative source, such as Worldscope, is that the data are standardized and thus directly comparable to the data for U.S. firms in Compustat.

[10] Ideally, we would like to measure *EFD* at the most disaggregated industry grouping possible. The constraint is the need to have a sufficiently large number of firms in a given sector to get a reliable estimate of the industry median. We thus count the number of U.S. firms in each four-, three-, and two-digit SIC industry over 1990–1999 and estimate *EFD* at the four-digit SIC level if the four-digit industry has at least 100 firms; otherwise we use the three-digit industry if there are at least 50 remaining firms (not counting firms already in a four-digit industry with at least 100 firms); otherwise we use the two-digit SIC group if there are at least 10 remaining firms. We also report results with firm-specific measures of external finance dependence, which avoids the need to have a critical mass of firms to estimate industry *EFD*.

[11] These firm-level characteristics are positively correlated—that is, firms with low cash flow tend to pay out less in dividends—but sorting firms into subsamples based on these characteristics does not generate the same subsets of firms. The correlation coefficient between being in the low-cash-flow and low-dividend (small size) sample is only 0.178 (0.096).

[12] These benefits are discussed in Rajan and Zingales (1998, p. 560) and numerous subsequent studies. For example, also see Beck and Levine (2002), Claessens and Laeven (2003), Kroszner et al. (2007), Laeven and Valencia (2013), Roberts and Whited (2013), and Larrain and Stumpner (2017).

[13] We explored whether this baseline result varies based on economic conditions. Specifically, if we split the sample based on high and low GDP per capita, or high and low GDP growth, we find a significant negative coefficient on the key interaction term in all subsamples. These results are available on request.

[14] The number of observations reported in column (5) (113,564) differs slightly from the number of observations reported in the summary statistics and country characteristics tables (114,558) because we lose 994 observations because of the inclusion of the granular fixed effects.

[15] Theoretically, this differential increase in R&D spending could be caused by lower dividend taxes leading to (i) more R&D in high-*EFD* industries, (ii) less R&D in low-*EFD* industries, or (iii) some combination of the two. To shed some light on this, we estimated separate regressions for subsamples of firms in high- and low-*EFD* industries. Because these regressions necessarily focus on the *DivTax* level rather than the interaction term, we replace the country-year dummy variables with aggregate year dummy variables and a parsimonious set of time-varying country control variables (*PersTax*, *CorpTax*, *RD Credit*, *GDPCAP*, and *Gwth real GDP*; the same variables used for the interaction terms in Table 3). In the subsample of high-*EFD* industries, *DivTax* is significantly negatively related to firm R&D spending. In the subsample of low-*EFD* industries, the coefficient on *DivTax* is near zero and statistically insignificant. Thus, the negative differential effect we focus on appears to be driven almost entirely by the fact that high-*EFD* firms spend more (less) on R&D when *DivTax* declines (increases).

[16] We build these measures using the insider ownership rates across U.S. industries in 2000 from Aswath Damodaran's website (https://pages.stern.nyu.edu/~adamodar/). The insider ownership rate is the number of shares held by insiders (corporate officers, directors and those holding more than 5% of the outstanding stock) as a percent of the total stock outstanding. We map the values on Damodaran's website to SIC codes. We choose the United States as the base country because the industry insider ownership rates are based on more data than for other countries. This is also consistent with our approach for measuring cross-industry differences in *EFD*. We note that the measure of industry insider ownership we focus on (the United States in 2000) is highly positively correlated with the (limited) values we have from other countries, such as Japan.

[17] Focusing on reforms of at least five percentage points is somewhat arbitrary, but this approach leaves us with a set of events that are economically meaningful, uncontaminated by policy reversals, and expected to be long lasting. In addition, if we require at least a five-percentage-point change, then we end up with a sample of events that are often considerably larger than five percentage points (as such, all of our findings are similar if we focus on large changes of at least 10 percentage points). France has three consecutive increases in 2011–2013 (of 5.2, 3, and 5.5 percentage points, respectively). The results are unchanged if we do not include France. For the other countries the large changes vary from just above five percentage points for Canada in 2006 to over 30 in Japan in 2004. The massive dividend tax cut in Japan coincides with other tax changes, notably in our context, the introduction of a sizable R&D tax credit in 2003.

[18] Exploring the economic mechanism even further, it is the intersection between firm-level investment opportunities and external finance dependence that should determine how much a firm responds to changes in dividend taxes. Consistent with this idea, we find that the effects are driven by the subsample of firms with relatively high investment opportunities (based on Tobin's *Q*) and relatively low cash flow. We thank an anonymous referee for suggesting this test.

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